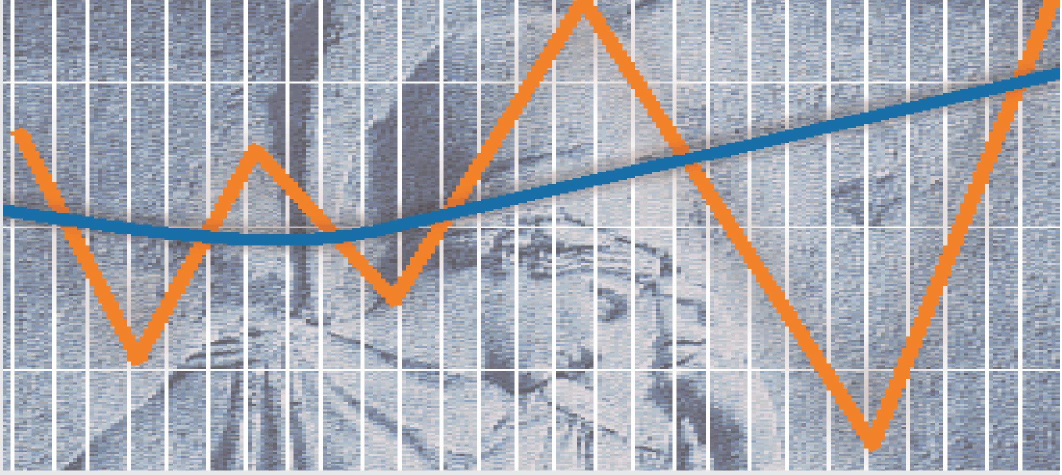

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The Collateral Policy of Central Banks – An Analysis Focusing on the Eurosystem

Christopher Weber

ifo Institut
Leibniz-Institut für Wirtschaftsforschung
an der Universität München e.V.

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Preface

This dissertation was written by Christopher Weber during his time as a research assistant at the Center for Economic Studies (CES) at the Ludwig-Maximilians-Universität (LMU) Munich. Parts of it originated during a research stay at the Bendheim Center for Finance at Princeton University in 2015. The dissertation was accepted as a doctoral thesis by the Department of Economics at the LMU Munich in November 2016. The goal of the thesis is to establish the configuration of collateral policy as a tool of central bank policies in pursuit of different objectives, and to present collateral policies in practice, as well as impact and effects of collateral policy.

The thesis comprises three parts, unifying nine chapters. Subsequent to an *introduction*, *Part I* discusses the role of collateral in central bank policy and comprises two chapters. In *Chapter 1*, possible tasks and objectives of central banks are historically deduced and subsumed as fiscal and economic stability, monetary stability, financial stability and financial soundness. The roles that central banks take during crises threatening their objectives to preserve the respective stability are defined as custodian of the monetary policy rule (COMPR), lender of last resort (LOLR) and market-maker of last resort (MMOLR). Furthermore, an interdependence between crisis origin and objective shifts is explained. *Chapter 2* defines six dimensions of collateral policy and integrates it into the system of central bank objectives. Thus, a normative framework for the role of collateral policy is developed.

In *Part II*, practical collateral policy measures are presented along the lines of this framework. The focus is placed upon the collateral policy of the Eurosystem. However, as a first step, *Chapter 3* delves into historical predecessors in collateral policy and analyzes examples of collateral policy conduction by central banks from the middle of the 18th century to the end of the 20th century. Relevant findings from the perspective of the Eurosystem are extracted. *Chapter 4* is at the heart of the analysis in this dissertation, presenting the collateral policy of the Eurosystem in detail. Narrative databases containing the development of the Eurosystem's collateral criteria and the haircut specification from 2001 until the end of 2014 are compiled such that the configuration of the Eurosystem's collateral framework is comprehensively exposed. In addition, a descriptive analysis of the development of the Eurosystem's eligible collateral pool is complemented. The collateral policy of the Federal Reserve System, the Bank of England and the Bank of Japan during the recent crisis years is described in *Chapter 5* and analyzed with respect to both the normative framework developed in Part I and in comparison to the Eurosystem's practice.

Part III starts with a theoretical foundation of the impact and transmission processes of collateral policy within the system of objectives of a central bank in *Chapter 6*. Collateral policy is thus differentiated into haircut policy and quantity policy and contrasted to classical interest rate policy. The optimal collateral policy with respect to distinct central bank objectives is discussed. Subsequently, effects of the configuration of the collateral framework of the Eurosystem are revealed: *Chapter 7* elaborates upon the unilateral subsidizing and thus adverse selecting of low-quality collateral due to the offering of segmentally-pooled refinancing conditions. *Chapter 8* explores the details of distribution effects within the EMU, which differ from the effects in fiscal unions, such as the jurisdictions of the Fed, the BoE and the BoJ. Finally, *Chapter 9* carves out lessons that can be drawn upon traces in market behavior in reaction to the collateral policy measures of the Eurosystem from a descriptive analysis of the Eligible Assets Database of the Eurosystem between 2007 and 2013. A *conclusion* summarizes and develops critical remarks on the Eurosystem's collateral policy to complete the dissertation.

JEL classification: E5, E61, E63, F33, F36, F45, G01, H12.

Keywords: collateral policy, collateral framework, central bank policy, central bank objectives, Eurosystem, Federal Reserve System, Bank of England, Bank of Japan, European Monetary Union, Eligible Asset Database, reverse transaction, haircut, segmental pooling, rating agency, collateral quality, distribution effects.

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vorgelegt von
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Referent: Professor Dr. Dr. h.c. mult. Hans-Werner Sinn
Korreferent: Professor Dr. h.c. Harold James, Ph.D.
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Meinen Eltern

Danksagung

Die vorliegende Dissertation entstand während meiner Tätigkeit als wissenschaftlicher Mitarbeiter am Center for Economic Studies (CES) und dem Lehrstuhl für Nationalökonomie und Finanzwissenschaft der Ludwig-Maximilians-Universität München. Im Verlauf des Verfassens haben mich einige Personen in besonderem Maße unterstützt – ihnen möchte ich nachfolgend danken.

Meinem Doktorvater, Herrn Prof. Dr. Dr. h.c. mult. Hans-Werner Sinn, möchte ich für seine fortwährende Betreuung meiner Arbeit sowie seine wertvollen Anregungen und hilfreichen Verbesserungsvorschläge an erster Stelle danken. Mein außerordentlicher Dank gilt ihm nicht nur für die Möglichkeit, innerhalb der ausgezeichneten wissenschaftlichen Strukturen der CESifo-Gruppe meine Forschungsinteressen zu finden und zu verfolgen, sondern auch für zahlreiche bereichernde Diskussionen, die Fortentwicklung meines ökonomischen Sachverstands und seine Ermutigung zu einer zielgerichteten Beantwortung volkswirtschaftlich relevanter Fragestellungen. Darüber hinaus danke ich in besonderem Maße Herrn Prof. Dr. h.c. Harold James, Ph.D., dem Zweitgutachter der vorliegenden Arbeit. Erkenntnisreiche Gespräche mit ihm haben mir die Bearbeitung der Fragestellungen meiner Dissertation erleichtert. Außerdem erhielt ich nützliche Hinweise im Austausch mit ihm und Herrn Prof. Michael Bordo, Ph.D., zu dem er für mich den Kontakt hergestellt hat. Erhebliche Fortschritte an der Dissertation entstanden aufgrund einzigartiger Bedingungen zur konzentrierten Arbeit während meines Forschungsaufenthaltes an der Princeton University, dessen Zustandekommen ich ebenfalls Professor James' Unterstützung verdanke. Für die Zeit am dortigen Bendheim Center for Finance danke ich zugleich dem Direktor des Instituts, Herrn Prof. Markus Brunnermeier, Ph.D. Bei Herrn Prof. Dr. Timo Wollmershäuser möchte ich mich für seine Bereitschaft, mündli-cher Prüfer zu werden, bedanken.

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München, im Juli 2016 Christopher Weber

Contents

List of Abbreviations and Acronyms

ABS	**A**sset- **B**acked **S**ecurities
ACC	**A**dditional **C**redit **C**laim
AMLF	**A**sset-Backed Commercial Paper **M**oney Market Mutual Fund **L**iquidity **F**acility
BoE	**B**ank **o**f **E**ngland
BoJ	**B**ank **o**f **J**apan
CCP	**C**entral **C**learing Counter**p**arty
CDS	**C**redit **D**efault **S**waps
CMBS	**C**ommercial **M**ortgage- **B**acked **S**ecurities
COMPR	**C**ustodian **o**f the **M**onetary **P**olicy **R**ule
CPFF	**C**ommercial **P**aper **F**unding **F**acility
CPI	**C**onsumer **P**rice **I**ndex
CTRF	**C**ontingent **T**erm **R**epo **F**acility
CQS	**C**redit **Q**uality **S**tep
DBRS	**D**ominion **B**ond **R**ating **S**ervice
DWF	**D**iscount **W**indow **F**acility
EBA	**E**uropean **B**anking **A**uthority
EC	**E**uropean **C**ommission
ECAF	**E**urosystem **C**redit **A**ssessment **F**ramework
ECAI	**E**xternal **C**redit **A**ssessment **I**nstitutions
ECB	**E**uropean **C**entral **B**ank
EEA	**E**uropean **E**conomic **A**rea
ELA	**E**mergency **L**iquidity **A**ssistance
EMU	**E**uropean **M**onetary **U**nion
ESCB	**E**uropean **S**ystem of **C**entral **B**anks
EU	**E**uropean **U**nion
Fed	**Fed**eral Reserve Bank/System
FLS	**F**unding for **L**ending **S**cheme
FOC	**F**irst **O**rder **C**ondition

FTO	**F**ine- **T**uning **O**peration
GC	**G**eneral **C**ollateral (Repos)
GDP	**G**ross **D**omestic **P**roduct
GLOC	**G**resham's **L**aw **o**f **C**ollateral
ICAS	**I**n-house **C**redit **A**ssessment **S**ystems
ICMA	**I**nternational **C**apital **M**arket **A**ssociation
ILOLR	**I**nternational **L**ender **o**f **L**ast **R**esort
ILTR	**I**ndexed **L**ong **T**erm **R**epo
IMF	**I**ntenational **M**onetary **F**und
IRB	**I**nternal **R**atings- **B**ased (System)
ISIN	**I**nternational **S**ecurities **I**dentification **N**umber
LC	**L**iquidity **C**ategory
LHS	**L**eft **H**and **S**ide
LOLR	**L**ender **o**f **L**ast **R**esort
LTRO	**L**onger- **T**erm **R**efinancing **O**perations
MBS	**M**ortgage- **B**acked **S**ecurities
MMIFF	**M**oney **M**arket **I**nvestor **F**unding **F**acility
MMOLR	**M**arket- **M**aker **o**f **L**ast **R**esort
MM-PC	**M**oney **M**arket- **P**articipation **C**onstraint
MRO	**M**ain **R**efinancing **O**peration
NCB	**N**ational **C**entral **B**ank
OMO	**O**pen **M**arket **O**peration
PDCF	**P**rimary **D**ealer **C**redit **F**acility
Repo	**Rep**urchase Agreement
RHS	**R**ight **H**and **S**ide
RMBD	**R**etail **M**ortgage- **B**acked **D**ebt Instrument
RMBS	**R**esidential **M**ortgage- **B**acked **S**ecurities
RT	**R**ating **T**ool
S&P	**S**tandard & **P**oor's
SLS	**S**pecial **L**iquidity **S**cheme
SLTRO	**S**upplementary **L**onger- **T**erm **R**efinancing **O**perations
SME	**S**mall and **m**edium-sized **e**nterprises
SPV	**S**pecial **P**urpose **V**ehicle
STEP	**S**hort- **T**erm **E**uropean **P**aper
TAF	**T**erm **A**uction **F**acility
TALF	**T**erm **A**sset-Backed Securities **L**oan **F**acility
TARGET	**T**rans- European **A**utomated **R**eal-time **G**ross settlement **E**xpress **T**ransfer system

TLTRO	**T**argeted **L**onger- **T**erm **R**efinancing **O**perations
TSLF	**T**erm **S**ecurities **L**ending **F**acility
UCITS	**U**ndertakings for **C**ollective **I**nvestment in **T**ransferable **S**ecurities
UK	**U**nited **K**ingdom
US	**U**nited **S**tates of America
ZLB	**Z**ero **L**ower **B**ound

List of Symbols

A	assets on bank balance sheet
A_e	eligible assets on bank balance sheet
b	fraction of subsidized bonds
BL	bank lending to investment projects (level of investment)
C	refinancing cost function of bank financing investment projects
CC	collateral constraint binding (for bank)
CV	collateral value of asset (amount that can be collateralized)
ECV	public collateral value of asset, i.e. CV if refinancing at central bank (e.g. Eurosystem)
G	return function on investment projects financed by BL
h	haircut applied to obtain collateral value
J	number of borrowers
L	central bank objective function, a quadratic loss function
m	initial margin, $m = \frac{1}{1-h}$
MC	marginal cost (of BL, i.e. investment financing)
MPC	marginal productivity of capital, i.e. of BL
MV	market value of asset
p	probability of pay-off of investment projects and consecutively counterparty (bank) survival
$1 - p$	default probability of investment projects and consecutively counterparty (bank)
PCV	private collateral value of asset, i.e. CV if refinancing in market
R	rent in the repo market (aggregate surplus)
r	interest rate
S	financial stability level
s	bond-specific signal on quality
v	valuation markdown
Y	output (GDP) level of economy
z	probability of applicability of collateral
$1 - z$	default probability of collateral

α	return to borrower from outside option
β	strength of weight on fiscal and economic stability objective
γ	strength of weight on financial stability objective
ϵ	misvaluation of bond quality; rating distortion
ζ	lenders' demand for bonds
Θ	set of marketing borrowers
θ	quality level of (unique) bond used as collateral in repo
μ	lenders' belief on average quality of traded bonds
π	inflation rate
ρ	bond price
τ	haircut subsidy provided by the central bank
Υ	theoretical value assigned to asset/bond
φ	error in theoretical valuation
Ψ	fraction of eligible bank assets ($\Psi = \frac{A_e}{A}$), determining quantitative dimension of eligible collateral pool
Ω	argument of G'^{-1}, implicitly defining optimal level of BL
$_{I}$	index for Scenario I
$_{II}$	index for Scenario II
$_{III}$	index for Scenario III
$_{a}$	index for add-on
^{B}	index for borrower in a repo
^{CB}	index for central bank
$_{e}$	index for effective (except in A_e)
$_{k\in\{1,3\}}$	index for CQS (1: CQS 1/2; 2: CQS 3)
^{L}	index for lender in a private repo (who is part of the ^{MM})
^{MM}	index for money market
$_{n}$	index for nominal
^{T}	index for target level (of π, Y and S)

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Introduction

Motivation and Research Goal

The role of collateral in loan transactions was already mentioned in the Old Testament: "If thou lend money to any of my people that is poor by thee, thou shalt not be to him as an usurer, neither shalt thou lay upon him usury. If thou at all take thy neighbour's raiment to pledge, thou shalt deliver it unto him by that the sun goeth down," (Exodus, 22:25–6, King James Bible).[1] As an elementary part of a collateralized loan, collateral is just as defining for the credit conditions as any other element of the loan contract, such as the amount, the maturity or the interest rate. Nevertheless, among central bankers collateral was rather considered a means to an end and collateral policy not a core function, at least until recently when the financial crisis of 2007/2008 created new challenges.[2] European Central Bank (2007) surveys pre-crisis principles of the collateral frameworks at the Federal Reserve Bank/System (Fed), the Bank of Japan (BoJ) and the Eurosystem in October 2007, revealing that an overarching function of collateralization from a central banking perspective is risk mitigation. Operational efficiency regarding monetary policy transmission is additionally underlined, while the effects on relative asset values and credit allocation are explicitly spaced out (cf. Federal Reserve System, 2002). The Eurosystem in particular states: "Collateral must protect the Eurosystem from incurring losses in its credit operations," (European Central Bank, 2007, p. 87) and "there should be no special or privileged treatment of public sector securities" (Cheun et al., 2009, p. 14), i.e. no active policy-making favoring specific economy sectors, particularly the public sector. Issing (2005) – then-member of the executive board of the European Central Bank (ECB) – clearly defined the "mandate of ECB's collateral policy, which is to manage risk in monetary policy operations. Assigning additional roles to collateral policy would deflect it from its primary and crucial purpose." Given the extraordinary importance of collateral in transactions of the Eurosystem – which has almost exclusively relied on collateralized lending for liquidity provision until recently and is constrained to base *all* transactions on adequate collateral by Article 18.1 of its statutes – these statements under-value the possibilities of collateral policy as a dimension of credit policy for central banks. After all, if liquidity is provided at a fixed rate, containing no premium above the policy rate and fully allotted – i.e. in the way that the Eurosystem has been acting since October 2008 – eligible collateral is very similar to cash liquidity (cf. Bindseil, 2014) and represents the only limit for refinancing loans for counterparties of the central bank. Despite this understatement, throughout the crisis management from the Lehman bankruptcy in September 2008 until the end of 2014, the Eurosystem made 74 changes to its collateral framework, reflecting

[1] For this analogy, see Coeuré (2012).
[2] See also Capel (2015), who confirms this and the following impressions.

three times the amount of collateral policy that it conducted during the time from 2001 until the crisis breakout (Eberl and Weber, 2014a). Although according to European Central Bank (2013b, p. 1) these changes to the collateral framework have only been made to "avoid widespread collateral constraints", "mitigate market malfunction" and implement "modifications to the Eurosystem's risk control framework", representatives of the ECB council have frequently mentioned changes to collateral criteria as part of the unconventional or non-standard policy that the Eurosystem has been conducting in its crisis management.[3] By the same token, academic literature has rather neglected the importance of collateral in the past (Coeuré, 2012), having only recently started to address collateral policy as an instrument for central banks. The importance of the collateral framework of the Eurosystem in particular has been recognized inter alia by Belke (2015), Cassola and Koulischer (2014, 2016), Claeys (2014), Cour-Thimann and Winkler (2012), Drechsler et al. (2016), Eberl (2016), Eberl and Weber (2013, 2014a,b, 2015), European Central Bank (2013b, 2015), Fecht et al. (2015), Gros et al. (2012), Hoffmann (2015), Hofmann (2011), Levels and Capel (2012), Singh (2013b), Sinn (2012b, 2014a,b, 2015a,b), Whelan (2014), and Wolff (2014). This dissertation aims to better establish collateral policy as a tool for central banks to reach their objectives, i.e. to *conduct* rather than simply *support* policy. For this reason, in the first place collateral policy and its dimensions have to be classed into all possible central bank objectives in a comprehensive way, extending beyond the typically-assigned relevance for risk mitigation and the scaling of central bank liquidity. Moreover, this thesis shows that the configuration of the collateral framework has been utilized by central banks at all times and in many ways – albeit not being a new phenomenon – and hence it is sequacious to be entitled "collateral policy" and encompassingly analyzed with respect to its impact and effects. The analyses throughout the dissertation will be conducted against the background of the Eurosystem and grow around the following research questions:

- What are the dimensions of collateral policy and what is the importance of collateral policy for central banks with respect to their ultimate objectives?
- How do central banks conduct collateral policy in practice and what can be inferred from it regarding their intentions?
- How does collateral policy unfold impact (as distinct from other central bank policy instruments)?
- What are the effects of collateral policy in homogeneous and heterogeneous central bank jurisdictions?

Related Literature and Contributions

The dissertation is conducive to several strands of literature, which will be bundled together in three bodies in the following. As a result, one central contribution of the dissertation is to bring together insights on collateral policy from these different strands and the comprehensive approach to the topic.

The first related body of literature describes and comparatively analyzes the configuration of central bank collateral frameworks in practice. The largest part of it is fairly

[3] E.g. Bini Smaghi (2009), Draghi (2012), and Trichet (2010a,c).

young and inspired by the changes since the financial market turmoils of 2007/2008. Chailloux et al. (2008a) review early policy responses of major central banks to the recent financial crisis, including a discussion of the collateral policies accompanying other measures taken to calm markets. Chailloux et al. (2008b), Cheun et al. (2009), and Tabakis and Weller (2009) provide surveys of principles shaping the collateral frameworks designed by major central banks and explain their main adaptions during the financial crisis. More recent comparative studies of collateral frameworks and crisis amendments are provided by Bank for International Settlements (2013b, 2015), European Central Bank (2013a, 2014a), Fisher (2011), Rule (2012), and Zorn and García (2011). Differences in the collateral policy-making of the Eurosystem and the Fed are highlighted by Gros et al. (2012) and explained in particular with the similarity of challenges during the financial crisis and the uniqueness of the following debt crisis to the Eurozone. Consequently, the collateral policy of the Eurosystem in particular has been pointed to in first overviews by European Central Bank (2013b), Hofmann (2011), and Sinn (2012b), among others, as well as being investigated in depth by Belke (2015), Eberl and Weber (2014a,b), and Nyborg (2015). A special focus on the operational conditions of collateralized lending – which are shaped by the risk management in lending operations, most importantly the haircut specification – features in the works of Bindseil et al. (2009a), Bindseil and Papadia (2009), Gonzáles and Molitor (2009), and Tabakis and Weller (2009).

This dissertation adds a collection of historical predecessors in collateral policy (classified by the objective that the respective central bank pursued) to the above-named literature, which is useful to show the development of collateral policy-making during historical times of challenges for central banks, as well as adding a historical dimension to the comparative analysis of the Eurosystem's collateral framework. Furthermore, it complements the literature with comprehensive and very detailed narrative databases on the Eurosystem's collateral criteria and the operational conditions for its collateralized lending, which are crucially influenced by the Eurosystem's risk control framework overviewing all relevant legal documents for the period from 2001 – when the collateral framework of the Eurosystem was created – until 2014. With the help of new data provided by the Deutsche Bundesbank, the consequent developments in the eligible collateral pool are revealed. Notably, an innovative inductive method elicits information on the credit quality structure of the pool. The Eurosystem's policy is evaluated against prescriptions that are deduced for the configuration of the collateral framework into a normative framework and is also assigned as supporting specific central bank objectives. In addition, the collateral frameworks of the Fed, the Bank of England (BoE) and the BoJ as important international peers of the Eurosystem and their amendments since the Lehman collapse are outlined and contrasted to the Eurosystem's practice. Peculiarities in the macroeconomic developments and the legal form of the jurisdictions of the central banks (as well as their legal mandates) are descriptively analyzed to explain the respective collateral policy actions within a model of central bank decision-making.

Second, the dissertation contributes to the large body of literature on central bank objectives to the extent that it defines the role of collateral policy as an additional tool within. One strand of this part of the literature deals with central bank objectives, in both a normative (e.g. Baltensperger, 1992; Borio, 2014; Cukierman, 1994; Ferguson, 2003; Friedman, 1959; Galati and Moessner, 2013; Goodhart and Schoenmaker, 1992; Jordan, 2010; Schoenmaker, 2013; Schoenmaker and Wierts, 2011; Summer, 2003; Weidmann, 2015) and positive (e.g. Bade and Parkin, 1988; Bank for International Settlements, 1963; Buiter, 2012;

Capie et al., 1994; Demopoulos et al., 1987; Elgie, 1998; Frey and Schneider, 1981; Goodhart, 1988; Goodman, 1992; Hodgman and Resek, 1983; Kindleberger, 2005; Oosterloo and Haan, 2004; Reinhart and Rogoff, 2013; Timberlake, 1993) fashion. Many of the latter studies draw lessons from large-ranging historical developments in central banking. For instance, the objectives of the Eurosystem in particular are discussed in Dornbusch (1996), Folkerts-Landau and Garber (1992), Galahn (1996), Issing et al. (2001), and Prati and Schinasi (1999). The concern of the above-named works is to discuss the extent to which central banks should and actually pursue the objectives of monetary stability, financial stability, fiscal stability, (real) economic or output stability and financial soundness (through supervision and regulation). Accordingly, an important element in the discussion is trade-offs and dilemmas between these objectives. An especially extensive presentation of trade-offs between price stability (a form of monetary stability) and several other objectives (employment, trade balance, government revenue, etc.) is given by Cukierman (1992). The classical trade-off between inflation and output (cf. e.g. Phelps, 1967) is e.g. addressed by Berger et al. (2001). End (2010) is an example covering the conflict between financial stability and price stability. Tucker (2009) in particular focuses trade-offs for central banks faced with crisis situations. The peculiarity of the Eurosystem – being faced with a fragmented, heterogeneous monetary union – has recently been implemented into the trade-off discussion by Henning (2015). Likewise with respect to the European situation but also including descriptions of historical parallels, "trilemmas" affecting (among other actors) central banks are highlighted by Bordo and James (2014, 2015).

The definition of all relevant dimensions of collateral policy in this dissertation complements similar attempts such as Bank for International Settlements (2013b, 2015), Bindseil (2014), and Capel (2015) and related works approaching elements of conditions for collateralized lending such as Adrian et al. (2013).

As already mentioned, the literature explicitly relating policy along dimensions of the collateral framework to various ultimate objectives is scarce. There is some literature exploring the role of collateral for the financial stability objective while discussing the central bank in the role of a lender of last resort (LOLR), cf. Bank for International Settlements (2014), Freixas et al. (1999), and Goodhart and Illing (2002) for overviews of this strand of literature, which goes back to Bagehot (1873) and Thornton (1802). Therein the consideration extends to the degree that the avoidance of collateral scarcity – obstructing the liquidity provision – has priority, see e.g. Bindseil and Winkler (2012), Levels and Capel (2012), Nyborg and Östberg (2014), and Singh (2013b). As a result, the central bank has to make additional collateral available (e.g. Bank for International Settlements, 2015; Bindseil, 2013).

The importance of collateral for the monetary stability objective is mostly narrowed to the risk-mitigating function of collateralization and subsequently appropriate haircut setting. An overview of the literature is given by Bindseil and Papadia (2009). Presentations of risks to central bank balance sheets and their possible management are among others offered by Bindseil (2007, 2009a,b), Bindseil and Papadia (2006), and Gonzáles and Molitor (2009). For an overview of haircut specifications of central banks in practice, see Tabakis and Weller (2009). Recently, haircut specifications were discussed in Bindseil (2014), Eberl and Weber (2014b), European Central Bank (2015), and Nyborg (2015).

Literature referring to collateral policy when discussing economic policy-making of central banks in the sense of pursuing a fiscal and economic stability objective marks the smallest strand within the second body of literature. Buiter and Sibert (2008) refer to collateral policy to some degree when providing their definition of a market-maker of last resort (MMOLR). The classical monetary transmission channels are defined regardless of the collateral policy tool, although it might have some effects within, as Bernanke and Gertler (1995) mention when defining the credit channel of monetary policy transmission or Haan et al. (2012) additionally note for the balance sheet channel or risk-taking channel. Therefore, Ashcraft et al. (2011) and Cassola and Koulischer (2014, 2016) explicitly work out transmission processes of collateral policy. Fegatelli (2010) interweaves the Eurosystem's crisis policy – including changes in collateral criteria – into an IS/LM framework. Bank for International Settlements (2015) recently presented a transmission map of collateral policy.

The dissertation adds a comprehensive discussion of the role of collateral policy towards central bank objectives. It presents the importance of collateral policy not only towards monetary stability but also towards financial stability as well as fiscal and economic stability. A normative framework containing the suggested configuration of the collateral framework along all its dimensions on an objective level is provided. Furthermore, the impact channels of collateral policy within the objective function of the central bank are explained and modeled. The presentation of the application of collateral policy is sub-divided into haircut policy and quantity policy and contrasted to classical interest rate policy. Subsequently, emerging trade-offs are evaluated such that the optimal use of collateral policy becomes apparent on this basis. On the way, the special features of collateral policy at the zero lower bound (ZLB) and in heterogeneous central bank jurisdictions become clear.

The third body of literature that the dissertation supplements analyzes the effects and impact of collateral policy-making on markets. Within this body, contributions are made to three strands of literature. For one, additional insight is provided with respect to the adverse selection of collateral by central banks (e.g. Singh, 2013a). Chailloux et al. (2008a,b) first pointed to this phenomenon, calling it Gresham's Law of Collateral (GLOC) and thus reinterpreting Gresham's Law of poorly-backed currency supplanting well-backed currency, as e.g. described by Macleod (1856) and von Hayek (1976). With respect to the collateralization of transactions with modern central banks, it has been argued that counterparties strive to pledge assets implying the least opportunity costs (Nyborg et al., 2002), the least liquid assets (Ewerhart et al., 2006) and the most risky ones (Ewerhart and Tapking, 2008). Eberl and Weber (2013) show the applicability of GLOC in a model tailored to the Eurosystem's collateral policy. Evidence of the adverse selection of collateral within Eurosystem transactions is presented by Bindseil and Papadia (2006) for the period from 1999 to 2005 and by Chailloux et al. (2008b) for the period from 2004 to 2007. Fecht et al. (2015) reveal the same phenomenon for German banks borrowing from the Eurosystem from 2006 to 2010, but call it "systemic arbitrage". Eberl and Weber (2015) provide descriptive evidence of GLOC at the Eurosystem during the crisis years from 2007 to 2013.

This dissertation shows how the Eurosystem's practice of collateral policy-making leads to GLOC in a theoretical model, which also includes asymmetric information and distorted as well as undistorted signals by rating agencies. The latter influence the extent of adverse selection in terms of the model, although they can also justify it along the lines of financial stabilization. Moreover, confirming descriptive evidence is presented. With a view to the heterogeneous EMU, the results from the model indicate a subsidization of member countries possessing lower-quality collateral.

For another, distributional effects within a central bank jurisdiction are analyzed. A particular focus is placed upon heterogeneity within the central bank's jurisdiction, such as in a heterogeneous monetary union. The dissertation thereby builds upon issues that have already been highlighted in the literature on optimum currency areas, which prominently includes Alesina et al. (2002), Eichengreen (1991), McKinnon (1963), and Mundell (1961). Alesina and Grilli (1991) take up the subject with respect to the Eurozone and show that implemented interest rates and precipitated inflation are unlikely to suit all member countries' preferences. Such inflation biases in currency unions are also particularized in Aizenman (1992) and Casella (1992). They are the result of heterogeneity between member countries – the existence of which in the EMU has been pointed to e.g. by Bordo and James (2008), Flaig and Wollmershäuser (2007), Sinn and Reutter (2000), and Sturm and Wollmershäuser (2008) – and a common pool problem regarding the money and credit provision by national central banks (NCBs). For instance, this interpretation is given in Dinger et al. (2014), who also refer to collateral criteria as a driving mechanism. Freeriding behavior in a monetary union is addressed by Chari and Kehoe (2008), while anecdotal evidence for suchlike utilization of collateral policy was recently provided in Brendel et al. (2015). In addition to inflation, the redistribution can work through more or less creation of seignorage and its subsequent allocation, e.g. Sinn and Feist (1997, 2000). Distributional effects of the monetary unification in Europe that work through effective financing conditions for investment projects in member countries have already been highlighted by Sinn (2010b).

This dissertation extents the latter by introducing collateral policy into effective refinancing conditions. Distribution effects are discussed with respect to heterogeneous fiscal and monetary unions. It is shown that the possibility to create asymmetric refinancing conditions through collateral policy is advantageous compared to interest rate policy. Therefore, this has already been suggested by Brunnermeier (2010) and in principle follows the finding of Gali and Monacelli (2008), although it implements the part that they assign to fiscal policy to collateral policy. Moreover, the effects of the Eurosystem's practice of segmentally pooling refinancing conditions are worked out. The relevance of the theoretically-derived distribution effects is underpinned with evidence of differences in collateral available at the country level. Subsequently, indications of NCBs attempting for the economies of their jurisdictions to particularly profit from the distribution effects of collateral policy are presented. It is inferred that collateral policy indeed leads to redistribution within the European Monetary Union (EMU), which likely occurs from non-crisis countries to crisis-afflicted countries.

Finally, the dissertation provides insights into the effects of collateral policy on market behavior. There is very little literature with a similar focus at present. Bindseil and Papadia (2006) examine the effects of central bank eligibility on market prices and bid-ask spreads of assets, although they only cover the pre-crisis period. Nevertheless, they show the existence of an eligibility premium. A more recent estimate of price effects is included in Bank for International Settlements (2015), while Cassola and Koulischer (2016) estimate the impact of haircut changes. The influence of collateral laws on market activity is examined by Calomiris et al. (2014), albeit without reference to central banks and their collateral policy-making. Tamura and Tabakis (2013) specifically analyze the use of credit claims as collateral. Changes in the provision of government guarantees in reaction to changes in respective collateral criteria are investigated by Levy and Schich (2010) and Levy and Zaghini (2010). Literature on the market impact of special facilities of the Fed is more numerous than for the Eurosystem's collateral policy, cf. Hamilton and Wu (2012) for an overview, as well as Duygan–Bump et al. (2013) and Fleming (2012). A related strand of literature examines the effects of unconventional central bank policy during the recent crisis years but does not focus on collateral policy in particular. Examples include Rogers et al. (2014), who provide a cross-country comparison, Vollmer and Bebenroth (2012) on the BoJ, Joyce et al. (2011) on the BoE, Trebesch and Zettelmeyer (2014) for effects of the Eurosystem's Securities Markets Programme or Hristov et al. (2014a) for effects of the Eurosystem's Outright Monetary Transactions.

This dissertation presents descriptive evidence of traces of collateral policy measures in asset markets as well as showing changing market behavior responding to such policy of the Eurosystem. It builds upon the Eligible Assets Database of the Eurosystem, combines it with market data on prices and bid-ask spreads and pioneers in extracting impact of changes to the Eurosystem's collateral framework from this data. It thereby sustains the role of collateral policy as an instrument for central banks that actually affects markets.

Main Findings and Implications

The dissertation analyzes the role of collateral policy as a central bank instrument and devotes particular attention to the practice of the Eurosystem. Important lessons and resulting implications can be summarized into eight main aspects.

Collateral policy holds relevance within each central bank objective. Collateral policy is defined along six dimensions, each with several layers. While the range of eligible asset types delimits the eligible collateral pool horizontally and eligible asset qualities define it vertically, there is an additional time dimension, which is dependent on the range of eligible asset ages. The value level of the eligible collateral pool is subsequently determined according to the operational conditions for collateralized lending. Of additional relevance are the flow-back dimension – i.e. the counter-assets possibly lent out – and as the sixth dimension the range of eligible counterparties, sizing the access window to central bank refinancing. Collateral policy is evaluated along these dimensions regarding its relevance in pursuit of three central bank objectives, which are demarcated as monetary stability, financial stability as well as fiscal and economic stability. Striving for its ultimate objectives, the central bank adopts the roles of a custodian of the monetary policy rule (COMPR), a lender of last resort (LOLR) or a market-maker of last resort (MMOLR). Collateral policy holds relevance for each objective and its respective configurations are suggested in a normative framework: taking the perspective of monetary stability, a COMPR should lend out liquidity at appropriate/prudent conditions against a small eligible collateral pool of high quality to a small set of solvent banks; a LOLR focusing on financial stability should offer converting already-issued assets of a wide range of types into liquid assets or sterilized liquidity at above (normal) market conditions to a wide set of solvent banks while respecting the inertia principle; and with the MMOLR's view to fiscal and economic stability, a selective choice of newly-issued assets of possibly low quality should be eligible and collateralized loans should be made at below (normal) market conditions to a wide set of counterparties (including non-financials).

Historically, collateral policy has been used in pursuit of all objectives, although typically within differentiated collateral sets or facilities. The dedication to fiscal and economic stability was especially pronounced in jurisdictions that currently belong to the Eurozone. Historical central bank actions from Europe, Japan and the United States of America (US) that include collateral policy measures are presented and evaluated along the normative framework of the collateral configuration. Subsequently, they are clustered into the roles of COMPR, LOLR and MMOLR. While the use of collateral policy can be identified within all roles, a predominant application of collateral policy in the role of a MMOLR is pronounced for central banks in jurisdictions that have later become a part of the Eurozone. Furthermore, the following findings from the past are remarkable from the perspective of the Eurosystem. While the Eurosystem only defines one unique eligible collateral set, different roles identified in the historical policy actions are mostly conducted with the help of distinct eligible collateral sets. These were often implemented via special purpose institutions, circumventing the regular collateral requirements of central banks. This differentiation of collateral sets is also identified in the Fed's and the BoE's crisis management during recent years. A shift in the predominant collateral type to government securities is identified around the time of the World Wars, connected to a trend of nationalizing central banks. Prior to then, private shareholders were primarily interested in risk mitigation, while public shareholders were willing to sacrifice some monetary stability for other objectives. Ultimately, fiscal and economic expansion and a lower cost of failing financial institutions could be traded off against lower monetary stability from an aggregate perspective. This entirely changes in a monetary union, where distributional effects between union members emerge instead.

The Eurosystem has intensified collateral policy-making throughout its crisis management, thereby exceeding a focus on monetary stability in its collateral policy. Not only measures targeting financial stability but also those categorized as fiscally and economically stabilizing are identified. From the comprehensive analysis and presentation of the Eurosystem's collateral policy within a narrative database of amendments, an intensification of policy-making after the default of Lehman Brothers stands out. It manifests in particular within changes to the configuration of the collateral framework along three dimensions of collateral policy. At the horizontal dimension of collateral policy, the Eurosystem broadened the eligible collateral pool quantitatively. Mostly general changes were made during the financial crisis period, thus suiting a LOLR role, although the activity was refined towards the alteration of asset type-specific criteria during the European debt crisis phase, pointing at a MMOLR role. The eligible collateral pool was also deepened vertically by deeming lower asset qualities eligible. Amendments to policy criteria with respect to asset types and qualities mirror in the development of the eligible asset pool, which changed in both size and composition, as shown in a descriptive analysis of new data provided by the Deutsche Bundesbank. Bank assets and government bonds particularly profited from the collateral policy measures. Moreover, assets traded on non-regulated markets gained importance, while foreign currency-denominated assets only added a relatively small fraction to the pool. An innovative outside-in analysis of the credit quality of the eligible assets reveals that the qualitative broadening has significant influence but did not substantiate until the European debt crisis. Furthermore, the geographical composition as well as the structure of residual maturities were altered. The value-level dimension of collateral policy is particularly shaped by the haircut specification. The Eurosystem's haircut policy not only lacks a frequent or market event-related updating procedure but also leaves information on asset characteristics behind, because a clustering approach is applied regarding liquidity, residual maturity and credit quality. In combination with the application of a first-best rule determining pivotal credit ratings, the allowance of theoretical valuation and the sequential application of valuation markdowns and haircuts, this leads to operational conditions for collateralized refinancing being segmentally pooled and thus likely to be subsidized relative to market conditions at least for a fraction of eligible assets. In addition to this segmental pooling, the introduction of the full allotment procedure for refinancing loans at prolonged durations and the permanence of relaxed conditions contribute to favorable operational conditions, which thus indicate a MMOLR role of the Eurosystem.

In comparison with major central banks, the collateral policy of the Eurosystem differs in scale and shape. In particular, it was more uniform, more permanent and affected larger parts of central bank operations. The development of collateral policies of the Fed, the BoE and the BoJ during the recent crisis years are presented, evaluated with respect to the served objective and compared with the Eurosystem's practice. While the Eurosystem already operated a unique and wide eligible collateral framework before the crisis breakout, the BoE operated a unique but narrow and the Fed a differentiated one. The BoJ's eligible collateral pool resembled that of the Eurosystem regarding its width and uniqueness, although it was only offered to a small range of counterparties. The importance of collateral policy at the Eurosystem is supported by a comparison of the fraction of collateralized lending operations in the balance sheets of central banks. The Eurosystem conducted its operations almost exclusively through collateralized lending, while the Fed, the BoE and the BoJ assign it a subordinate role, although the latter two significantly increased their reliance on collateralized lending temporarily during the financial crisis period. Moreover, the Eurosystem has been offering the crisis amendments to its collateral framework for the longest time – in fact making most of them permanent – while the international peer central banks only conducted temporary changes. The Fed, the BoE and the BoJ introduced differentiated collateral frameworks along the horizontal, vertical, time and value-level dimensions to a variable extent, while the Eurosystem has been operating a uniform framework. They could thus dispense their collateral policy towards each of the three central bank objectives by tailoring conditions accordingly. In effect, most measures of the BoE can be attributed to a LOLR role, although some also had a market-making character. The collateralized lending facilities of the Fed were partly designed to foster financial stability and partly catalyzed economic activity, while the BoJ primarily targeted economic growth stimulation. Moreover, the Fed and the BoE leveled their collateralized lending operations at premiums above market conditions or auctioned funds, while the Eurosystem and increasingly the BoJ fully allotted liquidity at the policy rate. As a result, the below-market lending of a MMOLR was most pronounced and affected the largest amounts there.

While monetary stability should primarily be sustained through classical interest rate policy, collateral policy can be used in pursuing financial stability or fiscal and economic stability. Quantity policy along the horizontal dimension of the collateral framework should be preferred to provide financial stability, while haircut policy along the value-level dimension of the collateral framework can help towards fiscal and economic stability. The optimal use of collateral policy as an additional policy tool to interest rate policy is deduced from a theoretical analysis of trade-offs evolving from an optimization of the central bank objective function. Although monetary stability can be influenced through both interest rate and collateral policy, the use of interest rate policy is preferable for a COMPR as it allows maintaining refinancing through the money market and does not require undercutting market conditions. Financial stability can best be targeted through quantity policy – i.e. scaling the eligible collateral pool along the horizontal dimension – as the trade-offs to other objectives can subsequently be minimized if high quality requirements and tight operational conditions are applied. The use of haircut policy for a MMOLR allows reducing the trade-off to monetary stability. Moreover, it allows crossing the ZLB. The relevance of the model specification underlying the analysis for central banks' practical decision-making is confirmed by stylized facts on the stability weights and driving forces within the objective function. While the policy choices by the Fed, the BoE and the BoJ seem to have been induced by macroeconomic developments as well as the state of the financial system in the respective jurisdiction, the case is more difficult for the Eurosystem, subserving a monetary union. Its policy as a LOLR during the financial crisis period was called upon to differing degrees from the heterogeneous member country perspectives. The MMOLR role that it took suggests different perceptions in the interpretation of central bank objectives within the monetary union in combination with evident differences in the need for fiscal and economic stabilization.

The offering of segmentally-pooled public refinancing conditions leads to adverse selection of collateral such that relatively low-quality assets are attracted. The concomitant subsidization of these assets identifies a market-making intention in case of undistorted or positively distorted ratings. In case of negatively distorted ratings, the segmental pooling can be justified from a financial stability perspective. Within a model of the European repo market, the impact of collateral policy along the vertical dimension (asset quality) is analyzed. On this market, private refinancing for investment projects is provided. The basic model shows how starting from an efficient equilibrium, the introduction of asymmetric information leads to redistribution within groups of borrowers and lenders while efficiency is remained. Through an undistorted signal, the symmetric information equilibrium can be reproduced. A distorted signal leads to redistribution across and within groups but retains efficiency. Aggregate surplus decreases when borrowers are offered an outside option that is less productive than the use of bonds by private lenders yet is sufficiently high to drive better qualities out of the market (and towards the outside option). The extended model designs the outside option according to Eurosystem practice, i.e. segmentally pooled in three steps: *(1)* the application of simplified haircuts that are too large for relatively high-quality collateral and too small for relatively low-quality collateral; *(2)* the application of supplementary haircuts irrespective of credit quality; and *(3)* the theoretical valuation of assets. The resulting adverse selection of relatively low-quality collateral is referred to as GLOC. It goes along with a subsidization of low-quality collateral by the central bank, which hence acts as a MMOLR for investment projects of lower quality (lower productivity). The rent of borrowers owning bonds of relatively low-quality within each credit quality segment is increased at the risk of the Eurosystem and thus at a threat to monetary stability. The additional implementation of positively distorted ratings leads to an intensification of the adverse selection described above. Furthermore, it yields an extension of the eligible asset pool beyond the control of the central bank. On the other hand, the case of negatively distorted ratings turns the market-making of the central bank into a LOLR activity, whereby the attraction of low-quality collateral, subsidization and risk-taking are alleviated. This scenario may serve as a justification for segmentally-pooled refinancing options, which work as an automatic stabilizer as rents of borrowers are preserved at a higher level than the (rating-distorted) market equilibrium would yield at manageable risk to the LOLR, albeit at the cost of a reduced aggregate surplus.

The offering of segmentally-pooled public refinancing conditions can be designed to lead to Pareto improvements in fiscal unions but implies redistribution between countries in a heterogeneous monetary union such that some members benefit at the cost of others. In the case of the Eurozone, evidence suggests that the redistribution is likely to work from non-crisis to crisis countries. A schematic model examines the distribution effects of collateral policy within a jurisdiction of one central bank comprising two heterogeneous market segments, which are interpreted as *(i)* branches/industries, *(ii)* regional economies and *(iii)* national economies. The heterogeneity of market segments emerges from differing productivities, which consequently lead to different collateral qualities. The analysis confirms that asymmetric haircut policy can reduce trade-offs for a central bank in pursuit of both monetary stability and fiscal and economic stability from a distribution perspective. However, Pareto improvements can only be reached in fiscal unions where compensational redistribution mechanisms exist. The redistributive policy-making in a monetary union is due to the incentives that an objective function comprising a fiscal and economic stability objective in addition to the monetary stability objective sets to the central bank, which consequently takes an aggregate perspective and nets out country preferences, even though no compensation is possible. The suggested redistribution from non-crisis to crisis countries within the Eurozone follows from a descriptive analysis showing a home bias in banks' balance sheets, as well as national differences in the structure of national collateral pools with respect to asset types and credit quality subsist, whereby all differences increased throughout the crisis. It manifests in a reduction of the recourse to central bank refinancing credit in non-crisis countries, which are inferred to predominantly use higher-quality assets of types that are less favored by the collateral criteria of the Eurosystem. On the other hand, the use of central bank refinancing credit in crisis countries sky-rocketed and is inferred to be collateralized as predicted by lower-quality assets of types favored by the segmentally-pooled refinancing conditions that the Eurosystem offers.

Traces of market affection by the Eurosystem's collateral policy measures are particularly visible in crisis countries and the banking sector, i.e. in the countries and economy sectors predominantly targeted by changes in collateral criteria. Lessons with respect to the market impact of collateral policy actions are elicited from the Eurosystem's Eligible Assets Database, which is combined with information on market prices and bid-ask spreads. The results from the descriptive analysis stretch along both the geographical and the economy sector dimension and are different during the financial crisis compared to the European debt crisis. Impact-identifying criteria applied in the analysis are *(i)* the structure of affected assets and markets, *(ii)* movements in market prices and bid-ask spreads as well as *(iii)* changing issuance behavior. Crisis countries in particular profited from the qualitative broadening during the European debt crisis, with respect to both newly-eligible assets and downgradings of already-existing assets. For assets from those countries, reactions in market prices and spreads to policy-induced eligibility are most pronounced. Bank assets from all countries especially profited from collateral policy measures during the financial crisis period, as well as showing a strong reaction in market prices and spreads to policy-induced eligibility. Changes in issuance behavior underpin the results in three ways: *(1)* the pre-eligibility issuance increased for lower-quality assets; *(2)* the provision of government guarantees increased for already-eligible bank assets during the financial crisis and for newly-eligible assets particularly from crisis countries during the European debt crisis; and *(3)* a striving for access to central bank refinancing is identifiable in crisis countries during the European debt crisis with a view to the number of eligible issuers, the reliance of each individual issuer on central bank-eligible collateral and the central bank-eligible share of banks' balance sheets.

Structure of the Thesis

The thesis comprises three parts, unifying nine chapters. *Part I* discusses the role of collateral in central bank policy and comprises two chapters.[4] In *Chapter 1*, possible tasks and objectives of central banks are historically deduced and subsumed as fiscal and economic stability, monetary stability, financial stability and financial soundness. The roles that central banks take during crises threatening their objectives to preserve the respective stability are defined as COMPR, LOLR and MMOLR. Furthermore, an interdependence between crisis origin and objective shifts is explained. *Chapter 2* defines six dimensions of collateral policy and integrates it into the system of central bank objectives.[5] Thus, a normative framework for the role of collateral policy is developed. In *Part II*, practical collateral policy measures are presented along the lines of this framework. The focus is placed upon the collateral policy of the Eurosystem.[7] However, as a first step, *Chapter 3* delves into historical predecessors in collateral policy and analyzes examples of collateral policy conduction by central banks from the middle of the 18th century to the end of the 20th century. Relevant findings from the perspective of the Eurosystem are extracted. *Chapter 4* is at the heart of the analysis in this dissertation, presenting the collateral policy of the Eurosystem in detail. Narrative databases containing the development of the Eurosystem's collateral criteria and the haircut specification from 2001 until the end of 2014 are compiled such that the configuration of the Eurosystem's collateral framework is comprehensively exposed. In addition, a descriptive analysis of the development of the Eurosystem's eligible collateral pool is complemented. The collateral policy of the Fed, the BoE and the BoJ during the recent crisis years is described in *Chapter 5* and analyzed with respect to both the normative framework developed in Part I and in comparison to the Eurosystem's practice.[8] *Part III* starts with a theoretical foundation of the impact and transmission processes

[4] Throughout the dissertation, the term "central bank policy" as distinct from "monetary policy" is deliberately chosen because it may contain elements of (stimulating or credit-directing) economic policy, which monetary policy usually leaves to fiscal policy.

[5] Collateral policy affects all "reverse transactions", i.e. either "collateralized lending" or "repurchase agreements (repos)". As both variants are similar from an economic perspective, the three terms are used interchangeably in this dissertation. In addition, the term "loan" may be used and have the identical intent, if not explicitly delimited as an "uncollateralized loan". In practice, collateral criteria may also be relevant for the choice of assets purchased outright, although these are beyond the realm of this dissertation. In particular, the Eurosystem recently claimed to respect its eligibility criteria for collateral when announcing its large-scale asset purchase programs. As the left panel of Figure 4.2 shows, loans were by far the primary means of operation of the Eurosystem until the end of 2014.[6] Hence, the exclusion of outright asset purchases from the discussion does not constitute a limitation with respect to the goal of this dissertation.

[7] Both "Eurosystem" and "ECB" are used throughout this dissertation. The intention is to use "Eurosystem" to make clear that collateral policy operations are conducted by the European System of Central Banks comprising the ECB and NCBs. In several cases, NCBs are consciously mentioned alone, i.e. as national institutions. In a few instances, "ECB" is used to pronounce that decisions are taken in Frankfurt.

[8] In what follows, by "(recent) financial crisis" the period globally kicked off by the 2007/2008 financial market turmoils and the (at the latest) Lehman Brothers collapse on 15 September 2008 is circumscribed, i.e. roughly the time from 2008 to 2010. The expression "European (sovereign) debt crisis" period refers to developments in European markets from around 2010 to 2012, although they remained palpable at the end of 2014 and even at present. Triggered by the financial crisis, (sovereign) debt problems emerged within several countries of the

of collateral policy within the system of objectives of a central bank in *Chapter 6*. Collateral policy is thus differentiated into haircut policy and quantity policy and contrasted to classical interest rate policy. The optimal collateral policy with respect to distinct central bank objectives is discussed. Subsequently, effects of the configuration of the collateral framework of the Eurosystem are revealed: *Chapter 7* elaborates upon the unilateral subsidizing and thus adverse selecting of low-quality collateral due to the offering of segmentally-pooled refinancing conditions. *Chapter 8* explores the details of distribution effects within the EMU, which differ from the effects in fiscal unions, such as the jurisdictions of the Fed, the BoE and the BoJ. Finally, *Chapter 9* carves out lessons that can be drawn upon traces in market behavior in reaction to the collateral policy measures of the Eurosystem from a descriptive analysis of the Eligible Assets Database of the Eurosystem between 2007 and 2013. A *conclusion* summarizes and develops critical remarks on the Eurosystem's collateral policy to complete the dissertation.

Eurozone, which are denoted as "crisis-afflicted countries", "crisis-stricken countries" or "crisis countries" in the following. They comprise Greece and Portugal, as well as Ireland – which was already in crisis slightly earlier – and stretch out to include Italy, Spain and even France to some degree. Cyprus would also naturally be included, although it is mostly omitted from the analyses due to a lack of data. The European debt crisis is connected to economic slump and competitiveness problems.

Part I

The Role of Collateral in Central Bank Policy

Chapter 1

Central Bank Objectives

One goal of this dissertation is to discuss the role of collateral criteria in central bank policy and strive forward in the understanding of the configuration of the collateral framework as an instrument of central bank policy. Central bankers make use of their policy instruments to reach their ultimate objectives, whereby they define (measurable) intermediate targets (such as an inflation target to ensure price stability) wherever possible and align the use of their instruments to these targets (see Goodman, 1992, Ch. 1). Establishing collateral policy as an instrument of central bank policy hence requires presenting central bank objectives first to subsequently integrate collateral criteria in this context. This chapter discusses four central bank objectives: *(i)* fiscal and economic stability, *(ii)* monetary stability, *(iii)* financial stability and *(iv)* financial soundness. All of them developed consecutively based on the needs of the respective time and thus are discussed in the order of their historical evolvement. Trade-offs between the objectives prevail and are presented below. Crises, threatening the respective stability contained in each objective, often shifted the focus on the particular objective, such that an interdependence between crisis origin and objective shifts can be identified (cf. Section 1.5). In conducting their crisis management, central banks adopt distinct roles in defense of the respective objective. These roles are deduced below and labeled as *(i)* market-maker of last resort (MMOLR), *(ii)* custodian of the monetary policy rule (COMPR), *(iii)* lender of last resort (LOLR) and *(iv)* banking regulator. While objectives *(i)*-*(iii)* are identified as possibly within central bank responsibility and discussed in detail in Chapter 2, *(iv)* is argued to be relinquished to a separate agency to avoid conflicts of interest for the central bank.

1.1 Fiscal and Economic Stability

The development of central bank objectives is closely connected to the requirements posed during the respective historical period.[9] In the first place, central banks were established to become the government's main banker, in fact often to encourage a banking and credit market altogether (e.g. in Sweden, Norway, Finland, Denmark, the Netherlands and Austria-Hungary, cf. Capie et al.

[9] For related presentations and discussions of central bank objectives, cf. Borio (2014), Capie et al. (1994), Goodhart (1988), Schoenmaker (2013), and Schoenmaker and Wierts (2011). Historical motivations for the foundation and reorientation of central banks are also discussed in James (2001).

(1994, p. 4)).[10] As Goodman (1992, p. 23) puts it, "the principle function of early central banks was to raise and advance money to governments." Particular examples are the Sverige Riksbank in 1668 (Bank for International Settlements, 1963), the BoE in 1694 (Clapham, 1944), the Banque de France in 1800 (Timberlake, 1993) and later also the Banco de Espana (Hamilton, 1945). In return for the credit-providing services, central banks were granted note issue privileges up to the monopoly over note issue (e.g. Cameron et al., 1967). The underlying objective driven by this incentive to establish a credit provision for the government and the economy is to foster the financing of fiscal and economic activities, i.e. **fiscal and economic stability**. The original charter of the BoE circumscribes the central bank's objective as to promote "the publick Good and Benefit of our People" (see Bank for International Settlements, 1963, p. 98). Later, after the departure from monetary standards such as the Gold Standard or Bretton Woods, macroeconomic goals were more explicitly written into the statutes of central banks. E.g. the reformed US Federal Reserve Act of 1977 states the "promotion of maximum employment" as one of three monetary policy objectives. Under this objective, the central bank secures an accessible credit market to finance real economic and fiscal activities. Employment and economic growth are measurable outcomes of its endeavor, as well as deep and liquid government debt markets. Making funds available to the real economy and the government – hence providing a credit market – is during normal times facilitated by developed financial markets, where either banks intermediate liquidity that has initially been provided to them by the central bank to investment projects and consumers or liquidity-seekers can directly tab a credit market for financing. Nonetheless, during normal times the degree of interventionism in the credit policy of central banks has seen a wide spectrum between trusting in the allocative powers of the markets and direct state control over credit flows (see e.g. Monnet, 2012, for a comparative discussion). Should this process be disturbed or clogged and credit unavailable for consumers, firms or the government during times of crises, a central bank under the sole objective of economic and fiscal stability would adopt the role of a **market-maker of last resort (MMOLR)**. Typically, in such a situation, financial markets – being uncertain about the true profitability of an investment project or doubting the creditworthiness of a borrower right away – do not lend. The central bank then either adopts its role as a lender directly, bypassing the transmission channel, or persuades the markets to do so, reassuring them in some way that they do not have to fear losses too much. In any case, the credit policy that central banks conduct in crises within this role and to strengthen the fiscal and economic situation then follows the principles seen e.g. in France or Italy after World War II, when "the principle of controlling credit flows [...] to serve national economic interests [was] fully accepted and extensively applied in practice" (Hodgman, 1974, p. 138).[11]

1.2 Monetary Stability

Naturally, supporting the fiscal and economic expansion alone gives rise to excessive note issue and inflation, especially in times of wars to be financed. "Inflation, like other taxes, especially taxes whose incidence is inherently uncertain, is unpopular, and governments will have an incentive to prevent it." (Capie et al., 1994, p. 7). Central banks founded after the Napoleonic wars – e.g. those of Austria-Hungary (1816), Norway (1816) or Denmark (1818) – thus illustrate the strive towards

[10] An associated purpose for early central banks was to organize the payment systems and note issue, e.g. in Germany, Italy and Switzerland (Goodhart, 1988).

[11] See also Monnet (2012).

the objective of **monetary stability**, see Capie et al. (1994, p. 5). Central to monetary stability is preserving the convertibility of the currency – i.e. the specie or banknotes – that central banks issue as a means to facilitate trade and payment, to e.g. gold. If the money supply is controlled in such a way that the backing of the currency is preserved, the value of the currency remains constant relative to real goods and values and hence monetary stability comes along with price stability, which is measurable by inflation. Therefore, central banks often translate their monetary stability objective into an inflation target. Monetary stability was desired not only for the sake of internal convertibility, as described above, but also to maintain external convertibility, which holds crucial importance for trade reasons and the balance of payments.

The described objectives of fiscal and economic stability and monetary stability stand in conflict as extensive credit supply such as government debt financing during war-time erodes the central bank's reserves and hence its ability to retain the convertibility of specie/banknotes to e.g. gold. Before monetary stability was more clearly perceived as a central bank objective for the first time after the Napoleonic wars, governments of existing central banks in England (1797-1821) and France (1805 and 1813) – as well as earlier still in Sweden (1745-1776) – had simply allowed their central banks to suspend the convertibility in pursuit of their extensive credit provisioning.[12] In the second half of the 19th century, monetary stability was anchored by the move to the classical gold standard, safeguarding internal and external convertibility without an explicit price stability goal (Borio, 2014). After World War II, the Bretton Woods system aimed at safeguarding monetary stability, although this proved fragile. Still during the Great Moderation that followed, the role of the central bank was perceived as primarily safeguarding price stability.

Regardless of whether the monetary regime is a peg of the currency to some other value such as silver, gold or another currency, the preservation of price stability connected to an inflation target or an expansion path for the monetary base, a central bank that only pursues the objective of monetary stability simply implements a monetary policy rule.[13] This role as the **custodian of the monetary policy rule (COMPR)** also persists in a crisis. However, in practice crises often affect the value of the currency, or at least threaten to do so. Therefore, it is also perceived as part of the fulfillment of this objective for the central bank to secure the ability to implement the monetary policy rule.

1.3 Financial Stability

The intention to originate a commercial banking system supported by the establishment of a central bank inevitably led to close ties between the central bank and the banking system, making the central bank not only the government's but also the bankers' bank. By the time of their founding, the full ramifications of this role were only dimly perceived (Goodhart, 1988), although the close relationship was intended. A relatively laissez-faire behavior towards financial market turbulence emerged in light of the international alignment to the gold standard and the accompanying focus

[12] See Capie et al. (1994), Goodhart (1988), and Kindleberger (2005). The overriding focus on monetary stability did not prevent suspensions of convertibility thereafter, especially during following wars. It will later be discussed in further detail how the prioritization of central bank objectives varies over time, often in a way that suggests an interdependency between crisis origin and objective shifts.

[13] The role of the central bank strictly implementing a monetary policy rule was fundamentally described by Friedman (1959), more recent discussions include Bernanke and Mishkin (1997) and Laubach and Posen (1997).

on monetary stability. In addition, some central banks were still standing in competition to commercial banks in some countries (such as France or Italy), cf. Capie et al. (1994) and Elgie (1998). Consequently, the necessity of an objective concerning **financial stability** evolved. While the gold standard reflected the strongest possible support for monetary stability, it left little room for financial stability (Borio, 2014). During the banking crises of the (in particular late-) 19th century, central banks started to intervene in favor of banks (Le Maux and Scialom, 2010). Characteristically, the need for the central bank's alertness concerning financial stability was written down in what is perceived as the foundation of the central bank's role as a **lender of last resort (LOLR)**, Walter Bagehot's *Lombard Street* (Bagehot, 1873), in the same year that the gold standard became the main exchange rate regime of wide parts of the industrialized world. The provision of liquidity to banks under distress – to calm financial markets, prevent bank-runs and resulting illiquidities – characterizes the central bank's LOLR role in crises. Much of the literature agrees on 1866 – the year of the Bank of the Overend Gurney crash in England – as when the BoE seminally accepted its role as a LOLR (Bordo, 1998; Eichengreen, 1996; Le Maux and Scialom, 2010; Schwartz, 1986). Continental European central banks followed, e.g. in Austria-Hungary during the stock market crash of 1873, in Portugal during the banking crisis of 1876 and in France during the stock market crash of 1882 (Capie et al., 1994). Where new central banks were to be founded during the time of the gold standard – e.g. in Japan (1882) and the US (1913) – countries sent delegations to Europe to elicit the best practice from European monetary policy at that time. Following the experience of the banking crises of the second half of the 19th century and particularly the banking crisis of 1907, which was triggered by the failure of the Knickerbocker Trust Company, the foundation of the US Federal Reserve was mainly motivated by the objective of financial stability, as made explicit in the Federal Reserve Act of 1913 (Reinhart and Rogoff, 2013).

Whereas the definition of monetary stability as described above is quantifiable and thus palpable and clearly distinguishable from its opposite (monetary instability), the meaning of the term financial stability is much less easy to specify. "Monetary stability is defined as stability in the general level of prices, or as an absence of inflation or deflation. Financial stability does not have as easy or universally accepted a definition. Nevertheless, there seems to be a broad consensus that financial stability refers to the smooth functioning of the key elements that make up the financial system" (Duisenberg, 2001, p. 38). The description of financial stability as the state of orderly functioning of financial markets is also shared by Galati and Moessner (2013), Oosterloo and Haan (2004), and Weidmann (2015). Oosterloo and Haan (2004) build their specification on a survey of central banks around the world. In the answers from these central banks, the ability of the financial system to absorb unexpected shocks (originating both within and outside the financial markets) and being able to remain working properly seems an important component of financial stability. Therefore, both the ex-ante prevention of disturbances and the ex post capability to manage them characterize a financial system as stable. The full understanding of the objective hence also requires a definition of financial instability, i.e. a non-functioning of the financial system. Ferguson (2003, p. 2) describes such a situation as the existence of "market failure or externalities that can potentially impinge on real economic activity."

The risks of financial instability can be tackled on two levels (Schoenmaker, 2013; Schoenmaker and Wierts, 2011), namely macro- and microprudentially. On the macroprudential level, the financial system as a whole holds relevance and central bank policies will be holistic. Promoting financial stability on this level follows three steps (Schoenmaker, 2013). *(1)* The assessment of the status quo, identifying price bubbles or systemic risks.[14] *(2)* Precautionary measures, i.e. soft and hard pressures to resolve systemic risks (such as overly easy credit provision) and leaning against price distortions (see also Buiter, 2012). *(3)* The reduction of the costs of disturbances, i.e. LOLR measures (Bagehot, 1873), emergency liquidity provision, according to Buiter (2012) even the recapitalization of financial institutions.[15]

From the beginning of central banks' awareness concerning financial stability, the insuring effect in particular of the central bank actions named under *(3)* gave rise to concerns regarding moral hazard (Capie et al., 1994). Thomson Hankey – then a director of the BoE – called the LOLR actions "the most mischievous doctrine ever broached in the monetary or banking world in this country; viz that it is the proper function of the BoE to keep money available at all times to supply the demands of bankers who have rendered their own assets unavailable" (Goodhart, 1988, p. 46). The objective of financial stability is hence in a very similar conflict with monetary stability as the afore-described fiscal and economic stability objective (cf. Borio, 2014; End, 2010; Goodhart and Schoenmaker, 1992). The reason is that despite the incentive distorting effects on banks' behavior, which can – as described in further detail by Ferguson (2003) – rebound to financial instability again, the reactive macroprudential financial stability policies bear the threat of monetization due to their impact on the central bank's balance sheet (Cukierman, 1994). While over the long run monetary and financial stability might be simultaneously achievable (Baltensperger, 1992), the interconnectedness of these two objectives leads to trade-offs along the way.

1.4 Financial Soundness

Consequently, a fourth objective evolves for central banks, which is intended to spare them from the risks and trade-offs described. It is labeled the **financial soundness** of the system and refers to the microprudential level of financial instability risks (see above) focusing individual institutions (banks), cf. Schoenmaker (2013). Financial soundness is generally implemented through all kinds of **regulatory arrangements** (such as capital/liquidity requirements, balance sheet sustainability assessments, etc.). Here, the Tinbergen Principle (Tinbergen, 1952) applies given that the policy goal of soundness of financial institutions needs and holds a separable tool (regulatory arrangements). For the same reason, it can be organized in a separate institution that might at most be advised by the central bank. Such an arrangement also surpasses any conflict of interest between monetary policy and banking supervision (e.g. Goodhart, 2000). In what follows, the financial soundness objective will thus not be further discussed as a monetary policy objective in this dissertation.

[14] Systemic risk is just as difficult to define as financial stability. The descriptions of the term in literature range from "popular catchword" (Summer, 2003, p. 7) to "useless" (Schwartz, 1995, p. 20). Linkages between important banks and financial market developments that would – once reversed – severely threaten the stability of the financial system are most commonly circumscribing the term (cf. Bartholomew P. F. and Kaufman, 1995).

[15] Tucker (2009) also discusses recapitalization within financial stability preservation, in the form of Capital of Last Resort.

1.5 Interdependence between Crisis Origin and Objective Shifts

It has been described above how central bank objectives evolved from the needs of different historical periods. It has also been indicated that an interdependence between crises – often their origins – and shifts in the relative focus on the four objectives emerged.[16] The course of this shifting shall be outlined in the following. As a key result, the difficulty in pursuing and reaching all objectives simultaneously becomes clear. Table 1.1 structures and summarizes the discussion.

Table 1.1: Focus on Central Bank Objectives over Time

The table shows how central bank objectives developed over time and the focus shifted during historical periods according to the needs evolving from preceding crises. As a key result, the difficulty in pursuing and reaching all objectives simultaneously becomes clear.

	Central Bank Objective			
Period	Monetary Stability	Fiscal and Economic Stability	Financial Stability	Financial Soundness
Foundation	no	yes (government's bank)	no (financial system just developing)	
Classical Gold Standard	yes	no	developing (LOLR)	no (liberalized)
Inter-War Years	mixed	mixed	no	changing
Bretton Woods	lost over time	increasingly	yes (financial repression)	
Post-Bretton Woods	regained over time	no (Great Moderation)	no	lost (deregulation)

Source: author's compilation.

Central banks were founded as the need for a standardized currency arose and to establish credit systems. However, in the first place, these systems were primarily used by governments and in particular to finance wars, whereas the importance of the disciplining objective of monetary stability was not anticipated. As credit systems and banks were in their infancies, financial instabilities were not yet an issue on the agenda. For the same reason, regulatory interventions in the developing banking system did not exist. Accordingly, solely the fiscal and economic development was facilitated and fostered by early central banks.

The classical gold standard was a reaction to currency instabilities and crises resulting from inflationary war financing, especially during the Napoleonic wars in Europe.[17] Central banks were ordered to safeguard the convertibility to gold. Monetary stability was hence the overriding objective, which developed as a counterpoint to the fiscal and economic stability focus. Financial stability was initially still not addressed, although the role of the LOLR developed during that time. It became necessary as a lack of financial soundness in extremely unregulated financial markets brought up early crises originating in instabilities of financial markets.

[16] This is described by Borio (2008, 2014), whereby this section draws upon and extends the information provided there. A related discussion is provided by Eichengreen and James (2003), who particularly ascribe monetary and financial reform to threats to the global trading system.

[17] E.g. Cooper et al. (1982) present the historical environment of the gold standard.

The inter-war years were characterized by a renewed attempt to introduce monetary stability through the gold standard and stabilize World War I-inflated currencies (cf. e.g. James, 2001). The transition to fiat regimes – from the gold specie standard via the gold bullion standard – led to monetary stability being increasingly defined as price stability. Related to this was the acceptance that the strength of a currency was based on the state's power to tax rather than gold reserves, such that government securities emerged as the primarily collateralizing assets in central banks' balance sheets. Hence, higher degrees of credit expansion became possible during the time of central bank foundation, given that the connection to the availability of gold was lost. For one, this was tempting, while for another, a more active role in macroeconomic policy-making became possible for central banks, which started to "experiment with more active monetary policies" (Borio, 2014, p. 6), juggling with the objectives of monetary stability and fiscal and economic stability. This led to increased vulnerabilities to economic and financial cycles and ultimately the Great Depression. The period can thus be summarized by a mixed record in terms of both monetary stability as well as fiscal and economic stability. Financial stability was lost sight of, ultimately triggering instabilities in all objectives. Therefore, the liberalism of financial markets was identified as the basic evil and regulations to implement financial soundness were installed.

After World War II, the desire to reintegrate international trade into autarkic post-war economies and the inflation experiences from the time of the Great Depression and the war years motivated the installation of the Bretton Woods system. Central banks were assigned to safeguard stable exchange rates to the USD, which was pegged to gold. While monetary stability was hence the initial goal, it was lost over time as the US reliance on fiscal and economic stability financed with the help of the regulations of financial repression exported inflation into the entire system. The Vietnam War financing in particular contributed to the demise of monetary stability in the Bretton Woods system, cf. Capie et al. (1994). A general reliance on the macroeconomic development of economies after the war emerged, resulting in the Great Inflation. Accordingly, financial stability faded into the background owing to the strongly regulated financial system.

After Bretton Woods broke down under the Great Inflation and capital account imbalances, central banks bethought themselves of price stability as a monetary stability target. In Europe, the Bundesbank most successfully managed to sustain stable prices, such that other countries decided to bind themselves into an exchange rate system again in 1978 and follow Bundesbank policy in the Exchange Rate Mechanism of the European Monetary System, cf. Capie et al. (1994). At the same time, financial soundness was sacrificed to deregulation and financial instabilities re-emerged. Central banks did not actively pursue a fiscal and economic stability objective during what was called the Great Moderation, where stable prices and economic growth coincided. While Mishkin (2001) attributes the high growth rates to the achievements of central banks with respect to price stability, Borio (2014) denies any self-stabilization forces in the financial system and the economy, which central banks can conjure through the protection of price stability.

Chapter 2

Collateral Policy within Central Bank Objectives

The previous chapter carved out four central bank objectives: fiscal and economic stability, monetary stability, financial stability and financial soundness. In order to foster financial soundness, means of choice are regulatory arrangements that can be implemented by an institution separate from the central bank. The focus of this chapter is to define the role of collateral within each of the three remaining monetary policy objectives, i.e. the role that a central bank will adopt under each objective, in particular when the respective stability is unsettled such that the central bank has to act according to the role emerging from the respective objective, i.e. *(i)* custodian of the monetary policy rule (COMPR), *(ii)* lender of last resort (LOLR) or *(iii)* market-maker of last resort (MMOLR). The chapter places particular emphasis on the configuration of the collateral policy stance within the fulfillment of the three roles. Therefore, as a first step, six dimensions are identified along which collateral policy can be scaled: *(1)* the horizontal dimension of the eligible collateral pool, i.e. the range of asset types, *(2)* the vertical dimension of the eligible collateral pool, i.e. asset qualities, *(3)* the time dimension of the eligible collateral pool, i.e. asset ages, *(4)* the value-level dimension of the eligible collateral, i.e. operational conditions for the collateralized lending, *(5)* the flow-back dimension, defining eligible counter-assets being lent out and *(6)* the dimension sizing the access window, defining the eligible counterparty set. Each dimension is described and its facets are named as different layers. Consecutively, the three central bank roles are defined and the associated collateral policy is defined along the six dimensions.[18] As a result, the subsequently normative frame for the discussion of collateral policy measures in practice in Part II is created. Table 2.2 summarizes the suggested configuration of collateral policy from a normative perspective.

[18] Of course, there are usually large interdependences between instabilities in the economy, the fiscal sustainability and the financial markets that can subsequently often also affect the exchange rate and inflation. However, it is important to consider the central bank reactions independently to range in the relevance of collateral policy into each crisis management.

2.1 Dimensions of Collateral Policy

Before the next sub-sections refine the possible application of collateral policy within the central bank's endeavors towards each of its monetary policy objectives, this sub-section will elaborate on the dimensions of collateral policy as such. There are many facets in the process of lending against collateral that affect the refinancing conditions provided by a central bank. In the following, they will be presented as six dimensions along which collateral policy can be conducted: *(i)* asset types, *(ii)* asset qualities, *(iii)* asset ages, *(iv)* operational conditions, *(v)* counter-assets and *(vi)* counterparties.[19] Table 2.1 structures and summarizes the following discussion.

Asset Types The range of asset types constitutes the horizontal dimension of the accepted collateral pool, also referred to in the following as the asset/collateral quantity. If one thinks of the origins of collateralized lending in a pawnshop, when defining his collateral policy along this dimension the pawnbroker would ask: "What do I take in?" The quantity dimension is scaled along four layers. First, the number of different marketable asset types that are eligible matters. Here, the framework can be very narrow, including only very specific asset types, which then tend to be government bonds and public sector security. Wider frameworks also include private bonds or private securities in general, which might have to be covered or are also accepted if uncovered, securitized papers as asset-backed securities (ABS) can be included, even equities, etc. Second, the quantity of eligible collateral is affected by the degree to which non-marketable assets are eligible, if at all. Non-marketable assets comprise e.g. credit claims and other assets that cannot be traded on financial markets due to their structure and thus are mostly illiquid in a counterparty's balance sheet if the central bank does not accept them. Third, the denomination of both marketable and non-marketable asset types adds an additional layer to the quantity dimension. If a central bank accepts assets denominated in foreign currencies, it possibly increases the number of eligible assets without affecting the quality dimension, assuming that the exact same asset type has already been eligible in local denomination. However, it takes exchange rate movements as an additional risk, as a relevant factor for its monetary stability objective, as will be described in the next section. Fourth, the same is true for accepted residual maturities. If assets maturing later in the future additionally become eligible, this does not affect their quality in the sense as described below. Nevertheless, the longer residual maturity implies duration risk for the central bank. An extensive discussion of risks connected to a collateralizing asset – including exchange rate risk and duration risk – is provided in Section 4.5.3. In turn, the additional collateral not only frees up more assets on a counterparty's balance sheet, but also offers the opportunity to move the moment at which an asset (in effect a claim on some other entity) can be exchanged into liquidity (or the counter-asset) from the maturity date to an earlier point in time, which is valuable to the counterparty.

Asset Qualities The collateral pool is also scalable at the vertical dimension with respect to the quality of the asset types discussed above. A pawnbroker would ask: "What shape (quality) of the collateral do I accept?" Asset qualities accepted as eligible collateral are defined according to the following aspects in this dissertation. First and foremost, the credit quality – e.g. as measured

[19] For similar discussions, providing information presented here, see also Adrian et al. (2013), Bank for International Settlements (2013b, 2015), and Bindseil (2014).

by credit default swaps (CDS) or credit ratings derived by rating agencies – constitutes a layer of asset quality dimension. Lower credit quality implies a higher probability of outright default, as well as further downward credit quality shifts. The legal certainty of an asset subsumes the legally unambiguous definition of the claim underlying the asset and its subrogation in case of default on the collateralized loan to the central bank in this specific case. Ensuring this legal certainty is connected to costs for the pledging counterparty and hence occupies importance within the dimensions of collateral policy shaping the conditions for receiving central bank liquidity (or another counter-asset). The lower these costs are in effect for the pledging counterparty, the higher the costs of handling and settlement will be for the central bank as a lender in case of counterparty default. The same holds true for the simplicity of a collateralizing asset, such as the associated degree of securitization. The last two aspects affecting the asset quality are related to the market upon which the asset is traded. The more transparent a market, e.g. the closer it follows uniform regulations, the more valuable the asset is in terms of quality. In particular, the availability of market prices for the asset plays a role in this respect. The latter issue is also connected to the market liquidity. For one, the valuation of the asset is more precise in a more liquid market, while for another the liquidation risk in such a market tends to be smaller.

The first two dimensions described illustrate the notion that the dimensions of collateral policy are at least partially intertwined, given that asset characteristics have multifaceted implications. In the example of the described dimensions of asset quality and asset quantity (types), every additionally-accepted asset quality naturally increases the quantity of eligible assets. On the other hand, increasing the quantity of eligible assets might imply in some way that the additionally eligible assets are of a different quality in some respect of the quality dimension. For instance, deeming additionally-eligible private sector bonds traded on a non-regulated market horizontally broadens the eligible collateral pool, but also includes (potentially) less simple, less certain and less transparent assets. Moreover, the trading volume on the respective unregulated market might be lower, thus yielding higher liquidity risk. All this implies a lower quality. Section 4.5.3 is helpful in this respect as it discusses different types of risk associated with an asset type and the relation to its quality. However, conceptually one can think of the eligible asset pool as being broadened at the extensive margin (horizontally) when purely increasing the number of eligible asset types versus being broadened at the intensive margin (vertically) if additional qualities of these asset types are added to the pool.

Asset Ages As defined through its horizontal and vertical dimensions, the eligible collateral pool has not been discussed along a time dimension thus far. Effectively, the pool is an accumulation of assets fulfilling the criteria defined at the quantity and quality dimensions that have been issued at any point in the past and not yet matured. However, of course the pool could also be scaled at this dimension, such that only assets issued less than some specified time age would be eligible or only assets issued at least some time ago, respectively. Imagine a pawnbroker not taking in brand-new collateral, possibly for legal reasons, because he would subsequently act as a retailer, simply being a major demander from the producer's perspective.

Operational Conditions Factors strongly influencing the overall conditions for refinancing as set by the collateral policy stance are included in the dimension of operational conditions. This dimension lifts and lowers the level of the value of the collateral pool from the perspective of asset owners relative to the market conditions. The pawnbroker's question is: "How do I value the collateral and what are the conditions of my loan?" Technically, the question is answered by defining the collateral value of an asset, which determines the maximum loan amount receivable from the central bank.[20] An important influencing factor of the collateral value is the haircut specification, which covers several issues. From the central bank's perspective, haircuts are applied for risk management purposes. In theory, the configuration should thus follow all risk-enhancing determinants of an asset. However, in practice, the configuration can be more or less specialized to the asset's characteristics.[21] In addition to the asset type-specific haircuts, add-on haircuts for risk-implying factors – e.g. the above-described eligibility of foreign currency-denominated assets – can influence operational conditions. Through influencing the collateral value, haircuts are also an important setscrew affecting the price of an asset in the private market, cf. Chapters 6 and 7. Equally closely connected to the collateral value is the method of valuating the collateral in the first place. A market price can be adduced in many cases, but also the outstanding amount or some theoretically assigned value can be used, subject (or not) to conditions such as the non-existence of a market price. The more restrictive and conservative the valuation possibilities, i.e. the closer to the market price or lower values it is, the less favorable it is for the counterparty. Moreover, during the life of the loan, movements in the market price of the collateral might be tracked, triggering additional collateral requirements once they exceed pre-defined variation margins. Leaving more room for variations similarly to the valuation principle marks looser collateral conditions. In processing the collateralized loan, the collateral pledged can either be pooled – such that the pool of collateral provided secures the loan (or several loans) and the composition can be changed during the life of the loan – or each collateralizing asset can be earmarked for a specific transaction. Subsequently, changes are impossible and the collateral cannot be used otherwise during the life of the loan. Obviously, the first case leaves more flexibility in terms of collateral conditions (see Callado-Muñoz and Restoy, 2011, on earmarking versus pooling systems). Any asset used as collateral might be linked to the pledging counterparty in some way, i.e. including a claim on the counterparty itself or an affiliated institution. The most extreme manifestation of this would be an own-use asset, e.g. a bond issued by the counterparty itself and perhaps even not further backed by any claim of the counterparty against a third party and hence uncovered and only issued against the reputation of the counterparty. The peculiarity of such an own-use bond would be that it might have never been traded or priced in the market, which would offer significant room concerning valuation. Such assets with close links to the pledging counterparty might be restricted as collateral in total or to some degree. Similarly, the use of any type of eligible collateral can be limited and a one-sided collateralization of a loan can be prevented.[22] The last three aspects of the operational conditions dimension discussed here refer less to requirements concerning the collateral characteristics in particular yet are noteworthy constituents of the general conditions of the collateralized loan. For one, the allotment procedure of the central bank liquidity matters. Suppose that the liquidity is provided in volume tenders, i.e. auctioned among counterparties. Possibly favorable conditions regarding

[20] See Section 4.5.2 for a deduction of the collateral value.
[21] See Section 4.5 on the Eurosystem's haircut policy for an in-depth discussion of haircut setting.
[22] See in particular Bindseil (2014, p. 116) on the effect of such limits.

the collateral requirements might subsequently lead to aggressive bidding behavior, resulting in higher interest rates on the loan, which put the loose collateral requirements into perspective.[23] On the other hand, full allotment of liquidity implies an unlimited opportunity for making use of the collateral criteria (cf. Nyborg, 2015). Subsequently, at which interest rate the full allotment is granted holds importance, compared to prevailing market interest rates. For another, the life of the loan – namely its duration – defines for how long these collateral criteria can be enjoyed and banked on. Finally, it holds importance whether the conditions are offered permanently or only temporarily, possibly conditional on counterparty- or market-specific state variables. All three aspects of the general loan conditions thus represent multipliers for the collateral policy and can amplify but also restrict its impact.

Counter-Assets Along the above-discussed dimensions, it was defined what is required to receive a collateralized loan. Naturally, it holds equal importance – although in practice not as diverse – what the borrowing counterparty receives in return. This defines the flow-back dimension in the relationship between lender and borrower, or in the pawnbroker's words: "What do I offer in return for the collateral?" In most cases, the asset lent out in a collateralized loan is central bank money, i.e. cash liquidity. The counterparty can use it to immediately make new loans itself or service claims of depositors and other creditors. However, other arrangements are also conceivable. For one, selection options regarding the denomination of the liquidity collateralized might be granted. This option leaves flexibility to the counterparty, which might have to acquire liquidity in foreign currencies or particular safe-haven currencies. For another, the counter-asset lent out in a collateralized loan can be some security. Such collateral swap/lending facilities have special implications. First, the central bank can ensure that it does not create additional money, such that the monetary base is kept constant. New loan-making by the counterparty is subsequently not possible without further ado. Nonetheless, illiquid assets or those that cannot easily be traded or pledged in private markets can be swapped for more liquid ones to unfreeze a counterparty's liquidity problems in a situation of tense financial markets. Counterparties can then use the liquid asset as collateral and borrow liquidity from a liquidity surplus unit in the private market. Instead of this operation, the central bank could just as well achieve itself the liquidity from the liquidity surplus unit in the market against the liquid collateral and subsequently lend this liquidity out to its counterparty against distressed collateral. However, in the first case, credit relationships in the private market remain intact, which might be desirable. Second, an asset swap facility obviously discriminates assets against each other. The supply for the counter-asset is increased in exchange for any eligible collateralizing asset, thereby ceteris paribus aligning their relative prices or worths by making them substitutable (according to some ratio defined by operational conditions, see above).[24]

Counterparties Finally, the set of eligible counterparties that can access the collateral-based transaction with the central bank determines who is offered the collateralized loan package defined along the five dimensions discussed above. This is the answer to the pawnbroker's question: "From

[23] See e.g. Bindseil et al. (2009b), Ewerhart et al. (2006), and Nyborg et al. (2002) for analyses of bidding behavior. Drehmann and Nikolaou (2013) and Dunne et al. (2013) indicate that banks especially desperate for liquidity during the recent financial crisis were bidding more aggressively for central bank liquidity.

[24] See also Bank for International Settlements (2014) on securities lending programs and their usage to free up collateral constraints in private funding markets.

whom do I take collateral and to whom do I lent in exchange?" This final dimension can be sub-divided along four lines, clustering the groups of possible counterparties into banks, non-bank financial institutions and non-financial entities. Moreover, quotas/limits per counterparty can fine-tune the degree of access of each counterparty. A central bank usually works together with banks. However, based on the structure of the financial system in its jurisdiction, it might choose to only offer access to its facilities to a small subset of them, in the sense of primary dealers. At the other end of the spectrum, a central bank could interact with every single bank in its jurisdiction. In practice, the eligibility for access decision typically builds upon the effectiveness of the transmission of monetary policy into the niches of the financial market and from there to the real economy. Therefore, a central bank might even decide to grant access to collateral-based lending facilities to non-banks, i.e. other financial institutions such as money market mutual funds, pension funds or insurance companies, as well as non-financial institutions such as companies or even private households. Independent of how many counterparties are eligible within the collateral framework, the access of each counterparty can be leveled by the implementation of limits on the use of the collateralized lending facility. These limits can assume the form of uniform absolute limits, restricting the access to a specific amount of credit, which is the same for all counterparties (e.g. Bindseil and Winkler, 2012, for the German case around 1930). Alternatively, there can be quotas restricting the access for a counterparty to some fraction of e.g. its balance sheet total (as also common more recently in several countries, see Kasman (1992)). It generally holds that the more open the access, the more direct the transmission of the conditions defined along all other dimensions of collateral policy.

The uniformity of the collateral framework as a whole is often cited as an elementary distinguishing parameter of collateral frameworks of central banks around the world (e.g. Bank for International Settlements, 2013a). A central bank can define one set of collateral criteria leading to one set of eligible collateral that is applicable to all of its liquidity providing operations with all counterparties or it can differentiate several such collateral sets. The differentiation can be made e.g. by group of counterparties or by type of liquidity providing operation, whether an open market operation (OMO) or liquidity provision through a standing facility. In particular, emergency lending facilities are sometimes subject to different (extended) collateral requirements. However, in what follows, the configuration of the six above-discussed dimensions of collateral policy will be deduced from all three central bank objectives presented in Chapter 1. It will become clear that each objective alone would call for a unique configuration along the dimensions and thus would imply a unique framework. Therefore, any differentiated collateral framework arises from the notion that central banks follow more than one objective and design their policy frameworks accordingly. This observation is rationalized in a simplified model in Chapter 6. It is shown that financial stability policy should make use of collateral policy along the quantitative dimension, defining the range of eligible asset types, while market-making to foster fiscal and economic stability should rather be undertaken by shaping operational conditions accordingly, cf. Section 6.3.

Table 2.1: Dimensions of Collateral Policy

The table shows the six dimensions along which collateral policy can be scaled and conducted. Each dimension divides into several layers.

Dimension	Layers
Asset Types	Range of eligible marketable asset types
	Eligibility of non-marketable assets
	Eligibility of foreign currency-denominated assets
	Residual maturities of eligible assets
Asset Qualities	Credit quality
	Legal certainty
	Simplicity of asset
	Transparency of asset market
	Liquidity of asset market
Asset Ages	Accepted issuance dates towards past
	Accepted issuance dates towards present
Operational Conditions	Haircut specification
	Collateral valuation
	Margin calls
	Interchangeability of pledged collateral
	Close links
	Quotas/limits per collateral type
	Allotment procedure
	Duration of loan
	Permanence of conditions
Counter-Assets	Liquidity
	Denomination
Counterparties	Openness to banks
	Openness to non-bank financial institutions
	Openness to non-financial entities
	Quotas/limits per counterparty

Source: author's compilation.

2.2 Custodian of the Monetary Policy Rule: Building upon the Origins of Collateralization

Fulfilling the role as COMPR – i.e. safeguarding monetary stability – yields two aspects for a central bank. The first is closely tied to the origins of collateralization and focuses the backing of the currency. Following this narrow definition of monetary stability, the single role of the central bank is to maintain the internal and external convertibility of the currency. Under a standard, this means pegging the currency to some external value, such as silver, gold or another currency. For each unit of the currency that the central bank has issued, representing a liability in its balance sheet, there must be reserves of the currency or asset pegging to on the asset side. In practice, the issuance of currency to commercial banks has to occur against the acquisition or the pledge of this reserve asset. Thereby, one unit of the currency always represents the same amount of the reserve asset, as intended by the peg. This is by definition simply monetary stability. In the absence of a peg, the monetary stability objective is usually translated into price stability. The mechanism to preserve it remains the same: as Nyborg (2015, p. 32) suggests, "we can think of the assets of a central bank as representing the 'gold' that backs up the money." The issuance of currency hence has to occur against assets representing the price index of goods and services targeted to remain stable. The most straightforward way to enforce this is to keep these assets as reserves on the central bank's balance sheet, thus backing each unit of currency that the central bank has issued as a liability.

From the currency-backing perspective, it occupies minor importance how the central bank conducts its monetary policy operations. Whether it outright purchases assets, discounts assets for liquidity or lends against collateral, the operation always represents an extension of its balance sheet in terms of both liabilities (issued currency) and assets, where regardless of the operational form some asset is added to back the currency. However, it holds importance which collateral criteria the central bank employs within the operational form that it chooses. In its early years, the Fed conducted around 80% of its monetary policy operations through discount window loans, before switching to open market purchases in the 1930s, recognizing the effectiveness in affecting credit availability for the real economy, cf. Clouse (1994) and Federal Reserve System (2002). The reason for this lies in the financial system of the US, where the financing of the real economy is strongly market-based. For this same reason, the Bundesbank – operating in a bank lending-based financial system – has always rather resorted to collateralized lending, cf. Deutsche Bundesbank (2006), Laurens (1994), and National Monetary Commission (1910). Until 2009, the ECB generally followed this approach for similar reasons (European Central Bank, 2011). Regarding the asset purchases that it has conducted since then, it has applied the same collateral criteria as for its collateralized lending.

The desire to stabilize the currency was the driving force behind the gold standard. The value of the currency should be secured. Collateralizing it with the precious metal, a very valuable and durable asset, minimized the risk of an eroding backing of the currency as it had been experienced in many cases before. For instance, such an erosion of the currency due to weakening collateralization had been experienced at Stockholms Banco, a forerunner of the Swedish Riksbank (see Flux, 1911). Any risk of a loss on the asset side of central banks' balance sheets is a risk of money issued (constituting a liability) and not matched by an asset. Weaknesses in a central bank's balance sheet affect its credibility, the trust in it and ultimately the stability of money and prices (Knot, 2013; Nyborg, 2015; Stella, 1997). The risk management function of collateral is hence primary to the objective of monetary stability (Bindseil and Papadia, 2006; Federal Reserve Bank of St. Louis, 1916). The stability was meanwhile originally only perceived as preventing *in*flation, the indication for the erosion of the value of the currency. Hence, monetary stability was originally not necessarily connected to price stability. By contrast, temporary *de*flation and depression were even perceived as healthy for the economy (Epstein and Ferguson, 1984).

Practically, central banks guaranteed convertibility to gold by specifying minimum gold coverage ratios, i.e. some fraction of each unit of the currency to be backed by gold. For example, the Reichsbank still defined a minimum gold coverage ratio of 40% during the inter-war years (Bindseil and Winkler, 2012). If the ratio fell below the defined minimum, central banks were unable to issue additional liquidity, even if such would be strongly demanded by the economy (from the fiscal and economic stability perspective). The collateral requirement thus made it difficult to react to fluctuations in money demand from the real economy, such as calendar effects or changes in business demands for credit. It represented an inelasticity that was commonly considered to have contributed to the panic of 1907 (cf. Federal Reserve System, 2002; Nyborg, 2015).

As a result, the second aspect incorporated into the understanding of monetary stability was the idea of a stable currency being elastic. It should expand and contract with the needs of the real economy. Thereby, the price stability component within monetary stability was strengthened as the issuance of money was connected to movements in real economic production and the creation of value. The key element was the Real Bills Doctrine, which allowed assets connected to actual real economic activity as secondary collateral for monetary policy operations. On the one hand, it followed the recognition that banks needed some scope to discount existing assets (claims) to make additional loans and finance commercial activity, see Warburg (1910). The Real Bills Doctrine was in this respect oriented to the clearing and settlement function of early clearing houses in the 16th century roots of European central banking, particularly in Germany and the Mediterranean, see Lacker (1997). They also had already issued certificates collateralized by claims resulting from real economic activities that could be subsequently traded, cf. Cannon (1911) and Gorton (1985). The certificates formed an early currency, which most naturally was connected to real economic developments, reflecting a practice that the BoE drew upon soon after its founding, cf. Richards (1934). On the other hand, the strong reliance on (usually short-term) commercial papers was regarded as ensuring "self-liquidation". In the sense that the liquidity provided was collateralized by the investment it was needed for in the first place, the loan would "pay back itself" and at the same time bear little risk for the central bank's balance sheet (Federal Reserve System, 2002). It also becomes clear that for the elasticity component of monetary stability, the collateralized lending more naturally follows the real economic demand for money than OMOs, cf. Federal Reserve System (2002).

The Fed Act of 1913 explicitly incorporates the Real Bills Doctrine, linking the amount of money issued to "notes, drafts, and bills of exchange arising out of actual commercial transactions, that is [...] issued or drawn for agricultural, industrial, or commercial purposes, or the proceeds of which have been used, or are to be used, for such purposes [...] with a view of accommodating commerce and business" (Sections 13 and 14 of the Act), cf. Friedman and Schwartz (1963). Moreover, a general aversion against the use of collateral based on purely financial transactions prevailed, as they were seen as a risk to monetary stability. The Fed Act specifically prohibited the discount of paper covering merely investments or issued or drawn for the purpose of carrying or trading in stocks, bonds or other securities, see Federal Reserve System (2002). As elasticity was meant to include both expansion and contraction rather than only inflationary expansion, a collateralization by government securities was also initially unprovided for. Warburg (1910, p. 37) emphasizes: "Notes issued against discounts mean elasticity based on the changing demands of commerce and trade of the nation, while notes based on government bonds mean constant expansion without contraction, inflation based on the requirements of the government without connection of any kind with the temporary needs of the toiling nation. Requirements of the Government should be met by direct or indirect taxation or by the sale of government bonds to the people. But to use government bonds or other permanent investments as a basis for note issue is unscientific and dangerous." While this sounds well defined, the decision concerning whether assets were being accepted as collateral – and hence considered Real Bills – has ever since implied manifold discussions. Steiner (1926, p.

327) expands upon these and concludes: “By no means do we find a clear-cut body of dicta which is logically consistent.”

The perception of monetary stability as uniting the aspects of a strong backing of the currency and the elasticity to real economic movements – and as particularized in the Fed Act – also prevailed in Europe. To be precise, the Fed Act was a collection of best practice from Europe evaluated by the National Monetary Commission between 1908 and 1912. The monetary stability objective thus brought together elements of the Currency Principle and the Banking Principle (Westerfield, 1921), that e.g. had already found their ways into the foundations of the Reichsbank in Germany in the 19th century, cf. Deutsche Bundesbank (2006) and Pfleiderer (1976). While the Reichsbank allowed gold and silver to be pledged to their full value (without applying a haircut), it assigned a collateral value of two-thirds of the nominal value to German merchandise and applied a haircut of at least 5% to bills of exchange, see National Monetary Commission (1910) and Reichsbank Act of 1875, Section 13.3. Moreover, foreign securities could be used as collateral to the amount of half of their value and German government or government-guaranteed assets (including those of railway institutions) up to 75% of their value.

With the abolition of the gold standard, gold increasingly lost importance as a collateralizing asset. As already noted in Section 1.5, the transition to fiat regimes brought along a shifting of the trust in currencies to the mightiness of the jurisdictional tax base. Government assets hence gained importance as a collateralizing device. Note that this can even be justified along the lines of the Real Bills Doctrine given that the taxing power and tax revenues are strongly related to the real economic development as long as government finances follow a sustainable path. However, should the credibility of a government be called in question, this indicates that the outstanding government debt has lost track of real economic activity generating tax income in an amount that ensures its sustainability. Consecutively, any currency-backing with this debt would equally be questionable. The collateralization with government securities can hence lead to problems from a monetary stability perspective whenever the connection between money growth and real economic growth is lost due to the detour in collateralization via government securities. Especially if governments tend to issue unsustainably high amounts of debt, any achievement of the Real Bills idea is destroyed.

The Real Bills view explicitly lived within the Bundesbank statutes until the 1990s, which required eligible bills of exchange to be based on deliveries of goods and services (“gute Handelswechsel”) (Deutsche Bundesbank, 1995, p. 101 f.). Bindseil and Papadia (2006) highlight this as superfluous when stating that monetary policy implementation nowadays works through the interest rate and liquidity management, such that it does not depend on the type of asset pledged. Collateral would thus simply be a means to an end, which serves as a risk-mitigation tool. Of course, the interest rate and – to be precise – all operational conditions as defined in the previous section together can be used to make central bank refinancing more or less expensive. In principle, a central bank can thus keep money growth in line with real economic developments.[25] Collateral would then only be required to mitigate counterparty risk, because the central bank interest rate cannot be differentiated individually according to the credibility of every single counterparty, cf. Section 4.5.3. For certain, any collateral taken in would also have to be completely safe, because any loss

[25] See also Issing and Rudolph (1988) for an elaboration on this argument.

on collateral would disturb the central bank's control of the money supply. Monetary stability can thus be implemented using any safe asset and controlling the money supply via refinancing conditions (both price and amount of central bank liquidity). However, at least three arguments advocate collateral criteria related to the economic activities, the prices of which are targeted to be kept stable. First, it is very difficult to find a collateralizing asset (in sufficient amount) that is completely safe, as it should for the reasons explained above be. The use of government securities in particular implies the risk of unsustainably high debt issuance beyond the realm of the central bank. Second, the central bank has to be able to steer the money supply according to real economic developments, i.e. measure and forecast it correctly. This is difficult and connecting central bank credit provision to this very economic activity by requiring collateral originating from it (thus being backed by it) constitutes a helpful anchor on the way. Third, there are limits to the transmission of interest rate policy, especially at the ZLB, which can be overcome through collateral policy as shown in Chapter 6.

In order to set a normative framework for the discussion of collateral policy measures in practice in Part II, Table 2.2 provides an overview of the requirements imposed upon the collateral policy stance by the central bank objectives presented in Chapter 1. It is structured according to the six dimensions of collateral policy deduced in Section 2.1.

From the perspective of the monetary stability objective, the aspect of mitigating risks to the central bank's balance sheet as well as mitigating deflationary and inflationary movements due to the too insufficient or excessive issuance of money relative to the developments of the real economy have to be combined. The quantitative dimension of collateral eligibility to enforce monetary stability can be kept small. The range of eligible asset types should strictly represent the index to which the money value should be aligned. If this value should simply follow gold, the collateralizing asset should be gold, whereas if it should follow another currency, the collateralizing assets should follow the movements of this currency. It is common to follow the real economic development and hence it should be backed by assets contributing to that. For this reason, as described above, initially eligible collateral comprised gold and Real Bills. If nowadays the value of money should be preserved in the sense of keeping some price index of goods and services constant, the issuance of money would have to follow the quantity of these goods and services. Broadly speaking, a bank contributing to an increase in this quantity by making a loan (or buying a commercial bond issued by a company to finance offering additional of these goods and services) should subsequently be able to pledge this claim (the commercial bond) as eligible collateral for additional central bank liquidity. Therefore, the amount of money and goods and services offered would increase to the same degree and prices would remain stable. In this example, the claim pledged by the bank might be a non-marketable asset and should in principle still be eligible. The eligibility of assets denominated in foreign currency is highly sensible if monetary stability is defined in relation to other currencies but otherwise yields the additional risk of exchange rate movements for the central bank's balance sheet. The movements of foreign currencies would then to some degree translate into the value of the local currency, which might be just intended. Originally, central banks required eligible assets to be of rather short residual maturities to preserve their "self-liquidating" character. From a risk management perspective, they definitely also have a point that should be respected by central banks pursuing monetary stability today.

As discussed above, in principle, the implementation of monetary stability can also be achieved if the collateralizing asset is disconnected from the development of the relevant price index. Subsequently, collateral has to be first and foremost safe. While it remains undefined what type of asset should be pledged, it is necessary to place special emphasis on the quality dimension. In any case, an important prerequisite of collateral fostering monetary stability is high quality.[26] Even if the gold standard was at some point loosened and later abandoned, the assets backing the issued currency still should be as safe as gold to limit the risk of losses for the central bank. This touches all aspects of asset quality similarly. In case the central bank would have to make use of the collateral because the counterparty defaulted on the loan, the underlying claim should be safe, simply enforceable and literally "self-liquidating".

There is no reason to restrict the age of the eligible collateral set from a monetary stability perspective, as long as assets are valued correctly.

This leads to the requirements on operational conditions. They should be appropriate, in particular not undercutting refinancing conditions in the market. Leaving a discussion concerning the single aspects of the operational conditions aside, the importance lies in the overall resulting conditions. A prudent haircut specification and a conservative valuation of the collateral can be used to mitigate any risks arising from the quality dimension. Close links will by definition not exist in eligible collateral, given that no assets based on purely financial transactions should be eligible if the monetary stability is defined in relation to the real economic development. However, a claim on an institution with close links to the pledging bank would be of this financial nature in most cases.

As the monetary stability objective does not seek to influence the relative value of two different assets, collateral swap facilities are not indicated. Foreign currency lending might play a role if monetary stability is defined in terms of an exchange rate relative to another currency.

Finally, from a risk management perspective, the counterparty access can be shaped in a rather restrictive way as long as the transmission of central bank liquidity to the demanding agents in the real economy is assured. Subsequently, only a small subset of highly credible banks would have to interact with the central bank and then initiate the further distribution of the liquidity. If investment projects are financed through bank credits, the access of non-banks would not be necessary. As long as loans to counterparties are collateralized by collateral as defined above, the limitation of liquidity per counterparty is not necessary, given that both risk of default (of the collateral) – hence losses for the central bank – and the threat of inflationary credit bubbles are kept in rein.

2.3 Lender of Last Resort Policy and Collateral

The LOLR role of a central bank is targeted at preserving its monetary policy objective of financial stability. It is called into action in times of liquidity crises in the banking sector, e.g. as described in Bindseil (2014, Ch. 11). These crises are triggered by some "sudden event", which in the words of Bagehot (1873, Ch. 6) can be of "the most various nature: a bad harvest, an apprehension of foreign invasion, the sudden failure of a great firm which everybody trusted, and many other

[26] For instance, Lehmbecker (2008) shows a negative correlation between eligible collateral quality and inflation.

Table 2.2: Configuration of Collateral Policy along Dimensions and by Central Bank Objective

The table provides an overview of requirements imposed on the collateral policy stance by the central bank objectives presented in Chapter 1. It is structured according to the six dimensions of collateral policy deduced in Section 2.1. The table thus provides a frame for the analyses of collateral policy measures in practice following in Part II by suggesting the configuration of collateral policy from a normative perspective.

Dimension	Central Bank Objective (Role)		
	Monetary Stability (COMPR)	Financial Stability (LOLR)	Fiscal and Economic Stability (MMOLR)
Asset Types Range (Horizontal)	small	wide	selective
Asset Qualities (Vertical)	high	according to inertia principle	low
Asset Ages (Time)	no restriction	already-issued	encouraging new issuances
Operational Conditions (Value-Level)	appropriate/prudent	above (normal) market	below (normal) market
Counter-Assets (Flow-Back)	liquidity	(sterilized) liquidity & swap	liquidity & swap
Counterparties (Access Window)	small set of solvent banks	wide set of solvent banks	wide set including non-financials

Source: author's compilation.

similar events, have all caused a sudden demand for cash." A threat to financial stability then arises from asymmetric information problems in the sense of Akerlof (1970), which lead to bank runs (Diamond and Dybvig, 1983). The interbank market collapses, while systemic risks such as credit exposure between banks amplify the process (Freixas et al., 1999). As a LOLR, the central bank is subsequently to provide the missing liquidity to banks, albeit the scope and conditionality of this provision are subject to discussions, as will be outlined below. Its actions are aimed at preventing fire sales and defaults or – in the language of multiple equilibria theory (cf. Freixas and Rochet, 2008; Morris and Shin, 2001) – preserving the no-run equilibrium (cf. Bindseil, 2013; Gorton and Ordooez, 2014).[27]

Technically, the LOLR role had been assumed by a central bank at the very moment it took responsibility for the stability of the banking system as a whole. Accordingly, for most central banks, this was probably before the publication of Lombard Street in 1873 (Bagehot, 1873). In any case, Bagehot built upon the thoughts of Thornton (1802), albeit without citing him. However, his book significantly contributed to clarifying the term's meaning such that a consensus on the importance of the inclusion of financial stability as a monetary objective had developed among central bankers by around the end of the 19th century (see Capie et al., 1994). Again, this manifested in the Fed Act, see above. Moreover, Bagehot's definition – or what since has been frequently called "Bagehot's Dictum", saying that in times of crises "to avert panic, central banks should lend early and freely (i.e. without limit), to solvent firms, against good collateral, and at high rates" (Tucker, 2009, p. 3) – was by that time agreed on by most central bankers.

Nevertheless, the spectrum of mindsets on the LOLR's tasks, its scope and conditionality is much wider than this. It mainly stretches according to four questions:

- Who, if anybody, should be the LOLR?
- Should the focus be on a global market level or extend to individual bilateral lending?
- How are the conditions of the last resort lending to be defined?
- Is liquidity provided to solvent but illiquid institutions only, or just as well to insolvent ones?

According to Goodhart and Illing (2002), four views on the markedness and the design of the LOLR role can be distinguished. *(i)* First, the necessity of a LOLR can be questioned altogether.[28] Banks could also coordinate liquidity lending among themselves in crises. As an early proof of the argument, clearing houses are brought up (Timberlake, 1984). Indeed, clearing houses assumed the role of reallocating liquidity among member banks, e.g. before a national central bank had been founded in the US. However, they were not very successful in preventing banking crises and with the foundation of the Fed the notion of advocates of central banking prevailed over the ideas of proponents of the free banking theory (see Goodhart, 1988, Ch. 2, for a description), which underlie the argument against an institutionalized LOLR. Naturally, with the decision for central banking, the need for the central bank to adopt the role of a LOLR emerged and was insofar accepted as central banks were public institutions responsible for the lending (of last resort) to banks in

27 The literature on the LOLR and descriptions of situations where it is needed is extensive. Particularly comprehensive overviews are e.g. provided by Bignon et al. (2012), Freixas et al. (1999, 2000), Goodhart and Illing (2002), and Nyborg (2015).

28 Goodfriend and King (1988) argue that in any developed country a solvent bank should always receive liquidity in an efficient market. Therefore, a central bank is not to assume this role. See Drechsler et al. (2016), who provide an overview on the literature in favor and against a LOLR.

a jurisdiction that was at the same time a fiscal union or a nation. The recent reversing call for more self-organization of the LOLR role among banks – such as in private bank-rescue funds – particularizes in Europe, where the mandate of the ECB for the LOLR role is not as easily taken for granted, e.g. as discussed by Aglietta (1999), Cour-Thimann and Winkler (2012), Folkerts-Landau and Garber (1992), González-Páramo (2013), and Prati and Schinasi (1999). *(ii)* Second, the way of thinking connected to Bagehot and Thornton conceives the LOLR as being oriented to the financial system as a whole. It offers lending at reasonably high conditions to all banks that are temporarily illiquid but solvent. *(iii)* Third, the "banking view" – sometimes attributed to the Federal Reserve Bank of New York (Tucker, 2014) – extends Bagehot's view and includes bilateral lending. This means that the LOLR should also make emergency loans outside its standing/discount facilities to particularly troubled banks. This emergency lending will be denoted by Emergency Liquidity Assistance (ELA) in the following, employing the term used by the Eurosystem. The conditions will subsequently be individually determined and might also be very soft and favorable.[29] The solvency condition fades into the background. *(iv)* Finally, the forth strand of thought calls for an international lender of last resort (ILOLR). The need for this international dimension has been debated (e.g. Bank for International Settlements, 2014; Capie, 1998; Fischer, 1999; Giannini, 1999; Schwartz, 1999). Sometimes the IMF is seen as an ILOLR, although it lacks a central bank-like integration into the financial system. As the ECB operates internationally, it can be seen as an ILOLR. However, just like the LOLR, the ILOLR is subject to risks. Goodhart (1999) and Goodhart and Schoenmaker (1992) thus perceive the LOLR role in the euro area with the respective NCB and not the ECB, because a central bank can only bear these risks and remain credible regarding other objectives if it is backed by a government that has the taxing power to guarantee for the exposure and recapitalize the central bank if necessary. This particularly holds in case of emergency lending and despite collateralization, because the collateral value can always fall below the loan value in a crisis (Freixas et al., 1999). As the majority opinion on the LOLR stretches within the range of the second and third angles described above, the following particularization will be narrowed accordingly.

The classical Bagehotian view on a LOLR is not delimited in a clear-cut way from extended definitions including ELA and even the role of a MMOLR, which will be discussed in the next section. In the original perception, the lending of last resort through central banks comes into effect as a rather passive process stemming from an extended elasticity understanding, as described in the previous section. Borrowing through the central bank facilities automatically increases as the interbank market dries up. As Bagehot states, the loans are to be secured by what is at normal times perceived as good collateral and to be offered at high rates. The underlying idea is that in normal times banks would easily be able to liquidate the acceptable collateral in the interbank market, whereas in times of crisis they are not. They are thus illiquid but not insolvent, which is an important precondition for LOLR action à la Bagehot. In addition, he calls for high rates compared to the pre-crisis rates. A straightforward justification for this claim would be that the lending would not be lending of *last resort* if it would occur at below market conditions, cf. Freixas et al. (1999). Instead, high rates are meant to bring about a selection between banks in need of liquidity and those hoarding liquidity, thereby aggravating the liquidity crisis. Insolvent banks

[29] For the regulations of the Eurosystem on ELA, see ECB, *ELA Procedures*, 17 October 2013, `https://www.ecb.europa.eu/pub/pdf/other/elaprocedures.en.pdf?3711be9539245568ac03563f983ac062`, last accessed 20 March 2016.

should be discouraged from taking additional loans altogether (Rochet and Vives, 2004). Only needing banks should borrow from the central bank. For hoarding banks, the opportunity costs of not lending should be increased and thus a revival of the interbank market should be encouraged and most importantly a signal of its unwillingness to become the MMOLR should be sent by the central bank (cf. Bignon et al., 2012; Martin, 2009). Another argument for high rates is the ex-ante prevention of moral hazard. Credibly announcing high rates for times of crises prevents banks from taking excessive risks and expecting cheap liquidity offered by the central bank in case of emergency (Sheng, 1991; Summers, 1991). Finally, high rates represent a compensation for the central bank exposure (Humphrey, 1989; Sleet and Smith, 2000).

Divergently, the third angle *(iii)* on the LOLR described above assigns a more discretionary role to the central bank as compared to the stricter rules of Bagehot's Dictum. While Bagehot does *not explicitly deny* bilateral lending (Capie et al., 1994) — in fact, he must have known and accepted it, provided that the configuration of conditions respected his prescriptions – the (as under *(iii)* described) extended view on the LOLR *explicitly includes* bilateral emergency loans, i.e. loans at favorable conditions compared to regular LOLR facilities. Connected to this is a revised thinking on the operational conditions of collateralized lending. Bignon et al. (2012) argue that part of Bagehot's request for high rates emerges from the obligation of central banks at his time to obey the gold standard. Low rates would have triggered a capital flight, placing the parity to gold at risk and leading to a gold drain. Having the gold standard left behind, they proceed to claim the case for zero interest rates would be substantiated by analyses of the coordination problem that prevents banks from lending to one another, requiring the LOLR to guarantee the continuation of liquidity provision. Other arguments against high rates include the risk of an aggravation of banks' crisis (e.g. Crockett, 1996), the stigmatization of banks that borrow at the high rates and possibly resulting gambling for resurrection (e.g. Freixas et al., 1999). As Bindseil (2007, p. 20) puts it: "financial crisis management measures are about supporting institutions in trouble, it would be contradictory to charge them a penalty rate which would reflect a full risk premium. [...] Overall, this topic seems to be somewhat overrated in the literature, as the rate charged, within the reasonable range, will not be decisive for anything, including incentives."

If it is insufficient to lower the rate of interest to zero and water down operational criteria, bilateral ELA can also be granted against an extended collateral set, which does not suffice the regular LOLR requirements on collateral. A discussion of ELA in comparison to regular LOLR actions is given e.g. in Bindseil (2007) or Cecchetti and Disyatat (2010). Such practice inevitably amplifies the above-described concerns of moral hazard. Most central banks do not disclose the circumstances and conditions upon which they provide ELA. They argue that this "constructive ambiguity" in executing ELA mitigates the amplified risk of moral hazard connected to this practice (Corrigan, 1990). The small number of central banks that specify a policy framework for ELA – notably the Bank of Canada, the Sveriges Riksbank and the Hong Kong Monetary Authority – state criteria used to check the solvency of the counterparty in advance. Proponents of ELA express the conviction that "one may imagine that due to supervisory functions, or close relation to the banking supervisor, a central bank has more knowledge than the market, and knows that a bank (or banking system) with liquidity problems is solvent, such that emergency liquidity assistance can be done with little or no risk, in view of the collateral the bank can offer" (Bindseil, 2007, p. 11), see also Freixas et al. (1999). However, at this stage at the latest, the solvency of the counterparty must be questioned.

Recalling Bagehot's above-presented argument that a central bank should accept the collateral of a temporarily illiquid bank in crisis (in its regular LOLR role) because this collateral would be liquid under normal conditions and hence at all times guarantees the solvency of the bank in this case leads to the conclusion that any bank without such collateral is likely to be insolvent. According to Goodhart (1999), the question of solvency is insignificant altogether given that in the heat of a crisis the central bank cannot evaluate it anyway. In his opinion, the ELA is provided in accordance with the respective government to redistribute possible losses among taxpayers. This corresponds to the incidence of ELA being frequently granted in combination with government guarantees for the counterparty or the insufficient collateral provided, yielding the existence of a national interest in liquidity provision to the respective bank and hence a relevance for the economy and welfare that exceeds financial stability objectives.[30]

Historically, the classical view on the LOLR following Bagehot's prescription of high rates, a broad range of collateral that would at normal times be of good quality, a predominantly global approach, offering the LOLR facilities to all banks equally given that these are solvent preserved until World War I as well as during the inter-war years. After World War II and during the Bretton Woods period, the LOLR role was not strongly discussed in the absence of a need for it (Le Maux and Scialom, 2010). When financial instabilities returned in the 1970s and 1980s, the re-assessment of the LOLR role in principle agreed to the elements of the second view *(ii)* described above, albeit defining the preservation of financial stability as clearly secondary to monetary stability, yet assigning the central bank a more active role by shifting the instrument of choice from the discount window to OMOs (Humphrey and Keleher, 1984, for an overview). The view shifted over time, by the end of the 20th century both including the offering of bilateral loans and softer interest rate conditions to solvent banks (cf. Capie et al., 1994). This was also put into practice, e.g. during the US savings and loans crisis (cf. Freixas et al., 1999). While central banks could never be certain about flawlessly identifying illiquid but solvent banks, the accusations of having failed to do so increased since 1970 and were especially pronounced during the recent financial crisis (cf. Salter, 2014). Because the Bagehotian prescriptions were designed to support identifying them, easing them raised the risk of failures. With the establishment of ELA, going even further and explicitly including collateral insufficient within the regular LOLR framework, the possibility of liquidity provision to insolvent banks was even supported, as described in the previous paragraph.

In terms of this dissertation, the definition of the LOLR role will follow the extended Bagehotian view of lending against a broad range of collateral to solvent banks, placing less weight upon the height of the interest rate. Nevertheless, important features in the design of the collateral policy shall be respected. While the interest rate does not have to be above the market rate, it can be. In any case, the operational conditions as a whole should be set at a premium in comparison to the rates in the money market in normal times. Thereby, the forces named in the arguments for high rates presented above can work, i.e. only illiquid banks make use of the LOLR facility, moral hazard is prevented, liquidity-hoarding is prohibited and the last resort character prevails. This definition in principle also allows for bilateral emergency lending to solvent banks. However, the

[30] Another voice arguing for the irrelevance of solvency is Kaufman (1991). However, he explicitly states that his point refers to regular LOLR assistance through the discount window: as long as collateralization standards are respected there, the possible insolvency of the counterparty holds minor importance to the central bank. However, in this point his definition of insolvency differs from the interpretation underlying in this dissertation, given that the availability of eligible collateral should be an indication of illiquidity rather than insolvency.

solvency condition must be met, as agreed by most literature (e.g. Humphrey, 2010; Tucker, 2014). Only Goodhart (1999) explicitly allows for insolvency. This implies that ELA, as conducted during recent central bank crisis management against collateral of quality that would not suffice under the regular frameworks, comes within the MMOLR role – which will be defined in the next section – for two reasons. First, the discretionary decision to accept ineligible collateral has an impact on the underlying asset market. Second, as described above, a bank not being able to bring up the collateral necessary for regular LOLR facilities is (by definition of the collateral requirements for LOLR facilities) likely to be insolvent. Arguments of central bankers against this claim build upon the supposedly superior knowledge of the central bank over the market and the superior ability of the central bank to secure its claims against the respective bank (cf. Bindseil, 2007). However, the integration of social costs in the decision to grant ELA is mentioned in the same breath, hinting at underlying interests of government, with the real economy and society exceeding the financial stability objective of the central bank. In this case, the incentives for ELA represent classical arguments in favor of bailouts and purposely steering credit. For both reasons described, ELA influences markets or creates markets where there would otherwise be none. Accordingly, it is included in the MMOLR role.

Implications for the design of collateral policy within the role of a LOLR emerge as follows and are summarized within Table 2.2. The quantity of eligible assets and the range of eligible asset types has to be large, because only then can a sufficiently large amount of liquidity be collateralized at all. Assets serve as a storage facility for liquidity that banks have to be able to tap on in a liquidity crunch (Nyborg and Östberg, 2014). Therefore, it relieves banks best from liquidity pressures originating on the liability sides of their balance sheets if large parts of the asset sides are pledgable at the central bank for liquidity or easily liquifiable assets. This approach is formally elaborated in Section 6.1.3. Central banks have to make the collateral available to substitute for the tightened collateral criteria of private markets during a crisis (cf. Bank for International Settlements, 2015). Bagehot quotes Jeremiah Harman, director of the BoE during the 1825 panic, to illustrate large quantity of assets a LOLR has to accept: “We lent [...] by every possible means [...]; we took in stock of security, we purchased Exchequer bills, we made advances on Exchequer bills, we not only discounted outright, but we made advances on deposits of bills to an immense amount; in short, by every possible means consistent with the safety of the Bank.” (Bagehot, 1873, p. 204). He himself adds: “The only safe plan [...] is the brave plan, to lend in a panic on every kind of current security, or every sort on which money is ordinarily and usually lent.” The inclusion of non-marketable assets into the eligible collateral set also offers the opportunity for counterparties to acquire additional liquidity against assets that they could not possibly liquidate in any market. Widening the eligible set to assets denominated in foreign currency and the acceptance of residual maturities of any length frees up additional potential for liquidity collateralization. Overall, a wide set of eligible asset types allows banks to take the initiative and decide which assets to use to borrow liquidity (Cour-Thimann and Winkler, 2012; Garvy, 1968). This represents an advantage over purchasing-based liquidity provision, where the initiative remains with the central bank.

Regarding the accepted asset quality, central banks should follow what Bagehot called the “inertia principle”. Accordingly, a central bank should not tighten the requirements on collateral quality in a crisis in contrast to the market (e.g. Bindseil, 2013). However, all eligible collateral must be at normal times “good collateral”, such that the quality requirements should not be watered down in a crisis. A temporarily lowered minimum credit rating requirement in particular might be justifiable if the rating lowering is driven by the temporary illiquidity of the asset or overly prudent sentiment among the rating agencies, driving rating cycles. This phenomenon is elaborated and technically analyzed in Chapter 7. In effect, the pool of eligible assets thus retains its size and the collateral acceptance remains unchanged during the crunch. Obviously, this distinction proceeds along a thin line, given that any extension of the accepted collateral to lower qualities helps to direct financing to less productive uses and represents economic policy, not monetary policy. The LOLR role thus does not comprise the acceptance of *additional* assets of lower quality.[31]

Making use of a restriction of collateral policy along the dimension of asset ages can be helpful to enforce the above-described inertia principle. If only assets of a certain age are accepted – e.g. those that have been issued (and compliant with quality requirements) at some point in time before the financial market tensions – then the central bank prevents itself from slipping into the MMOLR role, cf. the next section. The reason is that no loans to less productive investment projects can be made and refinanced at the central bank, by pledging them as lower-quality assets.

It was already mentioned above that the configuration of operational conditions on levels above the market levels in normal times can help to enforce this selection between illiquid assets existing on the balance sheets and newly-issued assets making use of the loosened collateral criteria. The idea is to grant liquidity against collateral that is temporarily illiquid in the market but not to beat the market conditions. Any offering of liquidity at conditions that the market would not even offer at normal times or at collateral that would not "then commonly [be] pledged" represents the provision of a (public) market, where there would otherwise be none and is likely to be driven by incentives to foster the economic or fiscal development in the way discussed in the next section. However, on terms as now defined, liquidity should be fully allotted and lent out for longer periods, such that the financial market can decide how much is sufficient to regain stability. Accordingly, collateralized lending can play out another advantage over purchasing-based liquidity provisions with respect to LOLR measures. A collateral pooling system offers further flexibility to counterparties. With respect to the permanence of LOLR facilities, it can be stated that while the LOLR role is to be designed such that it is only temporarily activated, it should be offered permanently. Therefore, the following time-inconsistency problem can be avoided. A central bank only lending against a small quantity of the best assets in normal times would be perceived as an bank-accommodating policy-maker if it broadens the standards of its LOLR facilities in a crisis in a reactive rather than a proactive fashion. This perception reinforces moral hazard for banks.[32]

Usually in financial crisis, the demand for liquidity in safe-haven currencies surges, whereby satisfying this demand is thus a LOLR tool to stabilize markets. Collateral swap facilities have two arguments on their side from the perspective of a LOLR: first, the monetary base is kept fixed, i.e. monetary stability is less threatened; and second, (temporary) collateral constraints in private markets are unfrozen, while those markets remain intact.

[31] If it is claimed that markets would only feel liquidity relief when central banks take in "bad collateral" (e.g. Singh, 2013a), this can only be meant in the sense of being "temporarily perceived as bad" to be included into the LOLR role as defined here.

[32] Cf. Tucker (2009), who provides elements of the collateral policy configuration of a LOLR in general and the last-made argument in particular.

As the interbank market has usually dried up if the LOLR is needed, it holds utmost importance to grant access to liquidity provision to a wide set of counterparties. All solvent banks should have access without individual limits. This is the only way to ensure that the policy measures described above pervade into the whole financial system. However, as the central bank defends its *financial* stability goal, there is no need to lend to non-financial institutions directly.

2.4 Market-Maker of Last Resort Policy and Collateral

As Tucker (2009) observes and underpins quantitatively, compared to the LOLR, the MMOLR is a much less studied phenomenon in literature.[33] In recent literature contributions, the MMOLR role is sometimes seen as an evolution from the LOLR function and is thus claimed as a new phenomenon (e.g. Buiter, 2012; Dooley, 2014).[34] Innovations from the LOLR are seen in the extension of the central bank credit provision *directly* to asset markets, i.e. to non-banks and counterparties of questionable solvency. The latter part is sometimes also denoted by Capital (Provider) of Last Resort, e.g. Tucker (2009). The straightforward way of fulfilling the MMOLR role is through outright purchases of particular securities, which is thus in the mind of most literature on the MMOLR (e.g. Bank of England, 2015; Tucker, 2009). Tucker (2009) defines a MMOLR as substituting itself temporarily for the money market without permanently replacing it; rather, aiming at kick-starting a market segment in a catalytic way. Propping up markets that would not exist in non-crisis times should be avoided through bidding relatively low prices for the assets purchased, as compared to normal conditions in private markets. However, this dissertation focuses on collateralized lending and thus also aims to define the MMOLR role accordingly. In this context, Tucker's definition strongly resembles the one given for a LOLR in a previous section, with just buying rather than lending. However, following the inertia principle of providing a wide eligible asset pool of at normal times good collateral, imposing adequate operational conditions and offering loans only to solvent banks, a LOLR does not discriminate collateral types and thus underlying asset markets in a crisis and does not further soften its conditionality for some collateral unilaterally during a crisis. Otherwise, it would actively guide the provided liquidity in a particular direction, a particular segment of the financial market, a particular segment of the real economy or to the government. Nevertheless, Buiter (2012, p. 1) claims that central banks as MMOLRs in fact have expanded their crisis management "to include solvency support for systemically important financial institutions and, in the euro area, the provision of liquidity support and solvency support for sovereigns." Rather than deducting the MMOLR as a new role emerging from the LOLR role, this dissertation proposes that central banks have just discovered their historical roots of credit policy within the MMOLR, following Le Maux and Scialom (2010). Already in 1866, the Bank of England accepted paper issued by railway companies as collateral to support this specific sector of the real economy and the acceptance of government securities offsetting convertibility to gold for the sake of war financing happened all over the world. Accordingly, the use of collateral policy as a MMOLR tool fostering the economy and government and hence also pursuing the objective of fiscal and economic stability is nothing new, but credit policy that has always been seen, even though the interventionalism of central banks was more or less pronounced (see Monnet, 2012).

[33] Moreover, he correctly points to the fact that the term has recently been coined predominantly by Willem Buiter, e.g. Buiter and Sibert (2008).

[34] More definitions and discussions of the term can be found in Bank for International Settlements (2014).

A MMOLR is not a liquidity provider of last resort but rather a credit provider of first resort, given that it bypasses the financial system and directly finances the real economy or conducts monetary financing of government securities in pursuit of the fiscal and economic stability objective. It has a direct influence on the allocation of credit in the economy (cf. Small and Clouse, 2005). The existence of eligibility premia (cf. Section 9.2, for a detailed discussion) proves the influence of collateral policy on asset markets (Bank for International Settlements, 2015). However, as banks can decide themselves which assets to pledge as collateral, credit steering to targeted markets can only be achieved through collateralized lending indirectly in comparison to outright purchases, namely if the use of one type of collateral can be made under more favorable conditions compared to another type. Thereby, demand for the favored collateral will increase in the respective asset market and the same relative price distortion as with outright purchases is induced, cf. Buiter and Sibert (2008), or Cour-Thimann and Winkler (2012), who assign distributional effects of a quasi-fiscal character to this interference with relative asset prices. For a technical analysis of distribution effects of collateral policy, see also Chapter 8.

The collateral policy chosen for the MMOLR role centralizes on the operational conditions, in particular the valuation and the haircut specification, as Table 2.2 reveals.

The use of collateral types that shall be specifically supported must enjoy more favorable conditions than the market would offer at normal times. Moreover, they have to be more favorable than conditions for other collateral types, otherwise the credit steering is not transmitted to asset markets. It is the goal of a MMOLR to affect an asset market such that new assets are issued on it, i.e. the financing of new debt of fiscal or real economic agents can be refinanced.[35] The allowance for close links not only circumvents valuation in the market but also makes it possible to steer credit to a counterparty or an institution with close links to the counterparty directly, marking a very direct way of steering credit. The interchangeability of collateral is not necessary from a MMOLR perspective; indeed, it might even be counter-productive as the particular asset pledged shall be subsidized. The longer the duration of loans, the better the predictability of lending in the targeted market segment for counterparties.

The range of eligible asset types on the quantitative dimension can be small or large, whereby it is selective in any case. Making assets eligible that are not accepted by the market (even at normal times) offers a refinancing market where there would otherwise be none. These assets will subsequently be used to collateralize central bank liquidity, while others are still used in the market.

A MMOLR more easily reaches new asset issuances in a targeted market segment if he accepts lower qualities. Expanding a market mostly implies the realization of less productive investment projects, which imply lower quality.

Because a MMOLR explicitly wants to encourage new asset issuance, it might be an option to restrict the offering of the above-described refinancing conditions to younger assets. In fact, granting better refinancing conditions to an old asset most likely results in a rent for the asset holder – not the asset issuer – and will thus probably not be followed by new issuances.

35 New issuances in the sense of additional new issuances that would not be made if it was not for the MMOLR activity. E.g. new issuances to roll over existing debt are not focused.

The use of collateral swap/lending facilities is helpful as it directly formulates relative prices of the pair of collateral types swapped such that an affection of this relative prices is most direct. Choosing liquidity as a counter-asset is nevertheless the most direct way of funding economic activity.

The set of eligible counterparties is particularly increased by institutions of questionable solvency, because ELA is included in MMOLR (as explained in the previous section). Credit steering can be facilitated through lending to non-banks, as well as through direct lending to non-financial entities, e.g. the government.

Part II

Collateral Policy Measures in Practice

Chapter 3

Historical Predecessors in Collateral Policy

Based on the normative framework of central bank objectives and the role of collateral policy within these objectives – which was deduced throughout the last two chapters – this chapter analyzes practical collateral policy measures conducted by central banks in the past. In particular, historical central bank actions during the time from the middle of the 18th century to the end of the 20th century are presented in chronological order. The collateral policy actions are evaluated along the normative suggestions on the configuration of collateral policy, as summarized in Table 2.2, being clustered accordingly into the roles of COMPR, LOLR and MMOLR. Thereby, a historical context for the following discussion of the Eurosystem's collateral policy is provided. In particular, five findings from the past are carved out and presented in Section 3.16: *(i)* the predominant use of collateral policy in MMOLR actions, especially within the regions and countries that later joined the EMU; *(ii)* the frequent implementation of the MMOLR role under the pretext of monetary stability through special purpose institutions, circumventing the regular collateral requirements; *(iii)* the confinedness of the LOLR role by monetary stability arrangements implying a coverage ratio; *(iv)* a shift in the predominant collateral type over time from gold and real economic assets to government and financial assets; and *(v)* the frequently parallel existence of several distinct eligible collateral sets.

3.1 Bank of Amsterdam in the 18th Century

A very early example of a broadening collateral policy along the quantitative dimension of the range of asset types included in the eligible collateral set can be found at the Bank of Amsterdam in 1763 (see Quinn and Roberds, 2012). The Bank of Amsterdam was the first municipal bank (founded in 1609) clearing bills of exchange between merchant banks, who typically issued these debt instruments – similar to today's asset-backed commercial papers – to refinance loans to merchants. This exposed the Dutch banking system to liquidity shocks, given that merchants took the borrowed money on long journeys (both time- and distance-wise), mostly by sea (e.g. think of the Hanse region stretching east to Novgorod) and bought large amounts of goods to take them back to Amsterdam. Both the ways there and back as well as the storage and sales back in Amsterdam entailed enormous risks at the time. Any default of a merchant on a loan meant a loss to the merchant bank and possibly to the holder of the debt instrument issued by the latter. Additionally, the business risks of merchants were correlated, putting the whole system at risk.

One of the banks – Gebroeders de Neufville – defaulted in 1763 and inter-bank lending froze. Liquidity-seeking banks turned to the Bank of Amsterdam's discount window for refinancing, where they were allowed to pledge trade coins as collateral. However, the stock of trade coins was limited and some banks where running out of it. Nonetheless, they still had silver bullion on the asset side of their balance sheets, yet no chance to have it minted into trade coins and then pledge it for fresh liquidity ("florins") at the Bank of Amsterdam in time. The Bank of Amsterdam reacted and also declared unminted bullion eligible collateral, albeit applying an implicit haircut on the value of the bullion, given that the amount of florins that bullion could be exchanged for at the Bank of Amsterdam was less than the amount that it would have yielded in minted form. Quinn and Roberds (2012) show that at least two banks were spared from default owing to this measure, such that a more severe course of the crisis was prevented. Nevertheless, the Bank of Amsterdam did not manage to broaden the collateral set further to channel funds to the satellite markets of Berlin and Hamburg, as it felt obliged to its conservative statutes. Hence, the banking crisis could not be similarly mitigated there.

The horizontal broadening of the eligible collateral set described above was clearly a LOLR policy. Silver bullion was likely a non-marketable asset at the time. By deeming it eligible, the Bank of Amsterdam offered the liquidation of an additional part of the asset side of banks' balance sheets. The implicit haircut that it applied reflects operational conditions, making it unattractive for merchant banks to use the refinancing option permanently, e.g. to make *additional* loans to merchants. The fact that eligible counterparties (in this case, merchant banks) still had silver bullion available proved their illiquidity but solvency. All this is in line with the normative configuration of a LOLR collateral policy, as summarized by Table 2.2.

From a comparative perspective to the collateral policy of the Eurosystem that is presented in detail in Chapter 4, the reluctant behavior of the Bank of Amsterdam with respect to channeling liquidity into the satellite markets of Berlin and Hamburg holds particular interest. While the ECB conducted collateral policies targeted towards markets of crisis-afflicted countries, the Bank of Amsterdam was unwilling to loosen its collateral policy on a qualitative dimension, as would have been necessary to reach the satellite markets.[36]

3.2 Bank of England in the 19th Century

Two opposing collateral policy approaches were conducted by the BoE during the crises of 1847 and 1866 (see Bignon et al., 2012; Flandreau and Ugolini, 2011; 2014). During the 1847 financial turmoil, only extremely short residual maturities were discounted by the BoE. In fact, the BoE during the crisis even withdrew previously-made commitments to discount assets below a pre-defined residual maturity and decreased the eligible collateral set further, as it only accepted assets of shorter residual maturities than previously announced. This diminished the relieving effects

[36] Obviously, the Bank of Amsterdam was not a common central bank within a monetary union, although the satellite markets still held importance from its perspective.

of an additional number of discounts made on short bills, as counterparties could only propone liquidation times minimally. Moreover, due to obedience to the convertibility obligation, in return for these additional discounts of short-term bills, advances on British Consols and exchequer bills were curtailed, marking a sterilizing measure. In effect, the rejection rates of assets pledged for discounting were as high as 16% at the peak of the crisis in October 1847.

This was very different in 1866, following the Overend Gurney crash. For comparison, the rejection rates then were as low as 3.5% at the peak of the crisis in May 1866, lower than in the same month one year before, which had still been a non-crisis time. The lower rates were the result of a maintenance in contrast to a tightening of criteria for collateral to be accepted during the crisis. Guarantors and issuers of bills accepted during normal times were perpetually being accepted. In some cases, the BoE even kept accepting guarantors, whose reliability was already in such doubt that they eventually failed. In contrast to the 1847 crisis, this time the BoE increased its liquidity support through advances, which were possible against a greater range of collateral types such as acceptances, British Consols or Indian government bonds.[37] Moreover, liquidity was provided to bill brokers and bankers directly, circumventing the usual way via discounters and hence a broad range of eligible counterparties could pay off.

While the fear of failing the monetary stability objective – i.e. the convertibility of the currency – was overwhelming during the crisis of 1847, such that the BoE reacted in panic, just as the financial markets, even tightening its collateral criteria to mitigate the risk of losses to its balance sheet, the reaction of the BoE around 20 years later had developed into the LOLR role, which strongly resembled the definition that Bagehot gave a few years later.[38] The further restriction of eligible residual maturities during the earlier crisis represented a collateral policy reducing the size of the eligible collateral pool in both quantitative (fewer assets) and qualitative dimensions, as longer residual maturities also represent higher duration risk, cf. Section 4.5.3. By reducing advances on other collateral for reasons of sterilization to safeguard monetary stability, the BoE tightened operational conditions as it allotted fewer liquidity through this collateralized lending operation. Later, in 1866, the BoE placed a stronger emphasis on the financial stability objective. The inertia principle was followed, as the eligible collateral set was kept upright as before the crisis event. For advances, the accepted collateral was even broadened horizontally by additional asset types.[39] Finally, the set of eligible counterparties was increased, whereby liquidity was offered to the wider set of bill brokers and banks rather than only discounters. Hence, the transmission to banks also became more direct. The three described measures clearly fit into the LOLR role as presented in Table 2.2. The acceptance of guarantors of questionable reliability might even indicate the

[37] Later, around the turn of the century, the accepted collateral for advances had been even further broadened to include any security traded on the London Stock Exchange, unless related to mining companies, which were deemed highly speculative (cf. Aldrich, 1910).

[38] Nevertheless, an overarching interest of the BoE at that time was always to protect its reserves (especially gold) and thereby prevent losses for its shareholders, which were private and not public (e.g. Capie et al., 1994). Hence, the BoE at times also conducted explicit collateral policies to protect its reserves: it borrowed gold from other central banks during the Barings crisis in 1890, collateralizing the loans with government securities (Vasudevan, 2014), re-introduced the gold standard after the Napoleonic wars in 1821 and selectively discounted bills discriminating against financial speculation and government securities in the early-20th century in support of high-quality commercial bills (Allen, 2014).

[39] It is not straightforward to evaluate the extent to which the additionally-accepted asset types also implied a vertical broadening, given that descriptions of credit qualities at that time are not available.

existence of elements of a MMOLR, because the respective assets would then be of lower qualities and accepted at below regular market conditions.

3.3 Reichsbank in World War I

With the beginning of World War I, the Reichsbank used collateral policy to finance the war and support the war-time economy.[40] The convertibility requirement was suspended in 1914 to free the Reichsbank of some expansionary constraints, although the requirement to cover banknotes in circulation with gold or imperial treasury notes ("Reichskassenscheine") to at least one-third was retained, such that a monetary stability objective was clearly stated but not practiced as the convertibility requirement to gold was suspended.[41] At the same time, eligible collateral was broadened selectively as bills of exchange on the Reich and government bonds of maturities up to three months also became eligible. This secured good financing conditions for the Reich at banks and other financial market participants.

Moreover, loan society notes ("Darlehenskassenscheine") were admitted as collateral on equal terms as imperial treasury notes, i.e. they could be calculated into the banknote coverage ratio of one-third. In principle, the loan societies ("Darlehenskassen") – which had only been established in August 1914 – were simply special purpose vehicles (SPVs) of the Reichsbank itself, which was charged with their management. In fact, loan societies were only opened at Reichsbank branches. The special purpose was to make direct loans to the real economy, especially fostering trade and commerce. The loans had to be collateralized, although the eligible collateral set accepted at the loan societies was much broader than that eligible at the Reichsbank and included almost anything from equities and further public securities to semi-finished goods and all kinds of assets issued in friendly foreign countries (cf. Feuchtwanger, 1918). In other words, there was "virtually unlimited access to the Reichsbank's discount facilities" (Tilly, 1986, p. 144), directly or indirectly. As the loan societies issued loan society notes to refinance the loans that they made, they acted like an additional central bank with much looser collateral requirements. As they were de facto allocated at the Reichsbank, one could regard them as a special lending facility of the central bank. In turn, the loan society notes could easily be exchanged for ordinary banknotes at the Reichsbank.

As one would expect from a war-time central bank, the Reichsbank hence effectively pursuit monetary financing and direct credit provisioning to the economy in the role of a MMOLR, cf. Table 2.2. Loans were made directly into the real economy, to non-financial counterparties to support the realization of new investment projects. The loan society notes were pledgable/discountable at the Reichsbank under the same conditions as imperial treasury notes. These favorable operational conditions could be forwarded in loans granted by the loan societies and likely undercut credit conditions in the market. At the same time, the pretext of monetary stability remained as the coverage ratio was in force, albeit circumvented via the loan societies. Therefore, a sterilization of the measures was not necessary.

[40] See Haase (1962), for a detailed discussion of the following.

[41] Imperial treasury notes were the uniform paper money that had been provided to the 22 state governments at the time of the foundation of the Reichsbank to facilitate the withdrawal of their paper money (National Monetary Commission, 1910).

3.4 Federal Reserve System in World War I

The Fed also made use of collateral policies striving to facilitate war financing. In 1916, the Fed Act was amended to permit collateralized loans to member banks (in addition to discounts) for up to fifteen days (Federal Reserve System, 2002). The loans had to be collateralized by paper eligible for discount or by obligations of the US. In fact preferential operational conditions were offered on the loans if these were collateralized by government securities (Bordo and Wheelock, 2011; Calomiris and Wheelock, 1998). Furthermore, lending to non-member banks became possible if collateralization was given with government paper (Hackley, 1973). The subsidization of the collateralizing asset type government security is a MMOLR measure channeling credit to the government to sustain fiscal stability.

3.5 Banque de France before and after World War I

While the French Franc issued by the independent Banque de France had been Europe's most stable currency from 1803 to the beginning of World War I, imposing strict collateral rules, the pressure from governments to water down collateral criteria rose towards the end of the 19th century and again after World War I, eventually leading to the loss of independence and nationalization in 1936 (cf. Goodman, 1992). In 1889, the Banque de France bailed out the deeply insolvent bank Comptoir d'Escompte (see Hautcoeur et al., 2014). It did so under explicit pressure by the French Minister of Finance to make a loan of FRF 100 million against dubious collateral not permitted by the Banque de France's statutes. Even though the loan went to a bank, the insolvency of the counterparty and the collateral – which did not fulfill the standards set by the regular collateral framework – identify the measure as an early example of ELA, see the discussion in Sections 2.3 and 2.4, which is to be included in the role of a MMOLR.

After World War I, French governments increasingly pressured the Banque de France to finance public expenditures as they themselves were unwilling to cut expenditures or impose additional taxes on the French population (Goodman, 1992). The argument was that future German war reparations would cover the costs of economic reconstruction and should be pre-financed by the Banque de France. As a first step, exceptional facilities were created, allowing the discounting of newly-issued Treasury bills, which had to be bought by the large commercial banks. Accordingly, this circumvented increasing the limit on direct central bank advances to the government, which would have led to public critique. The circumventing construction resembles that at the Reichsbank, as described in Section 3.3. Again, the (coerced) objective of fiscal stability was pursued as a MMOLR, channeling central bank credit towards the government, while upholding an appearance of independence and monetary stability outwardly. This shows that collateral policy can be an excellent means to steer public credit covertly.

3.6 Federal Reserve System between World War I and the Great Depression

Between World War I and the Great Depression, the Fed made use of some scope for interpretation within the collateral criteria defined in the Fed Act, which were following the Real Bills Doctrine (cf. Section 2.2). The strict limitations were eroded to accommodate business conditions (Federal Reserve System, 2002). For example, while papers issued to finance fixed investments in general were prohibited, those given for the purpose of purchasing machinery for agricultural operations became permissible (cf. Hackley, 1973). In 1915, trade acceptances and commodity papers were accepted at a preferential rate. Later, in 1923, the Fed Act was amended to ease credit conditions for farmers. The types and maturities of agricultural paper eligible for discount were broadened. All this marks action explicitly targeted at credit conditions for a specific sector of the real economy. Collateral policy was selectively conducted along the horizontal and potentially vertical dimensions. Moreover, the level of operational conditions was adjusted for certain collateral to incentivize the financing of new investments in the agricultural and trade sectors. Hence, the Fed pursued its economic stability mandate, using collateral policy in the role of a MMOLR, cf. the characteristics given in Table 2.2.

3.7 Reichsbank during German Hyperinflation

The above-described practice of the loan societies circumventing collateral standards of the Reichsbank was held upright during the whole inflationary period in Germany and significantly contributed to the money creation, given that loan society notes were almost exclusively discounted at the Reichsbank. The collateralized lending of the Reichsbank was extended in 1923 with the introduction of an emergency Lombard facility in light of the occupation of the Ruhr area, impeding the workaround through the loan societies there.[42] The eligible collateral included equities, mining share certificates and mortgages.[43] These measures represent credit channeling to a market segment through selective collateral criteria, here also established within a special facility, within the role of a MMOLR in terms of the overview provided in Table 2.2.

When it was finally decided to get a grip on inflation, the Rentenmark was introduced, issued by the Rentenbank, whose refinancing was secured by the Reichsbank through a general eligibility of the paper that it issued. Additionally, the Reichsbank statutes were redefined towards a strengthened monetary stability objective. Most importantly, the Reichsbank gained independence in 1924. From a collateral policy perspective, several tightening policies were introduced as the Reichsbank declared a "Kreditstopp" (e.g. Schnabel, 2004). Most of them resemble policies within the COMPR role, as defined in Table 2.2. Government securities became ineligible for discount, restricting the eligible collateral on the quantitative dimension. Monetary financing of additional fiscal activities should thereby be restricted. Apart from short-term loans of up to three months and to the maximum amount of RM 100 million to the Reich, no direct loans could be made to any public entity. This restricted the set of eligible counterparties. Loans to banks could only be collateralized by public sector securities of residual maturities of up to one year. Short-term loans could also be made against longer-term government securities, albeit only subject to the existence of additional guarantors, one of which had to be a bank. The latter options were explicitly given to ease collateralization for banks – who still had many already-issued government securities on the asset sides of their balance sheets – and not to support public finances. This particular part of the collateral policy measures thus stands out as being sorted into the LOLR role rather than the

[42] See Haase (1962) for a detailed discussion of the Reichsbank's collateral policies during German Hyperinflation, which are described in the following.

[43] The emergency loans also enjoyed a government guarantee.

COMPR role. Requirements for bills eligible for discount were tightened, e.g. the high quality was explicitly legally codified for the first time, restricting the collateral set on the qualitative dimension. Finally, the gold coverage requirement was increased. As a result of all described measures and due to the lack of eligible securities, the liquidity provision against collateral by the Reichsbank decreased between 1924 and 1926 by around 25% (Haase, 1962, Tab. 5).

However, already in 1926, the Reichsbank changed course and began easing collateral rules and broadening the eligible collateral set. To support public finances (MMOLR role), government bills to the amount of RM 400 million here allowed as collateral, subject to one further guarantor. In 1927, most obligations and covered bonds of public institutions were declared eligible for Lombard loans and in 1928, the collateralization with government bonds was facilitated. However, the eased collateral requirements were only applied selectively on the dimension of the access window, explicitly privileging the large banks (mainly located in Berlin) as only their discount quotas were relaxed, while remaining tight for smaller banks in the periphery (Schnabel, 2004), cf. also Section 3.9. Moreover, exceptions existed for banks making loans to agriculture, export industries and large industrial firms, such that sectors of the real economy were selectively targeted.

3.8 Federal Reserve System during the Great Depression

The Fed reaction during the Great Depression has often been described as "too little too late."[44] Indeed, collateral policy actions also started long after the stock market crash of 1929 and were subsequently classifiable two-fold with respect to the segmentation in Table 2.2: in the LOLR role against the banking panics and in the MMOLR role against the economic depression.[45]

At the time of the establishment of the Fed Act, the implemented elasticity of the currency was also thought to provide room for the LOLR role to automatically evolve in times of liquidity crises and stabilize the demand for currency (Bordo and Wheelock, 2011). In the view of the founders, the Real Bills Doctrine would not hamper the LOLR function because commercial banks at the time held a large fraction of their assets in eligible collateral (Friedman and Schwartz, 1963). However, the restriction of eligible collateral was one of several constructional aspects within the Fed system that were in the way of a functioning LOLR during the first years of the Great Depression. Although the total amount of eligible paper in the financial system far exceeded the amount of discounts actually made, they apparently were very unevenly distributed across banks of different sizes and across Fed districts. Chandler (1971, p. 232) explains: "The narrow definition of eligible assets, symbolizing a persistence of commercial loan ideas, contributed to bank closings and to liquidation of credit by banks that succeeded in remaining open."

The gold standard and its convertibility requirement – implying the coverage ratios for issued banknotes – stood in the way of central bankers' ability to significantly broaden the eligible collateral in all member countries of the gold standard, given that they feared being unable to remain on the gold standard if they would do it nonetheless (Allen and Moessner, 2012). Therefore, the first collateral policy reactions of central banks to the crisis were rather tightening than loosening,

[44] E.g. by Herbener (2014, p. 43), or by G. Richardson, "The Great Depression," *Federal Reserve History*, `http://www.federalreservehistory.org/Period/Essay/10`, last accessed 8 April 2016.

[45] The experience of central banks' reactions to the Great Depression also holds particular relevance for the recent crisis experience and the Great Recession, as Bordo and James (2009) highlight.

e.g. the BoE eventually refused to accept commercial bills of German merchants if these were in standstill – despite representing half of the discounted papers on its balance sheet – as it feared that the (already-ongoing) losses on these bills would threaten its monetary stability objective; hence, Bagehot's remedy was simply not implemented (Allen, 2014).

Two characteristics obstructed the liquidity provision through the Fed further. For one, as a constructional establishment in contrast to most European banking systems, where few large banks had many branches, the US banks followed the National Bank Act of 1853, which prohibited operation beyond the state borders. As a result, many small banks existed, although only a small fraction of them had access to the Fed discount window as Fed member banks. For example, after two years of Fed existence, in 1915, only seventeen state banks had become member banks and by 1923 1,620 member banks faced 19,345 non-member banks. For another, the Fed as other central banks strove to choke off any speculative (financial) activity with the use of liquidity that they provided. In February 1929, the Fed Board instructed District Feds to crack down on banks borrowing from the Fed for speculative activities (Bordo and Wheelock, 2011). Even after intensifying its LOLR policy – which will be described below – an explicit amendment to the Fed Act was made in 1933. Any collateralized loan could be made due and payable after one warning by the Fed Board if the borrowing bank increased its loans on stock and securities, i.e. was suspicious of engaging in speculative activity (Federal Reserve System, 2002). COMPR measures like these – intended to administer the discount window more tightly (access window dimension, cf. Table 2.2 – actively induced banks' reluctance to borrow from the LOLR in a crisis.

In 1932, the Fed started its collateral policy actions against banking crisis and depression. Most importantly, the Glass-Steagall Act of 1932 authorized the collateralization of loans to member banks with capital of less than USD 5 million, using any security meeting the satisfaction of the respective District Fed under exceptional and unusual circumstances (e.g. Bordo and Wheelock, 2011; Epstein and Ferguson, 1984; Hackley, 1973). The loans required the approval of at least five Fed Board members. Thus, the eligible collateral set was de jure maximally broadened and District Feds received idiosyncratic room to decide upon eligible collateral along both the horizontal and vertical dimensions.[46] Initially, the policy measure was set to expire in March 1933, although it was subsequently prolonged by the Banking Act of 1933. The Banking Act of 1935 made it a permanent amendment of the Fed Act and the conditionality on exceptional and unusual circumstances was dropped. The similarity to collateral policy measures of the Eurosystem presented in Chapter 4 is evident in the *(i)* initially temporary implementation of measures that were then permanently adopted, *(ii)* the conditioning of the eligibility on exceptional circumstances, which was later dropped, and *(iii)* the idiosyncratic room for District Feds or NCBs, respectively.

In 1937, restrictions on the use of finance paper were lifted (Federal Reserve System, 2002). Already in 1932, obligations of the US were allowed to cover outstanding banknotes in addition to gold and eligible paper (e.g. Hackley, 1973). Hence, the constraining coverage requirement was significantly eased. Furthermore, the Fed Act was amended to allow for a broader set of eligible counterparties (see Federal Reserve System, 2002): as of 1932, access to the discount window was granted to individuals, partnerships and corporations under unusual and exigent circumstances. However, the

[46] For a detailed presentation of the original eligibility criteria of the Fed Act in 1913, see Federal Reserve Bank of St. Louis (1916).

collateral had to meet the original requirements, whereby the broadened set was only eligible for member banks.[47] From 1933, loans of any term to individuals, partnerships and corporations could also be made if collateralized by direct obligations of the US, i.e. in addition to the short-term discount window facility. Finally, non-member banks could receive direct loans from the Fed on the same basis as member banks from 1933 onwards.[48]

Another extension of the eligible counterparty set was particularly targeted at stimulating economic recovery, whereby working capital loans to (particularly small) businesses became possible in 1934. In emergency situations, the loans could be made directly by the District Fed, with the support of the Fed Board. However, for non-emergency cases, it was made possible for member banks to pledge or discount such loans. Another relief in terms of monetary stability constraints was the abandoning of the gold standard from 1934 (Gold Reserve Act). In fact, no country was still on the gold standard by 1936 (Allen and Moessner, 2012).

Due to the decentralized Fed system, the practical implementation of the collateral framework also allowed space for regionally individualized – both relatively tight and relatively loose – crisis management by the different District Feds. After all, the eligibility decision left room for interpretations, such that some District Feds were more favorable in determining the collateral values than others (Chandler, 1971). In addition, e.g. the Fed of Atlanta deliberately supplied liquidity and assistance to member banks extending loans to non-member banks (Richardson and Troost, 2009), i.e. it effectively idiosyncratically increased the set of eligible counterparties.

3.9 Reichsbank during the Great Depression

The amendment of the German bank law of March 1930 effectively turned collateral criteria back to the looser state of pre-1924 (Haase, 1962). Consecutively, loans could again be made to non-banks and restrictions on the use of public (federal, state and municipal) securities as well as obligations of public institutions were revoked. However, as mentioned in Section 3.7, the Reichsbank was still trapped in its convertibility commitment and the respective coverage requirements for issued banknotes.[49] Hence, it continuously tried to make the split between MMOLR/LOLR (credit/liquidity provision) and COMPR (coverage protection).

In practice, a broad range of collateral was principally eligible but de facto not pledgable or discountable for most banks because their refinancing quotas were kept low, i.e. the access window dimension was restricted at the level of individual counterparties. The discrimination favored Berlin banks and in particular the large banks.[50] The tensioned situation in Germany intensified in the first half of 1931, as the liquidity needs of banks increased with deposit withdrawals. When foreign deposits at the large banks plummeted by 21.9% in June 1931, they seemed to have already used

[47] A regulation that was finally dropped in 1991, when discounts to individuals, partnerships and corporations could also be made against any satisfactory security.

[48] On the other hand, the discount window was not opened to non-member banks until 1980 (Bordo and Wheelock, 2011).

[49] See Schnabel (2004) for a detailed discussion of the discriminating discount policy, which is described in the following. For details on the German banking crisis of the 1930s and the Reichsbank policy at that time, see James (1984, 1985, 1986).

[50] One reason for this discrimination was that most foreign creditors held their deposits at large Berlin banks (Luther, 1964). They should be able to withdraw their deposits at any time to prevent bank runs of foreign creditors.

most of their eligible collateral because the Reichsbank started discounting bills that were not eligible in its collateral framework (cf. Bindseil and Winkler, 2012; Born, 1967; Priester, 1932). In principle, this can be accounted to a LOLR, although inasmuch as lending was discriminated and provided to insolvent institutions (selective ELA), it rather has to be classified into the MMOLR role, cf. Table 2.2. As Schnabel (2004, p. 28) observes: "Banks converted illiquid advances into acceptance loans, by allowing their customers to draw a bill of exchange on them, discounting the bill, and exchanging the bill with another bank to obtain the required third signature. Then the bill, which clearly was a pure financial bill and, hence, not discountable at the Reichsbank, was discounted at the Reichsbank." Especially pronounced was the use of the latter by (apparently already-insolvent) Danatbank during its last days before it had to be merged with Dresdner Bank in July 1931. As most of the liquidity provided was denominated in foreign currency, the Reichsbank had eventually exhausted its reserves. On July 15, 1931, the convertibility was suspended, failing to meet the coverage requirement. This date effectively marked the end of the gold standard in Germany, although this was not officially declared.

From July 1931 onwards, the Reichsbank participated in policies institutionalizing the above-described circumvention of its collateral criteria.[51] The Akzept- und Garantie-Bank AG was established on July 28, 1931 to facilitate liquidity provision to savings banks and short-term production credits to manufacturing companies. Again, mutually-drawn bills of exchange between banks or banks and their debtors were thus provided with the additionally-needed signature to be eligible for discount at the Reichsbank. The construction was extended in August 1931 with the establishment of the Lombardbank AG, facilitating access to liquidity for private mortgage banks, as well as the Berliner Lombardkasse AG, making the liquidation of securities possible for private Berlin banks. Behind the indirect and hidden lending behavior of the Reichsbank was the constraint to count direct Lombard loans into the coverage ratio. The auxiliary institutions helped to transform what was in effect simply an extended Lombard facility of the Reichsbank into bills of exchange (albeit of dubious and not high quality, as would have legally been required), which the Reichsbank was willing to officially count into its coverage ratio.

The president of the Reichsbank at the time, Luther (1964, p. 252 f.), admitted that the Reichsbank accepted "to some extent financial bills. It also financed production by agreeing to discount [...] bills relating to industrial exports to the Soviet Union, of which everyone knows that the true self-liquidation only arises in the course of two years, when being paid by Russia." In addition, he stated: "With the agricultural bills, we are also doing something that a central bank should do only extremely limitedly, namely to finance goods that have not yet been sold. Fact is that at end 1931 around one-third of bills discounted by the Reichsbank would not have been accepted in normal times, in particular finance bills and Russia bills. [...] The finance bills resulted mainly from the rescue measures for banks and savings associations."[52]

Not only auxiliary constructions to forward credits to banks and the real economy were founded, but also the default-threatened public finances were supported with the help of the Reichsbank's collateral policy. In this case, the monetary financing prohibition imposed on the Reichsbank by the Dawes and Young plans had to be circumvented, cf. Bindseil and Winkler (2012). However,

[51] See Haase (1962), for a detailed description.
[52] English quotes as in Bindseil and Winkler (2012).

the then-Reichskanzler Brüning (1970, p. 307) had devised a simple recipe: "In case the plan to obtain a foreign credit would definitely fail, the Reich would provide to banks bills in the amount of several hundred million Reichsmark that they would rediscount with the Reichsbank."[53] To sum up, when central bank independence, monetary stability and the prohibition of monetary financing were the key elements of what the Reichsbank strived to represent officially, it took the role of a LOLR and MMOLR under this pretext, being forced by the sovereign and banking crises, as well as the depressed economy.

After the Nazis seized power in 1933, a novella of the banking law was made and Lombard loans could finally be counted into the coverage requirement. Nevertheless, the Reichsbank remained independent until it was later alleged to Hitler directly and thus continuously was only allowed to directly discount government securities to the amount of RM 400 million (see above). Thus, full employment and war preparations had to be financed through the banking system.[54] Therefore, the government structured its financing needs into short-term bills of exchange, in particular one type to finance job creation schemes ("Arbeitsbeschaffungswechsel") from 1933 onwards, as well as one type to finance the buildup of the Wehrmacht ("Mefo-Wechsel," accepted by the Metallurgische Forschungsgesellschaft m.b.H.) from 1935 onwards. These bills of exchange were readily taken in by banks due to their short-term maturities and the guaranteed rediscountability at the Reichsbank. In addition, from 1938 onwards, suppliers of the government were paid by special debt obligations ("Lieferungsschatzanweisungen"), which could be pledged as collateral for Lombard loans. The financing of the entire German economy and the war preparations by the Reichsbank was orchestrated through a coordination of policies on and the design of collateral, while officially upholding the independence of the central bank.

3.10 Federal Reserve System in the 1970s and 1980s

In the 1970s and 1980s, instabilities in the financial system occupied central banks for the first time after the Great Depression, cf. 1.5. The Fed had to fulfill its role as a LOLR several times through the regular conditions that it offered at its discount window (cf. Kaufman, 1991). Moreover, in two instances, policies on discount window conditions explicitly supported particular collateral in an attempt to foster credit supply in the underlying asset markets and hence can be attributed to the MMOLR role.

In June 1970, the Penn Central Transportation Company – with commercial paper to the amount of more than USD 84 million outstanding – defaulted.[55] The default hit the relatively newly developed commercial paper market hard and by surprise. Immediately, investors were concerned that other companies might also default, whereby uncertainty was high as commercial paper ratings were only in their infancy. As the government was unwilling to provide fiscal funds to the part of the economy drawing credit from this market, the Fed felt urged to particularly target credit conditions for companies on this market. Hence, it took its role as a MMOLR and chose to subsidize the conditions whereby commercial paper could be used as collateral at its discount window. Funds to member banks that were willing to lend to customers with maturing commercial papers were

[53] English quote as in Bindseil and Winkler (2012).
[54] See Haase (1962), for a detailed description.
[55] For details, see Calomiris (1993) and Stojanovic and Vaughan (1998).

granted discount loans to finance the rollover of commercial papers. The use of commercial papers as collateral was subsidized and thus distinguishable as a MMOLR measure (cf. Table 2.2) in the sense that banks were made indifferent between refinancing in the inter-bank market and refinancing at the central bank, as well as being guaranteed liquidity for the purpose of pass-through loans (Calomiris and Wheelock, 1998). In particular, non-pecuniary costs – which were usually connected to borrowing from the discount window – were lowered to zero. For example, the Fed usually imposed special bank examinations on counterparties borrowing from the discount window to strengthen the last resort character. Additionally, the Fed announced that it would lend to companies directly, clearly stating that more defaults were not to be expected, although this direct lending ultimately did not become necessary. The total amount of discount window borrowing collateralized by commercial paper in the weeks after the Penn Central default was around USD 500 million (Melton, 1985).

Another instance in which the Fed made use of subsidized discount window loans collateralized by a specific asset class was the stock market collapse of 1987. Calomiris (1993) supposes that the Fed encouraged pass-throughs of liquidity to futures markets and the chairman of the Fed at that time, Greenspan (1994, p. 137), indicated that "[t]elephone calls placed by officials of the Federal Reserve Bank of New York to senior management of the major New York City banks helped to assure a continuing supply of credit to the clearinghouse members [...]" (cf. Carlson, 2007).

Apart from these crisis event-driven collateral policies, the Fed made amendments to its collateral framework in 1973,[56] reflecting an "intend to encourage greater use of the discount window" (see Hackley, 1973, quote: p. 195). Papers financing the purchases of goods and services (consumer papers) as well as fixed investments were made eligible as long as the proceeds were not used merely for the purpose of investment, speculation or dealing in stocks, bonds or other such securities, aside from direct obligations of the US. Until then, the discounting of papers that financed permanent investments such as real estate, buildings or machinery was ineligible, given that they had originally been seen as not self-liquidating. In addition, the granting and rediscounting of consumer credits was supported. The 1973 amendment also expressly emphasized the possibility (originally established in 1932, see above) to make direct loans to individuals, partnerships or corporations collateralized by obligations of the US or – as allowed for in 1968 – by obligations of other issuers if guaranteed by the US, in emergency situations and if in the interest of the economy. The Fed role of a LOLR and MMOLR to all segments of the economy was thereby solidified. However, note that the extension of the eligible collateral set for the discount window along the horizontal dimension represents a LOLR measure. As long as this wider set was offered at a premium and only to banks, it follows the respective configuration given in Table 2.2. Finally, in 1978, discount window access was extended to the US branches of foreign banks (Federal Reserve System, 2002), which were growing influential factors on the financial stability objective.

3.11 Banque de France during Financial Interventionism

After the World Wars, the understanding that credit allocation has to be controlled and rationed was prevalent until the liberalizing of financial markets in 1985 (financial repression, see also Section

[56] As well as to a lesser extent in 1968.

1.5). The Banque de France played a central role in the particularly interventionist system of credit directing in France and only gained independence in 1994. Governments saw it as providing a "credit armature" that could be used to pursue the general economic strategy of growth and full employment with the Treasury (which supervised the central bank) in the center of the financial system (Goodman, 1992).

The market-making of the Banque de France was gradually shifted from the direct monetary refinancing of the planned government financing of the economy to a bank-based credit provision during the 1960s and 1970s. Nevertheless, the government ensured that it remained in control of credit provision with the help of collateral policy. A system of selective rediscounting was implemented as follows (see Loriaux, 1991; Pérez, 1998, for details). Banks were receiving requests for loans from the real economy, although to ensure that they were able to use these loans as collateral when refinancing with the Banque de France they had to first consult semi-public financial institutions for underwriting and sponsoring. Loans that received the approval for discounting ("accord de réescompte") preferably went to agriculture and export-oriented industry, while mortgages were also supported. As a result, there were no transparent collateral criteria, although liquidity provision was selectively targeted to preferred sectors of the economy. On the other hand, banks were guaranteed liquidity and thus did not have to worry about maturity transformation, cf. Pérez (1997b). They were thus induced through the leveling of the refinancing conditions that the central bank offered to steer credit as politically desired and hence not necessarily according to the productivity of investment projects. Central bank claims shifted from claims on the Treasury to claims on banks, however the MMOLR character of the central bank stayed as it was.

The second flow of the privileged financing circuits effectively gave (fiat) money creation powers to the Treasury directly. Financial institutions – especially savings banks – had to keep a fraction of their deposits at semi-public institutions (comparable to minimum reserves). These were controlled by the Treasury and made loans discretionarily themselves, using the bank deposits, cf. Pérez (1997a).

In the 1960s, the Banque de France developed a stronger focus on monetary stability. In order to control inflationary pressures yet remain able to keep funds available to favored sectors at low interest rates (Cohen et al., 1982) – which were a publicly important signal – the Banque de France started to regulate the discountability of loans in the 1960s, making banks to finance parts of them from their own deposits, which implicitly meant implying haircuts on the collateral. Here, the substitutability of haircut and interest rate took effect, cf. Section 4.5.3 for details. This tightening of operational conditions was a first step towards a more rationally assessed loan-making by banks, which now had higher stakes in the qualities of the investment projects that they financed.

3.12 Banco de Espana during Financial Interventionism

The development in Spain resembled that in France, see Section 3.11. Collateralized lending played a similarly important role for the directioning of credit. Between 1940 and 1959, Spanish industrialization had mainly been financed in autarky through a practice known as automatic collateral lending ("pignorcion automatica"). Spanish banks were allowed to monetize up to 80% of their public assets with the Banco de Espana at their own discretion (cf. Pérez, 1997a, for details on this and the following). During this period, no further ado from the central bank was needed to steer credit towards the preferred sectors of the economy, given that most of the domestic production was financed by public institutions issuing the aforementioned public assets regardless.

In 1959, this practice was stopped on requirement of the IMF, whose support became necessary due to a severe balance-of-payments crisis. In what followed, liquidity had to be guided towards politically desired purposes through the banking system, whereby the Banco de Espana introduced selective rediscounting in 1960. The selection of loans that could be rediscounted was made in accordance with the criteria set out in the National Development Plans. As a MMOLR selectively subsidizing refinancing conditions, the Banco de Espana thus incentivized loan-making by banks to the politically desired investment projects.

As in France, a second channel of credit direction was offered through public credit institutions, making loans and in effect creating (fiat) money. Savings banks were required to deposit 80% of their liabilities with them and commercial banks 10%. By 1970, 49% of the private sector financing in Spain was raised through the two publicly controlled channels.

3.13 European Monetary System during the Crisis of 1992

During the exchange rate crisis of the early-1990s in the European Monetary System,[57] – which eventually led to the exit of the GBP – several European central banks made use of collateral policies to preserve the financial stability in their jurisdictions (see Borio, 1997). The reason for liquidity tensions was that the defense of currencies under downward pressure – and in a fixed exchange rate system – led to a withdrawal of liquidity from domestic financial markets because central banks bought domestic currency using foreign currency. In France, Italy, Spain and the United Kingdom (UK), the collateral availability of banks became a constraint to their refinancing needs from central banks in September 1992, such that a horizontal broadening of the eligible collateral set was needed. As described in Section 2.3 and already illustrated in Section 3.8, although the total might be sufficiently large to secure liquidity needs, the outstanding eligible collateral might be unevenly distributed throughout the financial system, thus making an eligibility broadening necessary to fulfill the LOLR role.

As a result, central banks within the European Monetary System reacted in the role of LOLR as follows, cf. Table 2.2. The Banco de Espana reactivated an additional credit line, thus increasing the amount of liquidity that banks could be allotted against collateral. The Banca d'Italia introduced foreign exchange rate swaps, offering an additional counter-asset. The Banque de France accepted "Obligations Assimilables du Trésor" as an additional publicly-issued asset type temporarily as collateral and extended the fraction of eligible commercial bills (Goldstein et al., 1997). Similarly, the BoE introduced a repo facility using Treasury gilts as an additional collateral type.[58] The latter two measures were horizontal broadenings of the eligible collateral set. Furthermore, the set of eligible counterparties at the BoE was broadened. In effect, the European central banks

[57] For details on the course of the crisis, see e.g. James (2012, Ch. 9).

[58] It was initially designed for one week only, but had to be offered thirteen times in the following sixteen months, before it became permanent in January 1994, see Bank of England, *Market Operations Timeline*, `http://www.bankofengland.co.uk/markets/Documents/sterlingoperations/nonflashtimeline.pdf`, last accessed 10 April 2016.

made more collateral available to more counterparties, as well as increasing its pledgability, while retaining the LOLR character because operational conditions and the quality dimension were not touched.

3.14 Bank of Japan in the 1990s

During the Asian banking crisis of the late-1990s, the BoJ made use of collateral policies to support the financial system as a LOLR, as well as making emergency loans to especially troubled institutions. The latter represent ELA and thus are counted within the MMOLR role, cf. Section 2.4. The LOLR measure comprised the following. In October 1997, a repo program collateralized by government bonds aimed to foster the general liquidity level, i.e. a larger amount of collateralized loans was allotted.[59] Moreover, the uncollateralized loan rate for overnight lending was lowered slightly below the discount rate. This is an exceptional measure as it infinitely widens the eligible collateral set from a counterparty's perspective, because no collateral had to be pledged at all, albeit only for overnight loans. In addition, the set of eligible counterparties was extended to foreign banks. The MMOLR character was more pronounced in the measures described next. Special collateral – which was ineligible under the Bank of Japan Law from 1942 – was accepted for emergency loans to Kyoto Kyoei Bank and Hokkaido Takushoku Bank. Completely uncollateralized loans were made to Fuji Bank to be passed through to Yamaichi Securities, a non-bank institution. Moreover, when the Japanese Deposit Insurance Corporation encountered funding problems due to bank failures, it started issuing government-guaranteed bonds, which were in turn accepted as eligible collateral (Nakaso, 2001). The BoJ hence contributed to the disbursement of bank depositors.

3.15 Deutsche Bundesbank until the 1990s

With the foundation of the Bank deutscher Länder and later the Deutsche Bundesbank, the set of eligible counterparties was tightened compared to the Reichsbank and only banks were eligible to access the collateralized lending facilities – i.e. the discount facility and the Lombard facility – at regular conditions (cf. Haase, 1962).[60] Since any coverage requirement for issued currency was abandoned, collateral requirements were solely subject to the Bundesbank's monetary stability objective of price stability. Eligible collateral for discounts comprised bills of exchange of good quality ("gute Handelswechsel") that were guaranteed by the signatures of three (or at least two) solvent parties, as well as German government securities. Lombard loans could also be collateralized by any other debt instrument declared eligible by the Bundesbank.[61]

Some discretionary power evolved from a particularity of the German collateralized lending system. Following a Reichsbank tradition, in contrast to discount window facilities of other central banks, the discount facility was offered at below market conditions, while the Lombard rate usually

[59] For this and the following, see Bank of Japan, *Major Decisions by the Policy Board in Fiscal 1997*, Announcement, September 1998, `https://www.boj.or.jp/en/announcements/release_1998/giji97.htm`, last accessed 10 April 2016.

[60] The eligible counterparty set was extended to credit institutions in general, insurance companies and savings and loan associations for any Lombard loan collateralized by equalization claims against the German sovereign, resulting from the currency reform of 1948 or the German unification. See Bundesbankgesetz of 1957, especially Paragraphs 19 and 24.

[61] See Bundesbankgesetz of 1957, especially Paragraph 19.

incorporated a LOLR character and was kept (around 1-3 percentage points) above the discount rate. To make up for that, discount credit was rationed. However, quotas for individual banks were defined in a partly opaque way (Bank for International Settlements, 1963) and were sometimes said to be used as a means of punishment for non-compliance with regulatory standards (Nelson, 2002). Critics pointed to the competitive distortion through this central bank credit at concessionary terms (see Issing and Rudolph, 1988, on the whole issue). In principle, the Bundesbank subsidized counterparties and the issuers of eligible collateral – i.e. the government and the real economy – to the extent of discount loans that it made and thus took a MMOLR role.

Besides the described institutionalized features, the Bundesbank used collateral policies for several special purposes, as described in the following.

First, it granted additional discount loans to support exports, small and medium-sized enterprises (SMEs) and inter-German trade after the German unification (see Deutsche Bundesbank, 1995; Issing and Rudolph, 1988, for details). Special purpose credit institutions made loans to the respective sector of the economy and could refinance themselves at the Bundesbank up to a pre-defined contingent. The regular collateral requirements were extended to suit their purposes. In particular, they could collateralize the Bundesbank liquidity with own-use promissory notes ("Eigenwechsel/Solawechsel"). Special purpose rediscounting was e.g. undertaken through the AKA Ausfuhrkredit-Gesellschaft mbH from 1952, initially to the amount of up to DM 600 million. This limit was gradually extended to DM 5 billion in 1981. Other examples include the Gefi Gesellschaft zur Finanzierung von Industrieanlagen mbH and the Privatdiskont AG. The latter was institutionalized in 1966 and extended up to an amount of DM 4 billion for most of the 1980s.

Second, in 1990, the Bundesbank granted East German banks access to its lending collateralized by simple own-use promissory notes of the banks (see Deutsche Bundesbank, 1995). Moreover, East German banks could refinance through the lending facilities of the Bundesbank to an amount up to their balance sheet total. The practice was terminated in 1993. East German banks were thus guided into the Western inter-bank markets by the Bundesbank as LOLR and subsidized lending to the region of Eastern Germany was offered by the Bundesbank as a MMOLR.

Third, in the aftermath of the Herstatt-Bank failure, in 1974 the Bundesbank pushed the foundation of Liquiditäts-Konsortialbank, a joint venture of mainly private banks (who held 31.5% of the shares), public credit institutions (26.5%), mutual banks (11%), installment credit financing institutions (1%) and the Bundesbank itself (30%). If financial institutions were in liquidity problems, the credit committee of the Liquiditäts-Konsortialbank – comprising one Bundesbank member plus one member of each of the other three bank stakeholder groups – analyzed whether the illiquidity was temporary and the troubled institution otherwise sound. If these conditions were met, the bank could pledge own-use promissory notes of three months' maturity to receive loans from the Liquiditäts-Konsortialbank. Importantly, if the resources of the Liquiditäts-Konsortialbank were insufficient, the troubled bank was allowed to discount its own-use promissory notes at the Bundesbank's discount window, receiving the required second signature by the Liquiditäts-Konsortialbank (see Pistelli, 1999; Prati and Schinasi, 1999). The whole construction was in principle designed as a LOLR facility, given that both the solvency condition and the extended collateral set were implied. However, as subsidized operational conditions were applicable, it contains some elements of a MMOLR facility and consequently – just like the offering to East German banks – was a hybrid in terms of Table 2.2.

Through the three channels described, the Bundesbank followed the Reichsbank tradition of channeling central bank credit to special purposes described in Section 3.9. As liquidity was partially transmitted via separate institutions and the broadening of the collateral criteria was outsourced to them, the focus of the Bundesbank on its single objective of monetary stability remained in the foreground. Nevertheless, through the Liquiditäts-Konsortialbank, the Bundesbank certainly took (at least) a LOLR role and via the special purpose discount loan institutions it influenced markets of specific segments of the economy as a MMOLR. The support for eastern German banks was both a LOLR to secure the stability of the financial system of Eastern Germany and an immanent assistance to the East German real economy as a MMOLR.

In addition to the above-described measures, two further policy measures to ease conditions for collateralized lending are remarkable (see Deutsche Bundesbank, 1995, on both issues). First, in May 1982 the Bundesbank granted unlimited access to its Lombard facility. Until then, Lombard loans had been capped at an amount of approximately 15-20% of the respective banks discount quota or at times the Lombard facility had been completely shut down, being substituted by a higher-rate special Lombard ("Sonderlombard," e.g. November 1973 and February 1981). In effect, a full allotment policy persisted and banks were able to transform eligible collateral of any desired amount into liquidity. When banks reacted to this policy measure by regarding the Lombard facility as (what it was) an ever-accessible means of refinancing that they kept using, the Bundesbank shifted its monetary policy to a greater use of OMOs using repos on eligible collateral.[62] The reason was that it wanted the Lombard facility to be seen as a marginal lending facility for LOLR purposes. Thus, the initiative regarding both collateral and liquidity amount was transferred from banks to the Bundesbank – which thereby escaped from what it called the Lombard trap ("Lombardfalle"), see Deutsche Bundesbank (1995, p. 110) – and regained sovereignty over the liquidity amounts provided through collateralized lending. Second, haircuts on the eligible collateral were abolished in mid-1994, allowing banks to receive more liquidity for any eligible collateral and significantly easing this element of operational conditions.

3.16 Findings from the Past

Having compiled and analytically described policies of central banks with collateral policy relevance over a period from the middle of the 18th century to the end of the 20th century – which were all clustered into the roles of COMPR, LOLR and MMOLR along the lines of Table 2.2 – the following five findings stand out.

First, of the fifteen previous sections containing historical collateral policy actions of central banks, eleven contained actions assignable to the MMOLR role,[63] seven presented examples of policies supporting the LOLR role,[64] and five illustrated how collateral policies were adjusted to fulfill the

[62] Although the Lombard facility operated at a premium in terms of operational conditions, these were apparently still set sufficiently low to be attractive for permanent refinancing.
[63] See Sections 3.2, 3.3, 3.4, 3.5, 3.7, 3.9, 3.10, 3.11, 3.12, 3.14, 3.15.
[64] See Sections 3.1, 3.2, 3.8, 3.10, 3.13, 3.14, 3.15.

role as a COMPR.[65][66] Thus, the anecdotal evidence suggests that collateral policy was mostly used to support the fiscal and economic stability and selectively subsidize public finances or sectors of the economy in the past. Moreover, the tendency to take the role as a MMOLR seems especially pronounced for central banks that became a part of the Eurosystem later, as those who have not do not exhibit the bias towards a MMOLR. For the latter subset, the distribution is: COMPR contained in two sections,[67] LOLR contained in four sections,[68] and MMOLR also only contained in four sections.[69] In particular, the policies of the Banque de France, Banco de Espana and Reichsbank stand out, although the Bundesbank also conducted collateral policies targeting specific market segments. This difference between the historical predecessors of EMU versus non-EMU regions is remarkable insofar that the ECB was only explicitly assigned an objective for monetary stability. Nevertheless, it very strongly engaged in collateral policy-making, cf. Chapter 4.

Second – and connected to the first finding – the MMOLR role was often taken with the help of special purpose institutions, circumventing the regular collateral requirements of central banks. Both the Reichsbank and the Bundesbank have very prominently used these constructions, cf. Sections 3.3, 3.9, 3.15. Typically, a public institution providing direct loans to preferred sectors of the economy issues debt instruments for refinancing, which are subsequently discountable at the central bank. Similar examples were described in France, Spain and during the World Wars, cf. Sections 3.5, 3.11, 3.12. The reason for the installation was often to circumvent monetary stability requirements such as a coverage ratio, tighter regular collateral rules directly at the central bank or a monetary financing prohibition.

Third, in early times the LOLR role was often restricted by a monetary stability arrangement implying a coverage ratio, most prominently under the gold standard. Central banks were then hesitant to broaden the eligible collateral set horizontally and widen the access window to sufficiently many counterparties (e.g. Sections 3.2, 3.8). Since monetary stability has been defined in terms of price stability without convertibility promises, central banks installed quantitatively larger collateral sets, thus representing a LOLR to a larger degree (e.g. Sections 3.10, 3.13, 3.14, 3.15).

Fourth, there was a shift in the predominant collateral type from assets connected to the convertibility requirements – especially gold – to government securities around the time of the World Wars.[70] Connected to this development was a trend to nationalize central banks that had previously been privately owned (e.g. Capie et al., 1994, esp. Tab. 1.7). While private shareholders were primarily interested in risk mitigation, the public shareholders placed a stronger focus on fiscal, economic and financial stability (increasingly more financial assets were also accepted as collateral over time) and were also willing to sacrifice some safety of the central banks' balance sheets. Ultimately, fiscal and economic expansion and a lower cost of failing financial institutions could be traded off against lower monetary stability from an aggregate perspective. This entirely changes in a monetary union,

[65] See Sections 3.2, 3.7, 3.8, 3.11, 3.15.

[66] Note that each role was at most counted once within each section, although several different roles can apply to each section.

[67] See Sections 3.2, 3.8.

[68] See Sections 3.2, 3.8, 3.10, 3.14.

[69] See Sections 3.2, 3.4, 3.10, 3.14.

[70] A different concept of money in the understanding of central bankers of the 19th compared to the 20th century is also described by Bordo and James (2006). They denote the earlier concept as "Newtonian", as it is strongly coined by the currency-backing with precious metals, and the later as "Einsteinian", because the relative value of goods and the currency is determining.

where the above-named trade-off might imply distributional effects between union members, as discussed in Chapter 8. The lesson from the past in this case suggests that members of a monetary union as private shareholders should place a stronger emphasis on a safe collateral set because they cannot rely on a trade-off argument.

Fifth, the anecdotal evidence displays a significant difference to the collateral policy approach of the Eurosystem, which is analyzed next, cf. Chapter 4. While the Eurosystem only defines one unique eligible collateral set, different roles identified from the historical policy actions are mostly conducted within distinct eligible collateral sets, i.e. central banks make a difference between the collateral that they accept within COMPR measures, LOLR measures and MMOLR measures. For the latter, this manifests in the auxiliary constructions (via public institutions as SPVs), which always imply a difference between the collateral sets eligible at the central bank directly and at the auxiliary institution. Alternatively, in the example of the Bundesbank, cf. Section 3.15, a smaller collateral set was eligible at the discount facility at subsidized conditions (MMOLR) compared with the Lombard facility, where a large range of asset types was eligible, albeit at tighter operational conditions (LOLR). For a central bank in pursuit of more than one central bank objective, it thus seemed historically common to define different collateral requirements for different lending facilities. This has already been suggested by the different normative prescriptions of Table 2.2. Moreover, it will be shown in Section 6.3 that it is optimal to use different dimensions of collateral policy in pursuit of different objectives.

Chapter 4

The Eurosystem's Collateral Policy and the Application in Crisis Management[71]

In this chapter, an in-depth description of the collateral policy of the Eurosystem is provided, which is situated at the heart of the analysis in this dissertation. For one, the findings are discussed in the light of the normative framework of collateral policy established in Part I. For another, the unique comprehensive narrative databases of both the Eurosystem's collateral criteria and its haircut specification from 2001 to 2014 – which are compiled – build the basis for the comparative analysis of international collateral policy in the following Chapter 5 and for the analyses on the impact and effects of collateral policy in Part III, where the Eurosystem's collateral policy approach plays a leading role for the setup of the theoretical models.

In the following Section 4.1, the role of collateral in policy operations of the Eurosystem is described. It is concluded that collateral plays a particularly important role as the overwhelming majority of the policy operations conducted by the Eurosystem were collateralized lending-based.

Consecutively, the narrative database of collateral criteria is compiled in two steps. First, in Section 4.2, the structure of the Eurosystem's collateral framework is explained, including the division into the General Framework and the Temporary Framework, its origins and the harmonization of national criteria. Additionally, three general principles are carved out, namely close links, valuation principles and the Eurosystem Credit Assessment Framework (ECAF). In the second step (Section 4.3), the development of criteria for collateral eligibility over time is spread out. Both general and asset type-specific developments for government-related (issued or guaranteed) assets, assets traded on non-regulated markets, bank bonds, ABS and corporate bonds are presented. As an overarching result, the collateral policy can be denoted as harmonizing until the financial crisis of 2007/2008 and as quantitatively and qualitatively loosening the collateral criteria, hence horizontally and vertically broadening the eligible assets pool from then onwards. Furthermore, the summarizing Section 4.4 highlights that the collateral policy-making activity of the Eurosystem was strongly intensified, comprising 74 changes in 44 official documents since the Lehman event compared to 25 changes in only 6 official documents during all previous years. A further finding is that the

[71] This chapter bases on joint work with Jakob Eberl (Eberl and Weber, 2014a; b; 2015), which has also been used in his dissertation (Eberl, 2016).

crisis management conducted through collateral policy measures can be sub-divided into the first response to the turmoil, comprising rather general changes and resembling LOLR actions, as well as the refinement of collateral policy over the following years and throughout the European debt crisis towards the alteration of asset type-specific criteria, when a MMOLR role is deduced from collateral policy measures. For one, the latter measures particularly targeted government-related securities, especially those of lower qualities and thus of crisis-afflicted countries. The lowering of the minimum credit rating threshold, the suspension of this threshold and the acceptance of Dominion Bond Rating Service (DBRS) as an External Credit Assessment Institution (ECAI) contributed to this finding. For another, bank assets particularly profited from collateral policy measures such as the acceptance of the Short-Term European Paper (STEP) Market, the acceptance of own-use government-guaranteed uncovered bank bonds and the close links regulations for own-use covered bank bonds, as well as the acceptance of credit claims and the allowance for idiosyncratic policy on the collateral criteria for these.

While collateral criteria shape the horizontal, vertical and time dimensions of collateral policy configuration, the haircut policy is a crucial layer of the operational conditions dimension (cf. Table 2.2) determining the collateral value in relation to both refinancing in the market and as the maximum loan amount. Section 4.5 adds a comprehensive description and evaluation of the Eurosystem's haircut specification. In the beginning, it is worked out how haircuts are applied to collateral for the sake of risk mitigation and their stressed position within the set of risk control measures is deduced. Consecutively, seven normative propositions for the specification of haircuts are made and mirrored against the Eurosystem's practice. This practice addresses all rules set out in the normative propositions, albeit to differing markedness. While legal risk, operational risk and exchange-rate risk are sufficiently respected, wrong-way risk and market risk are only incompletely incorporated, inter alia because respective haircut regulations have been abolished at some point. Regarding interest-rate risk and quality risk, information is left behind in a clustering approach along three out of four haircut-determining dimensions of asset characteristics: liquidity, residual maturity and credit quality. The effects of this clustering approach – which is schematized as segmentally-pooled haircut conditions – are discussed in further detail in Chapters 7 and 8. Chapter 7 presents the quality effects of the approach resulting from the positive (and negative) subsidization of different collateral qualities. Chapter 8 deduces distribution effects within a central bank jurisdiction, which hold particular relevance in a monetary union. Further shortcomings identified within the Eurosystem's haircut specification include the sequential application of different types of haircuts (nominal haircuts, add-on haircuts and valuation markdowns) and its rigidity, which contributed to favorable refinancing conditions using distinct asset types, as described above.

It is not very well documented descriptively how the Eurosystem's collateral policy shaped its eligible assets pool. Information on the composition of the pool over time is thus refined in Section 4.6 with the help of the Eligible Assets Database, compiled from data provided to the author by Deutsche Bundesbank. The refinement has several dimensions. First, a monthly frequency allows an easier connection to policy changes than the annual frequency publicly offered by the ECB. Second, nominal values of individual assets are included. Third, a regional subdivision of the pool by country is provided and shows an increase of the national eligible collateral pools in crisis countries. Fourth, the distribution according to asset quality is added to the data through an inductive identification strategy combining the information in the Eligible Assets Database with a newly-compiled comprehensive database of haircuts set by the Eurosystem. The method allows an assignment of quality to 99% of all assets included in the pool and shows a deterioration of the credit quality within. Fifth, the distribution according to denomination is revealed, showing that foreign currency-denominated assets were significant contributors to newly-eligible assets. Sixth, the importance of assets traded on non-regulated markets is discussed. Seventh, changes in the residual maturity structure of assets in the pool show a shifting towards shorter (residual) maturities.

Finally, in Section 4.7, conclusions with respect to the targeted central bank objective are drawn from the description of the collateral policy of the Eurosystem. Amendments to the configuration of the collateral framework have significantly exceeded the role of a COMPR, who solely safeguards monetary stability. Elements of LOLR policy have found their way into the collateral policy measures and in particular the policies targeting specific asset types and the qualitative lowerings must be ascribed to the pursuit of a fiscal and economic stability objective as a MMOLR, if evaluated along the normative framework proposed in Part I of this dissertation.

4.1 Collateral in Eurosystem Policy

The Eurosystem possesses three main monetary policy instruments: open market operations (OMOs), the minimum reserve system and standing facilities.[72] It uses them to steer short-term money market rates and ensure the functioning of the money market through the provision of liquidity to banks. The practical execution of monetary policy operations takes place between NCBs and eligible counterparties. Eligible counterparties have to obey the minimum reserve system and be supervised by an European Economic Area (EEA) national authority as well as "financially sound".[73] In contrast to other central banks such as the Fed – which mainly interacts with a very small number of primary dealers (see Section 5.1) – the Eurosystem pursues a decentralized implementation of its monetary policy, i.e. an interaction with many counterparties through the NCBs. At the end of 2014, the number of potentially eligible counterparties reached an all-time low of around 6,500 monetary financial institutions.[74] In principle, all credit institutions subject to minimum reserve requirements are eligible counterparties of the Eurosystem if they meet the aforementioned requirements (cf. Blenck et al., 2001; European Central Bank, 2015). The widest range of counterparties have access to standing facilities. Most of them are also eligible for OMOs, although only a small number have access to fine-tuning operations (FTOs).

Article 18.1 of the Statute of the European System of Central Banks (ESCB) allows the ECB and NCBs to operate in financial markets but requires all Eurosystem credit operations to be based on adequate collateral. The concept of adequate collateral has two dimensions: first, it implies that the Eurosystem should be protected from potential losses in monetary policy operations; and second, it requires that sufficient collateral is available to a broad set of counterparties. The Eurosystem's understanding of adequacy will be extensively discussed throughout this chapter. In the following,

[72] For the ECB's monetary policy conduction, see also European Central Bank (2011). For the role of collateral in Eurosystem Monetary Policy, see e.g. Deutsche Bundesbank (2015).

[73] Exceptions are possible, e.g. for branches of non-EEA banks within the euro area. Furthermore, operational criteria by the respective NCB have to be met.

[74] See ECB, *Number of Monetary Financial Institutions (MFIs)*, December 2014, `https://www.ecb.europa.eu/stats/money/mfi/general/html/mfis_list_2016-02.en.html`.

a general description of the involvement of collateral in the Eurosystem's main monetary policy operations is given.[75]

OMOs most importantly comprise the main refinancing operations (MROs) and longer-term refinancing operations (LTROs). MROs are the regular liquidity-providing transactions, conducted weekly and usually have a maturity of one week. LTROs are conducted monthly and usually have a maturity of three months. For both, the Eurosystem announces whether it wants to distribute a certain volume of liquidity through a fixed or a variable-rate tender. In the former, banks only state the amount of money that they would like to lend at the pre-defined interest rate, while in the latter they state both the desired rate and amount.

However, the outbreak of the financial crisis significantly altered the execution of OMOs.[76] Until October 2008, the provision of liquidity was limited by variable-rate tenders without full allotment.[77] Since October 2008, the Eurosystem has been conducting its liquidity provision via fixed-rate tenders with full allotment. Hence, the Eurosystem determines the interest rate and eligible counterparties can borrow unlimitedly at the given interest rate. This measure massively amplified the importance of collateral criteria as from then onwards the volume of refinancing credit drawn from the Eurosystem was in effect no longer determined by the ECB, but was rather dependent on the amount of eligible collateral and the criteria concerning pledgability. Furthermore, the Eurosystem extended maturities for LTROs on several occasions: in April 2008, it introduced supplementary longer-term refinancing operations (SLTROs) with a doubled maturity of six months, in June 2009, it extended the maturity to one year and even prolonged it to three years in December 2011. Above that, targeted longer-term refinancing operations (TLTROs) with a maturity of up to four years (but an early repayment option) were first conducted in September 2014. Hence, to calm financial markets during and since the financial crisis, the Eurosystem fully allots liquidity with maturity of up to three years. In addition to MROs and LTROs, the Eurosystem's OMOs toolkit contains FTOs and structural operations as non-standardized and non-regular instruments. This last type of monetary policy operation is used to adjust the amount of liquidity in the market over the longer term.

The third monetary policy tool is the overnight and unlimited liquidity-providing marginal lending facility. Conditions of this *standing facility* are determined by the Eurosystem and the counterparties can access the facility whenever and to the extent that they desire and are able to collateralize.

The actual transaction behind a liquidity-providing monetary policy operation is usually a *reverse transaction*.[78][79] First, a reverse transaction can be a repo, where the central bank and counterparty

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75 Obviously, of the three monetary policy tools, *the minimum reserve system* does not involve a collateralization requirement given that banks simply have to hold minimum reserves in accordance with the size and composition of their balance sheets at the central bank in cash. Furthermore, the following text focuses on liquidity-providing operations of the Eurosystem (in opposition to liquidity-absorbing operations).

76 For technical details of the Eurosystem's reaction to the financial crisis, see e.g. European Central Bank (2010a,b), Gros et al. (2012), Sinn (2014b), and Trichet (2010b). A special focus on the management of the European sovereign debt crisis is laid in Claeys (2014), Cour-Thimann and Winkler (2012), and Sinn (2014b). Cf. also the annexes of the monthly bulletins of the ECB for chronological overviews.

77 The Eurosystem had only used fixed-rate tenders (without full allotment) since the very beginning of the third stage of the EMU (January 1999 to June 2000), see Catalão-Lopes (2010).

78 Only for FTOs foreign exchange swaps and for structural operations outright asset purchases are possible additionally.

79 See Kopcke (2002) for an earlier discussion of central bank practice regarding reverse transactions.

agree on two transfers at two points in time. Initially, the central bank buys an asset from the counterparty and at some pre-defined time later the counterparty buys the asset back from the central bank. In this case, the ownership of the asset is transferred to the central bank and back. The interest rate that shall be applied to the monetary policy operation is implemented in the difference between the purchase price and repurchase price. Repos are elaborated in further detail in Section 7.1.1. A second possible way in which the reverse transaction can be realized through is a collateralized loan. Here, the central bank makes a loan to the counterparty, which is secured by an asset. The asset is retained by the counterparty, although the ownership would be transferred to the central bank in case of non-fulfillment of the debt obligation. In practice, the assets pledged as collateral have to be stored at a safe custody account of the responsible NCB at a clearing and depositary institution. To collateralize a loan, the counterparty can choose to use either the earmarking system – where each asset pledged is earmarked for only one specific transaction – or a pooling system, where the collateral is considered in total. The NCB credits the collateral account of the counterparty (at the NCB) with the corresponding value and the counterparty can participate in monetary policy operations to this extent. In the specific case where the collateral comprises credit claims, it is pledged by assignment for security such that the NCB becomes the new creditor by law, although normally the counterparty remains the visible contact for the debtor in terms of repayments. In case of a default of the counterparty, the NCB can use the collateral to settle its claims of principal and interest as well as administrative costs. If it generates higher proceeds, these belong to the counterparty. If only a part of the claim can be met, the rest remains outstanding. The assets provided as collateral have to be of an adjusted market value that exceeds the volume of the liquidity provision over the entire period of the reverse transaction.[80] To calculate the adjusted market value of the collateral, a haircut is deducted from the market value.[81] There is not a default form for reverse transactions; rather, the individual NCB decides whether a repo or a collateralized loan will be conducted or leaves the choice with the counterparty. However, in practice, most NCBs make exclusively collateralized loans as Figure 4.1 reveals. From an economic perspective, repos and collateralized loans are similar, as discussed in further detail in Chapter 7. Therefore, reverse transactions are called loans in this dissertation, for reasons of simplicity.

The monetary policy of the Eurosystem primarily bases on loans and only recently – in the course of asset purchase programs like the Covered Bond Purchase Programs (1, 2 and 3, starting in 2009, 2011 and 2014, respectively), the Securities Market Program (from 2010 to 2012) and the Asset-Backed Securities Purchase Program (since 2014) – have outright asset purchases been conducted as OMOs. The left panel of Figure 4.2 gives an impression of the dominance of loans in the Eurosystem's liquidity provision. Moreover, the maturity structure of the loans made by the Eurosystem significantly shifted towards longer terms as the right panel of the figure reveals. Since early 2012, most of the loaned liquidity was granted for the longest possible term of three years.

Not only were maturities prolonged and volumes extended (fully allotted) throughout the crisis years, but also interest rates were lowered and the frequency of refinancing operations increased:

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80 Depending on the system used, earmarking or pooling, this has to be ensured for each individual transaction or in total.

81 The haircut reflects inter alia liquidity and remaining maturity of the security and is defined according to the provisions of the risk control measures of the Eurosystem, see Section 4.5.

Figure 4.1: Practice of Reverse Transactions at National Central Banks

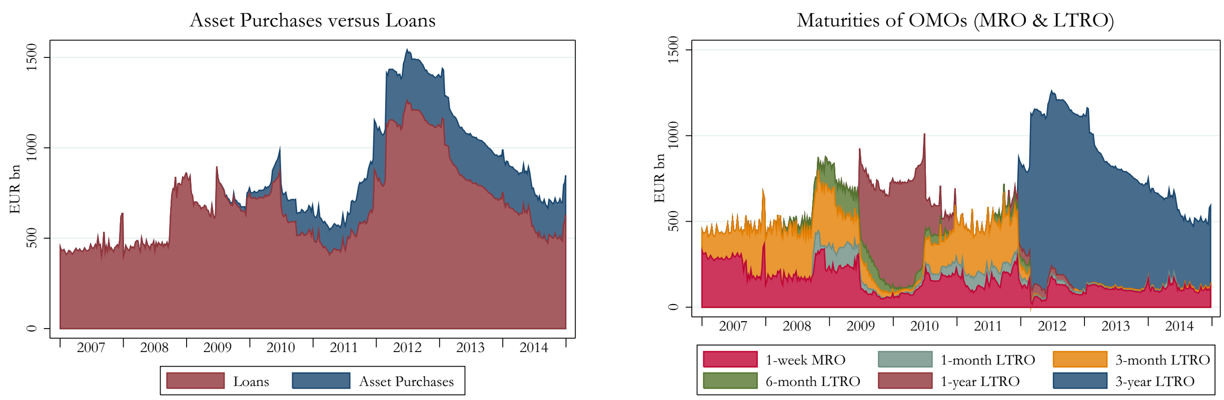
The figure provides an overview concerning how NCBs perform reverse transactions. Almost all NCBs apply collateralized loans only, whereas only four NCBs allow for both repos and collateralized loans. Solely Estonia opts for repos.

Source: author's compilation; NCBs.

Figure 4.3 shows both the Eurosystem's main refinancing rate and the number of monthly refinancing operations in one picture. The refinancing rate started at 3.5% in January 2007 and was even increased to 4.25% before the crisis hit in October 2008. Followingly, a process of substantial lowering steps set in, with the rate arriving at the ZLB (at 0.05%) six years later. The number of monthly refinancing operations starts at 5 in the picture, before subsequently increasing up to peaks of 10 (in October and December 2009) in reaction to the crisis. The average number is 5.5 across the period from January 1999 until September 2008, but 6.8 thereafter. With the more frequent, unlimited liquidity provision at the ZLB of interest rates and prolonged maturities, the table was set for an important role of collateral policy measures, which will be described in the following.

Figure 4.2: Structure of the Eurosystem's Liquidity Provision

The figure shows that the Eurosystem primarily conducted its policy through loans rather than asset purchases until the end of 2014 (left panel). The right panel details the maturity structure of OMOs and shows that it significantly shifted towards longer terms. This is an important contribution to the power of collateral policy along the dimension of operational conditions (cf. Table 2.2).

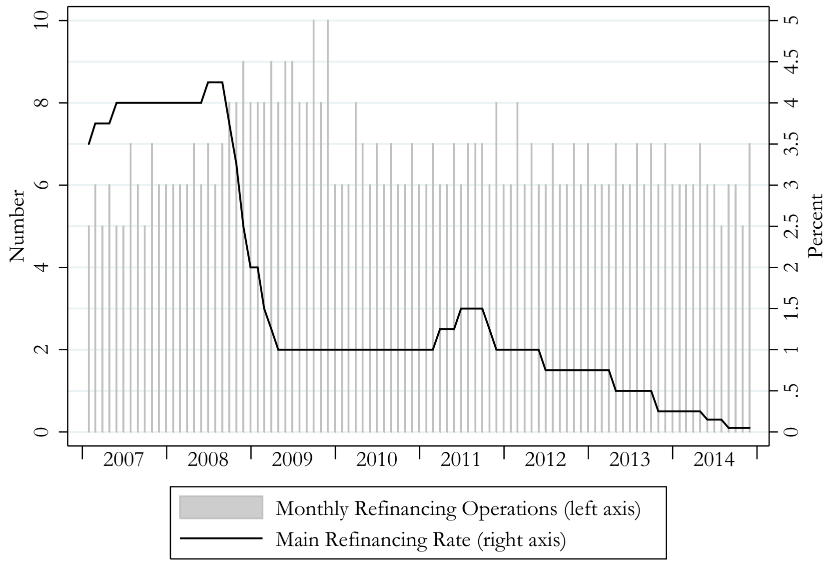


Source: author's illustration; ECB.

Source: author's illustration; Claeys (2014); ECB.

Figure 4.3: Frequency and Interest Rate of Refinancing Loans

The figure shows development of the Eurosystem's policy rate, the main refinancing rate, over time. It had already been lowered to very low values in 2008 and 2009, leaving little room for interest rate policy. Eventually it reached the ZLB. Moreover, the number of monthly refinancing operations was increased during crisis management, especially during the financial crisis. Both measures increase the set the stage for a powerful collateral policy, as described along the description of the dimension of operational conditions, cf. Table 2.2.



Source: author's calculation; ECB.

4.2 Eligibility Criteria in the Eurosystem's Collateral Framework

As discussed above, Article 18.1 of the Statute of the ESCB allows the ECB and NCBs to operate in financial markets. However, when doing so, it also calls for all Eurosystem credit operations to be based on adequate collateral. Adequate collateral is ensured by the Eurosystem's criteria for eligible assets. The distinction between general and temporary eligibility rules, the initial general framework, the Single List of eligible assets as well as some basic principles of the Eurosystem's collateral policy are examined within this section.

4.2.1 Two Collateral Frameworks

Criteria for assets to be eligible as collateral are specified within two parallel frameworks set out by the Eurosystem: *(i)* the General Framework and *(ii)* the Temporary Framework. Whenever assets fulfill the eligibility requirements defined by the Eurosystem, NCBs are obliged to accept assets as collateral and grant refinancing credit to the pledging counterparty.

The general collateral criteria in terms of the General Framework are laid down in the "General Documentation", which entered into force in January 2001 and has been amended several times until 2011. All these amendments were incorporated in the recast of the General Documentation, which entered into force on January 1, 2012 and was still in force at the end of 2014.[82]

[82] This chapter is based on information available at the end of 2014 unless otherwise marked. However, the Eurosystem published another recast of the General Documentation at the end of 2014, which came into force on May 1, 2015 but is not incorporated in this chapter.

However, besides the general eligibility for collateral, the Temporary Framework complements the General Framework and lays down additional temporary measures on collateral eligibility. Temporary measures became necessary since the turmoil on financial markets and the implementation of fixed-rate tenders with full allotment called for additional collateral. With liquidity becoming scarce, eligible counterparties made extensive use of the option to unlimitedly borrow against collateral from the Eurosystem, see e.g. Drechsler et al. (2016). With the financial crisis being considered a temporary phenomenon, the Eurosystem reacted to the increased demand for collateral by setting up the Temporary Framework to define temporary eligibility criteria in October 2008. It was initially thought to be set up until the end of 2009; however, as liquidity demand grew further rather than returning to normal, the Eurosystem decided to maintain the complementing framework.[83]

As a result, what was initially thought to be a "crisis framework" for a limited period – aiming at the availability of additional collateral, which became necessary to make the high liquidity provision possible – remained in force at the end of 2014. Important eligibility criteria that were said to be temporary were carried over to the General Framework or ultimately remained in force without expiration date. The General and Temporary Framework both set out the eligibility criteria for collateral, thus constituting the Eurosystem's collateral framework that will be investigated in toto throughout the remainder of the analysis.

4.2.2 The Initial General Framework: Tier-1 and Tier-2 Eligibility

The Eurosystem had distinguished since 2001 between two categories of eligible assets: tier-1 and tier-2 assets. Within these two asset categories, various types of marketable and non-marketable assets were initially eligible or became eligible over time.[84] In particular, the type of asset, the type and residence of the issuer/debtor/guarantor, the place of issuance, the credit quality of the asset and its denomination are crucial elements for determining the eligibility of assets and thus have been main facilities for alteration.

The distinction between tier-1 and tier-2 assets was necessary as at that time, economic integration across the Eurosystem was at its beginning and differences in financial structures of countries were still substantial. Therefore, NCBs were given the right to consider eligible as tier 2 certain assets

83 The General Documentation, the Temporary Framework, as well as amending legal acts can be found on the ECB website. Information included in this chapter can be found in these documents unless otherwise or more precisely marked in the following. Cf. ECB, Legal Framework, Monetary Policy and Operations, Monetary Policy Instruments: General Framework, Temporary Framework and Expired Legal Acts, `https://www.ecb.europa.eu/ecb/legal/1002/1014/html/index-tabs.en.html`, last accessed March 4, 2016.

84 Marketable assets are assets for which active markets exist and which may be liquidated within a short time, e.g. bank bonds, corporate bonds and ABS. Hence, a market value exists for those assets. The set of eligible marketable assets at the end of 2014 comprised ECB debt certificates, central government debt instruments, debt instruments issued by central banks, local and regional government debt instruments, supranational debt instruments, covered bank bonds, credit institutions debt instruments, debt instruments issued by corporate and other issuers and ABS. The ECB publishes an asset-by-asset list of eligible marketable assets on a daily basis. Non-marketable assets are, by contrast, not traded on a regular market but instead are dealt in private transactions or are held by the owner until maturity. As a consequence, non-marketable assets generally lack a market value. The set of eligible non-marketable assets at the end of 2014 comprised credit claims, retail mortgage-backed debt instruments (RMBDs) and fixed-term deposits. Credit claims are defined as debt obligations of a debtor vis-à-vis a Eurosystem counterparty and also referred to as bank loans. RMBDs are debt instruments (promissory notes or bills of exchange) that are secured by a pool of residential mortgages but fall short of full securization. Only Irish mortgage-backed promissory notes have been labeled as such thus far. Due to the non-marketability, neither the ECB nor the NCBs are able to provide information on the amount of eligible non-marketable assets.

that were regarded as particularly important for national financial markets and banking systems, while the Eurosystem only applied uniform eligibility criteria to tier 1.

These uniform eligibility criteria specified by the Eurosystem permitted two types of assets: Debt certificates issued by the ECB or NCBs prior to the adoption of the euro and debt instruments issued or guaranteed by entities established in the EEA which were admitted to trading on regulated and non-regulated markets (see also Section 4.3.3).[85] Moreover, eligible tier-1 assets had to meet "high credit standards" to ensure financial soundness of the pledging counterparty. However, these standards were not specified further in the beginning. Furthermore, debt instruments had to be denominated in EUR to be eligible. The Eurosystem prohibited NCBs to accept as collateral "own-use debt instruments", i.e. debt instruments which are pledged by the issuing counterparty itself. The ineligibility of debt instruments with close links to the pledging counterparty has been modified several times and its development is discussed in Section 4.2.4.1.

Furthermore, as indicated above, marketable and non-marketable assets which were regarded as particularly important for national financial markets and banking systems could be made eligible as tier-2 assets. Unlike tier-1 assets, the eligibility criteria for these assets were not established by the ECB but idiosyncratically by the NCBs, albeit subject to approval by the ECB Council. Tier-2 assets had to be either debt instruments (both marketable and non-marketable) or equities traded on regulated markets.[86] Like for tier 1, tier-2 assets had to be denominated in EUR and were ineligible if they were own-use.

4.2.3 A Comprehensive Collateral Framework: The Single List

As economic and financial integration proceeded over time, the Eurosystem repealed the possibility of idiosyncratic acceptance of assets by introducing the Single List, a comprehensive framework for eligible assets in January 2007. The two-tier system was phased out gradually until May 31, 2007 with tier-2 assets not qualifying for the Single List remaining eligible until May 31, 2007.[87] Instead, the Single List has been drawing a distinction between marketable and non-marketable assets. While marketable assets comprise former tier-1 assets, two types of assets were initially summarized as non-marketables: credit claims – i.e. bank loans – and RMBDs. The Eurosystem

[85] These entities included Eurosystem, public sector and private sector entities from EEA countries as well as international and supranational institutions.

[86] However, exceptions could be authorized by the ECB. In particular, NCBs could be allowed to include any other assets, e.g. debt instruments issued by credit institutions not complying with Article 22(4) of Directive 88/220/EEC amending Directive 85/611/EEC (hereafter referred to as "UCITS Directive"). According to the Eurosystem, a credit institution is any institution that is either *(a)* an undertaking whose business is to receive deposits or other repayable funds from the public and grant credit for its own account, or *(b)* an undertaking or any other legal person, other than those under *(a)*, which issues means of payment in the form of electronic money. For the sake of simplicity, credit institutions are hereafter referred to as banks. Article 22(4) specifies the following criteria for a covered bond to comply with the Directive for Undertakings for Collective Investment in Transferable Securities (UCITS): *(i)* The issuer of the bond must be a credit institution; *(ii)* issuance has to be governed by a special legal framework; *(iii)* issuing institutions must be subject to special prudential public supervision; *(iv)* the set of eligible assets to cover the bond must be defined by law; *(v)* the cover asset pool must provide sufficient collateral to cover bondholder claims throughout the entire lifetime of the covered bond; *(vi)* bondholders must have priority claim on the cover asset pool in case of default of the issuer. Covered bonds that comply with those requirements are considered particular safe. Debt instruments fulfilling the criteria set out in this directive will be denoted as "UCITS-compliant covered bank bonds" or simply as "covered bank bonds" in the remainder of the chapter.

[87] Phasing out was subject to the exception of units of French fonds communs de créances (FCCs; French securization funds) which were formerly eligible as tier 1. These units remained eligible until December 31, 2008.

thereby harmonized the former idiosyncratic eligibility criteria for tier-2 assets, with the exception of credit claims for which some idiosyncratic acceptance criteria remained.[88]

4.2.4 General Principles of the Collateral Framework

In this section, three general principles within the Eurosystem's collateral framework will be discussed: *(i)* close links between counterparties, *(ii)* the valuation of assets eligible as collateral and *(iii)* the Eurosystem Credit Assessment Framework (ECAF) within which the Eurosystem evaluates the credit quality of eligible assets.

4.2.4.1 Close Links

The ineligibility of assets with close links was already part of the initial General Framework as of January 1, 2001. Accordingly, assets were ineligible if issued or guaranteed by the counterparty submitting the asset. The most extreme case of close links is the own use of assets, i.e. a situation in which the asset is issued and pledged by the same party. Close links were initially defined according to Directive *2000/12/EC* of the European Commission (EC) focusing on links in participation or control.[89] However, four exceptions were made: *(1)* close links between the pledging counterparty and public authorities of EEA countries; *(2)* close links in trade bills, i.e. trade bills for which at least one entity (other than a credit institution) was liable in addition to the pledging counterparty; *(3)* close links in UCITS-compliant covered bank bonds and *(4)* cases in which debt instruments were protected by specific legal safeguards comparable to *(3)*, although they were not further specified.

This definition and the general application of the ineligibility of assets with close links was successively altered as depicted in Table 4.1.[90] In May 2005, the Eurosystem deviated from the EC's rather general definition of close links, making the definition more closely related to its collateral policy.[91] The definition was again slightly changed in January 2007 when not only issuers were incorporated in the definition, but also debtors and guarantors. At the same time, trade bills with

[88] The Single List allowed for idiosyncratic criteria regarding only size and handling fee until December 2011. Thereafter, NCBs were allowed to idiosyncratically accept credit claims within the "additional credit claims framework", see Section 4.3.1.2.

[89] According to Directive *2000/12/EC*, the Eurosystem defined close links as situations in which two or more entities were linked by *(1)* participation which meant "the ownership, direct or by way of control, of 20% or more of the voting rights or capital of an undertaking", or *(2)* control, which meant "the relationship between a parent undertaking and a subsidiary, in all the cases referred to in Article 1 (1) and (2) of *Directive 83/349/EEC*, or a similar relationship between any natural or legal person and an undertaking; any subsidiary undertaking of a subsidiary undertaking shall also be considered a subsidiary of the parent undertaking which is at the head of those undertakings." Also, a situation in which two or more entities were "permanently linked to one and the same person by a control relationship shall also be regarded as constituting a close link between such persons." This definition, as the EC emphasizes, laid down only minimum criteria for the close links-provision.

[90] The table includes also assets-specific developments. For the description of these specific applications of close links to the asset classes, see the respective sections below.

[91] As of May 2005, the Eurosystem defined close links as cases in which *(1)* "the counterparty owns 20% or more of the capital of the issuer, or one or more undertakings in which the counterparty owns the majority of the capital own 20% or more of the capital of the issuer, or the counterparty and one or more undertakings in which the counterparty owns the majority of the capital together own 20% or more of the capital of the issuer;" or *(2)* "the issuer owns 20% or more of the capital of the counterparty, or one or more undertakings in which the issuer owns the majority of the capital own 20% or more of the capital of the counterparty, or the issuer and one or more undertakings in which the issuer owns the majority of the capital together own 20% or more of the capital of the counterparty;" or *(3)* "a third party owns both the majority of the capital of the counterparty and the majority of the capital of the issuer, either directly or indirectly, through one or more undertakings in which that third party owns the majority of the capital."

close links became ineligible. A significant change was undertaken by the Eurosystem in February 2009. As government guarantees gained importance during and since the financial crisis, the Eurosystem declared government-guaranteed debt instruments with close links eligible.[92] Since February 2009, all marketable and non-marketable debt instruments with close links have been eligible (even if they were own-use) provided that they were guaranteed by a government of an EEA country and complied with the general eligibility criteria. Furthermore, RMBDs with close links became eligible.

4.2.4.2 Valuation Principles

Valuation principles lay down rules concerning how to assess assets that are pledged as collateral. These principles hold crucial importance as risk control measures are applied and refinancing credits are granted based on the valuation.[93] Valuation principles were already broadly specified in the initial General Framework. As with the entire framework, the principles were successively altered over time. By the end of 2014, the Eurosystem calculated the value of marketable assets based upon a representative price on the business day preceding the valuation date (market price). If more than one price is quoted, the lowest of these prices is used. In the absence of such a price on the preceding business day, the last trading price is used. However, if the last available price is older than (or has not moved for at least) five days, the Eurosystem assigns a theoretical value to the asset. For non-marketable assets, a theoretical value or simply the outstanding amount is always used. Additional valuation haircuts are deducted if the value is not supported by a market price for covered and uncovered bank bonds as well as for ABS.[94] For credit claims, this additional haircut is even higher, if the outstanding amount is drawn on for valuation means.

Hence, the Eurosystem has implemented general principles regarding the valuation of eligible collateral but the potential of valuation errors remains. This is the case for both marketable and non-marketable assets and particularly relevant for own-use collateral, i.e. securities pledged by the issuing counterparty itself, as such assets are never traded. Hence, no market price exists and the assets have to be theoretically valued.

A valuation error in theoretical pricing may involve risks. First, the refinancing credits granted for such an overvalued asset would be too high. In addition, the risk control measures applied to a misvalued asset would not capture the true underlying risk.[95] In case of default, the pledged security might subsequently be insufficient to cover the default loss.[96]

92 See Section 4.3.2 for a closer investigation.

93 See Section 4.5 on the risk control conducted by the Eurosystem.

94 These haircuts are directly applied at the level of valuation in the form of a valuation markdown, see Section 4.5.4.1.

95 See Section 4.5.2 for details on the risk control measures applied by the Eurosystem.

96 This can best be illustrated by an example: imagine that the true value of an asset which a bank pledges with the Eurosystem to receive refinancing credits is 80 but unknown to the Eurosystem, which in addition cannot consult the market price, e.g. because the asset is non-marketable. Due to this lack of information, the Eurosystem may overvalue the asset by assigning a theoretical value of e.g. 100. Subsequently, for every valuation haircut smaller than 20%, the Eurosystem would grant refinancing credits to an amount that is not entirely collateralized by the underlying asset. For instance, for a haircut of 10%, the Eurosystem would be left with a loss of 10 in case of a bank default.

Table 4.1: Changes to the Collateral Criteria of Securities with Close Links

The table depicts the evolution of collateral criteria of securities with close links from 2001 to 2014. The most extreme case of close links is the own use of assets, whereby the asset is issued and pledged by the same party. Initial criteria were broadly defined and seldom changed prior to the onset of the financial crisis. Thereafter, amendments became more frequent and related to specific asset types (especially bank bonds).

Date	Action	Asset Type
01/01/2001	Ineligibility of debt instruments with close links (with exceptions); definition of close links according to Directive 2000/12/EC (ECB/2000/7)	all
30/05/2005	Modification of the definition of close links beyond Directive 2000/12/EC (ECB/2005/2)	all
01/01/2007	Ineligibility of trade bills with close links (ECB/2006/12)	trade bills
01/02/2009	Eligibility of government-guaranteed debt instruments and of RMBDs with close links; ineligibility of ABS with close links within a currency hedge (ECB/2008/13)	all, RMBDs, ABS
10/10/2010	Eligibility of residential real estate loan-backed structured covered bank bonds with close links (ECB/2010/13)	covered bank bonds (ABS)
01/02/2011	Eligibility of commercial mortgage loan-backed structured covered bank bonds with close links (ECB/2010/30)	covered bank bonds (ABS)
19/12/2011	Ineligibility of ABS with close links within an interest rate hedge (ECB/2011/25, ECB/2012/11, ECB/2012/17, ECB/2012/18, ECB/2013/4)	ABS
03/07/2012 to 02/05/2013	Limitation of use of government-guaranteed bank bonds with close links (ECB/2012/12, ECB/2011/25, ECB/2012/17, ECB/2012/18)	bank bonds
03/01/2013	Eligibility of further non-UCITS-compliant covered bank bonds with close links (ECB/2012/25)	covered bank bonds
03/05/2013 to 28/02/2015	Release of NCBs obligation to accept eligible government-guaranteed uncovered bank bonds with close links where the guarantor is a country under an EU/IMF program and whose credit assessment does not meet high credit standards; limitation of the use of government-guaranteed uncovered bank bonds with close links (ECB/2013/4)	uncovered bank bonds
01/03/2015	Ineligibility of government-guaranteed uncovered bank bonds with close links (ECB/2013/6)	uncovered bank bonds

Source: author's compilation.

4.2.4.3 The Eurosystem Credit Assessment Framework

Since January 2007, the Eurosystem has been ensuring that all eligible assets comply with uniform credit rating standards by setting up the Eurosystem Credit Assessment Framework (ECAF). The ECAF was introduced to assess the creditworthiness of collateral based on several credit assessment sources.[97] The Eurosystem has always been stipulating since the initial General Framework that at least one credit assessment from an eligible ECAI for the *security issued* had to comply with high credit standards. In January 2007, the Eurosystem specified that in absence of a rating for the security issued, the creditworthiness of the *issuer* would be decisive. In case of a guaranteed issue, the creditworthiness of the *guarantor* was only considered in third place. Thereby, the Eurosystem had established a clear pecking order of credit ratings: *(1)* issue, *(2)* issuer and *(3)* guarantor. The respectively next credit rating was only used in case the precedent rating was not available.[98] However, the Eurosystem defined down the pecking order in October 2013. From then onwards, *program* ratings could be considered equally to issue ratings. In addition to this extension of step *(1)*, in absence of an issue or program rating, the Eurosystem has effectively equated *(2)* and *(3)* of the pecking order as it has subsequently only considered the better rating. Hence, in case of a missing issue rating, a first-best rule has been applied if the issuer and guarantor ratings differ. This first-best rule has already been applied since January 2007 to the issue ratings of all assets except ABS, when these ratings from eligible ECAIs differ.[99]

In January 2011, the Eurosystem undertook a major step towards making ratings from different ECAIs comparable and introduced its "harmonized rating scale".[100] As all eligible ECAIs assess credit risk according to different rating scales, the harmonized rating scale aims to standardize these divergent credit rating scales.[101] The Eurosystem defines three credit quality steps (CQSs) for both short-term and long-term credit assessment. The three CQSs are comparatively arranged in Table 4.2.[102] Since October 2013, the Eurosystem distinguishes short-term assets (i.e. assets with an original maturity of up to 390 days) from long-term assets (i.e. assets with an original maturity

[97] More specifically, the ECAF relies on four sources of credit assessment: External credit assessment institutions (ECAIs), NCBs' in-house credit assessment systems (ICASs), counterparties' internal ratings-based (IRB) systems and third-party providers' rating tools (RTs). As ECAIs cover all eligible issuers/debtors/guarantors from EEA or non-EEA G10 countries, external credit assessment plays the most important role. ICASs and RTs cover only country-specific non-financial corporations while the use of IRB systems has to be permitted by the NCBs and is also subject to a performance monitoring process. Thus, credit rating requirements are generally defined in terms of rating requirements from ECAIs.

[98] Nevertheless, some NCBs had obviously neglected this pecking order. See Brendel et al. (2015) and Section 8.6 for these and other inconsistencies in the application of the ECAF as well as the down-defining sketched in the following.

[99] For ABS, the Eurosystem set up the second-best rule in October 2010 according to which also the second-best available credit rating had to comply with the minimum rating threshold for ABS.

[100] At the end of 2014, the Eurosystem took into account credit ratings from four agencies: Standard & Poor's (S&P), Moody's, Fitch and DBRS; see also below.

[101] The S&P long-term rating scale comprises 22 credit rating notches from AAA to D, the scale of Moody's comprises 21 (Aaa to C), the scale of Fitch only 20 (AAA to D) and DBRS differentiates between 26 notches (AAA to D).

[102] According to Table 4.2, the three CQSs are defined as follows: CQS 1 ranges from a rating of Triple A (Eurosystem's notation) which equals to "Aaa" from Moody's and "AAA" from Fitch, S&P and DBRS to a rating of Double A (Eurosystem), which comprises "Aa3" from Moody's and "AA-" from Fitch and S&P as well as "AA(low)" from DBRS. CQS 2 equals to at least Single A (Eurosystem) which means a rating of "A-" by Fitch or S&P, "A3" by Moody's or "A(low)" from DBRS and is equivalent to a probability of default over a one-year horizon of 0.1%, Finally, CQS 3 corresponds to a credit rating of at least Triple B (Eurosystem) which equals to "BBB-" from Fitch or S&P, "Baa3" from Moody's and "BBB" from DBRS. CQS 3 is equivalent to a probability of default over a one-year horizon of 0.4%. For convenience, the Eurosystem's notation shall be used in this dissertation, whenever possible.

of more than 390 days). For the former, both short-term and long-term ratings are accepted, on a first-best rule basis. For the latter, only long-term ratings are considered.

The harmonization of credit rating scales is exemplified for the rating scale of S&P in Table 4.2. The four credit rating notches from "AAA" to "AA-" are summarized in CQS 1, the three subsequent notches from "A+" to "A-" are collected in CQS 2 and the last three notches above non-investment grade – "BBB+" to "BBB-" – are aggregated in CQS 3. To summarize, the Eurosystem pools information on asset qualities by arranging all eligible assets into only three CQSs. This pooling naturally leaves some information behind. This and other poolings within the risk control of the Eurosystem will later be defined as "segmental pooling", see Section 4.5.7.

Table 4.2: Harmonized Rating Scale of the Eurosystem

The table displays the harmonized rating scale according to which credit ratings of the four agencies are matched. Three ratings of DBRS are highlighted as they were later on shifted. The long-term rating BBBL was introduced in CQS 3 in April 2014. The short-term rating R-1L was moved from CQS 1/2 to 3 and R-2L was introduced to CQS 3 in 2014. Hence, the Eurosystem relaxed collateral criteria by deeming eligible assets with a first-best rating of BBBL or R-2L from DBRS.

		Credit Quality Step (CQS)		
		1	2	3
Short-Term	DBRS		R-1H, R-1M	**R-1L**, R-2H, R-2M, **R-2L**
	Fitch		F1+, F1	F2
	Moody's		P-1	P-2
	S&P		A-1+, A-1	A-2
Long-Term	DBRS	AAA to AAL	AH to AL	BBBH to **BBBL**
	Fitch	AAA to AA-	A+ to A-	BBB+ to BBB-
	Moody's	Aaa to Aa3	A1 to A3	Baa1 to Baa3
	S&P	AAA to AA-	A+ to A-	BBB+ to BBB-

Source: author's illustration; ECB; see also Brendel et al. (2015).

4.3 The Development of Eligibility Criteria

Having described the collateral framework and some general principles within the Eurosystem's collateral policy-making, this section will focus the analysis on the development of the framework. It will become clear from the description that the development has had two major effects. On the one hand, the Eurosystem met its quantitative goal to increase the amount of available collateral. However, on the other hand, it led to a deterioration in quality of the Eurosystem's eligible collateral pool, i.e. the pool of assets eligible as collateral for refinancing credits. To elaborate on these two consequences, first the general changes affecting the eligibility of all assets (both marketable and non-marketable) will be discussed. Second, a description of the amendments to the eligibility of bonds issued or guaranteed by governments follows. After that, the specific development of the eligibility of debt instruments traded on non-regulated markets will be examined. Subsequently, changes to the eligibility of three asset classes will be investigated: Bank bonds, ABS and corporate bonds.

4.3.1 General Changes to the Eligibility of Assets

Modifications to and the development of general eligibility criteria applied to all marketable and non-marketable assets were manifold and are clearly arranged in Figure 4.4. The timeline shows that the Eurosystem's activity in modifying the general eligibility criteria changed over time: In the first years after setting up its collateral framework (2001–2007), the Eurosystem made only few modifications aimed at standardizing and harmonizing the Eurosystem's collateral framework. The individual collateral policy-making by NCBs was abolished and no amendments were made as responses to market developments. However, since the outbreak of the financial crisis in 2008, the Eurosystem intensified collateral policy-making tending to alleviate distortions in financial markets. This behavior was justified along the lines of the central bank as the LOLR. The developments within these two periods are described in the remainder of this section.

4.3.1.1 Modifying the Collateral Framework until 2007

First changes to the collateral framework were made in March 2004 when the Eurosystem divided marketable assets into four categories of decreasing liquidity and hence increasing haircut values applied.[103] Moreover, it further specified the nature of a guarantee for eligible tier-1 and tier-2 assets.[104]

EUR-denominated debt instruments issued by entities established in countries being part of the G10 but not the EEA, i.e. the US, Canada, Japan and Switzerland, became eligible in May 2005. In contrast to this broadening of eligible assets, equities were deemed generally ineligible (they could be accepted by NCBs before). At the same time, the Eurosystem also made first efforts towards the Single List by announcing that it would phase out the two-tier system gradually and replace it with a uniform framework of marketable and non-marketable assets. The Single List was subsequently introduced in January 2007 as the most substantial step towards standardizing the collateral framework across the Eurosystem; see Section 4.2.3.

4.3.1.2 Modifying the Collateral Framework in Response to the Crisis (since 2008)

The Eurosystem's endeavor to create a coherent collateral framework was stopped dead by the collapse of Lehman Brothers in September 2008. As a prompt response, the Eurosystem made one of the most fundamental changes to its collateral framework in October 2008: It lowered the minimum credit rating threshold for eligible assets (except ABS) from Single A to Triple B, i.e. the last rating notch above junk status. In order to capture additional risk involved in the acceptance of such low-rated assets, the Eurosystem applied a uniform add-on haircut to all eligible assets with a rating lower than Single A.[105] The lowering was at first said to be temporary but prolonged by

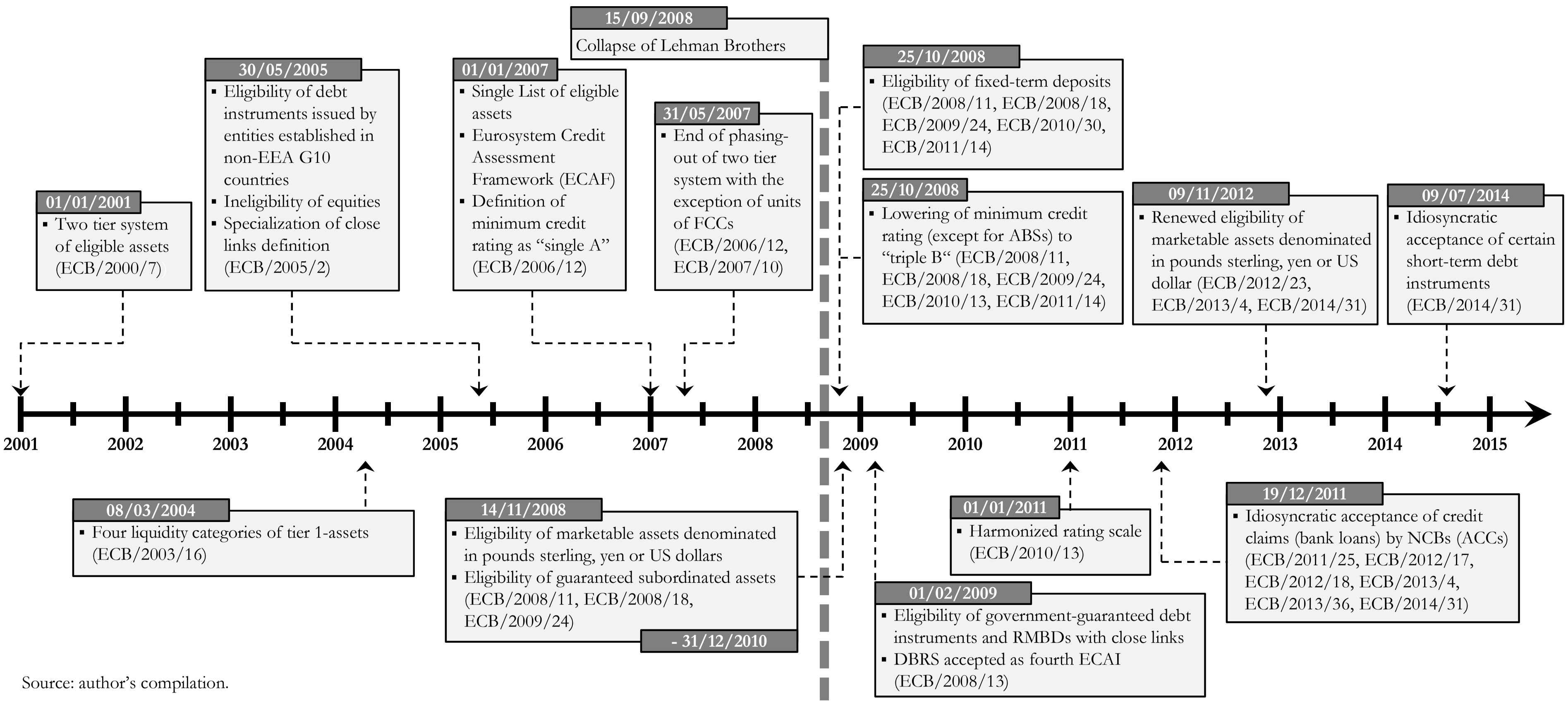
[103] Central government debt instruments and debt instruments issued by central banks were subsumed in liquidity category (LC) 1. Local and regional government debt instruments as well as jumbo Pfandbrief-style debt instruments, agency debt instruments and supranational debt instruments were summarized as LC 2. All traditional Pfandbrief-style debt instruments, credit institution debt instruments and debt instruments issued by corporate and other issuers were marked as LC 3 while all eligible ABS were classified as LC 4.

[104] From then onwards, a guarantee has been accepted if the guarantor had unconditionally and irrevocably guaranteed the obligation with respect to the payment of principal, interest and any other amounts. The guarantee was to be payable on first demand but not necessarily in the case the guarantor was a government. Moreover, the obligations of the guarantor had to rank at least equally with all its other unsecured obligations.

[105] This decision has led to differentiated haircut values applied to assets of CQSs 1/2 and CQS 3 as of January 2011; see Section 4.5.5.

Figure 4.4: Changes to General Collateral Criteria

The timeline depicts the amendments to general collateral criteria from 2001 to 2014. The Eurosystem made only few modifications aimed at standardizing and harmonizing the framework during the first years (2001–2007). During that time, idiosyncratic collateral criteria were abolished and no amendments were made in response to market developments. The Eurosystem intensified amendments since the onset of the financial crisis in the fall of 2008 in response to financial market turmoil.



Source: author's compilation.

several legal acts until January 2011, when the lowering of the minimum credit rating threshold was adopted in the General Framework and hence is in force without expiration date.[106]

Eligibility was first only temporarily implemented for fixed-term deposits. Initially, the Eurosystem collected fixed-term deposits for fine-tuning purposes only, i.e. in order to absorb excess liquidity in the market. Such liquidity absorption became particularly relevant after the Eurosystem started its outright purchases in June 2009. Nevertheless, the Eurosystem has already been allowing eligible counterparties to place fixed-term deposits as collateral with the NCBs since October 2008. As this eligibility was only temporarily valid, it had to be prolonged two times (December 2008 and January 2010). Since January 2011, fixed-term deposits have been included in the General Framework as a third class of eligible non-marketable assets, not being subject to any valuation haircut.

As a next response to the outbreak of the financial crisis and hence another move towards a significant broadening of eligible collateral, the Eurosystem declared debt instruments denominated in GBP, JPY or USD together with guaranteed subordinated assets temporarily eligible in November 2008. This was achieved with the provision that these foreign currency debt instruments were issued and settled in the euro area and the issuer was established in the EEA. The temporary acceptance was again repeatedly prolonged until December 2010. For foreign currency debt instruments, the acceptance was re-introduced in November 2012 and remained operative at the end of 2014.[107]

In February 2009, the Eurosystem undertook another amendment that seems minor yet holds high importance in practice, whereby the list of accepted ECAIs was expanded by a fourth agency: DBRS.[108] Compared to the "big three" rating agencies, i.e. S&P, Moody's and Fitch, which unite a market share of about 95%,[109] DBRS is a small Canada-based agency. On the one hand, the inclusion of another ECAI should be positive as more information can be taken into account when the quality of collateral is assessed. On the other hand, the first-best rule is applied to eligible assets other than ABS in case of differing assessments; see Section 4.2.4.3. Hence, each ECAI has the power to be pivotal for an asset's relevant credit rating, which is subsequently decisive for the eligibility and the haircut determination. With each additionally-accepted ECAI, the competition among rating agencies to provide the highest and thus pivotal rating might increase.

A rather small rating agency thus received the power to substantially influence the refinancing conditions at the Eurosystem. DBRS (of course also the other three rating agencies) has discretion to assess the quality of an eligible asset and hence influence whether collateral is deducted by the lower valuation haircuts applied within credit quality Segment 1 (CQS 1/2) or by the higher haircuts within credit quality Segment 2 (CQS 3), cf. Section 4.5.7. As haircuts substantially differ among the two segments, the potential consequences of this discretion are enormous. Figure 4.5 shows the development of long-term credit ratings of the four ECAIs for Ireland, Portugal, Italy

106 The initial legal act came into force on October 25, 2008 and expired on November 30, 2008. The first prolongation lasted from 1 December 2008 until December 31, 2009. The follow-up prolongation lasted from January 1, 2010 and December 31, 2010. In the General Framework, the minimum credit rating requirement for RMBDs was defined in terms of credit quality step two, or a long-term Single A-rating, respectively, as of January 1, 2011.

107 Prolongations were made in December 2008 and January 2010.

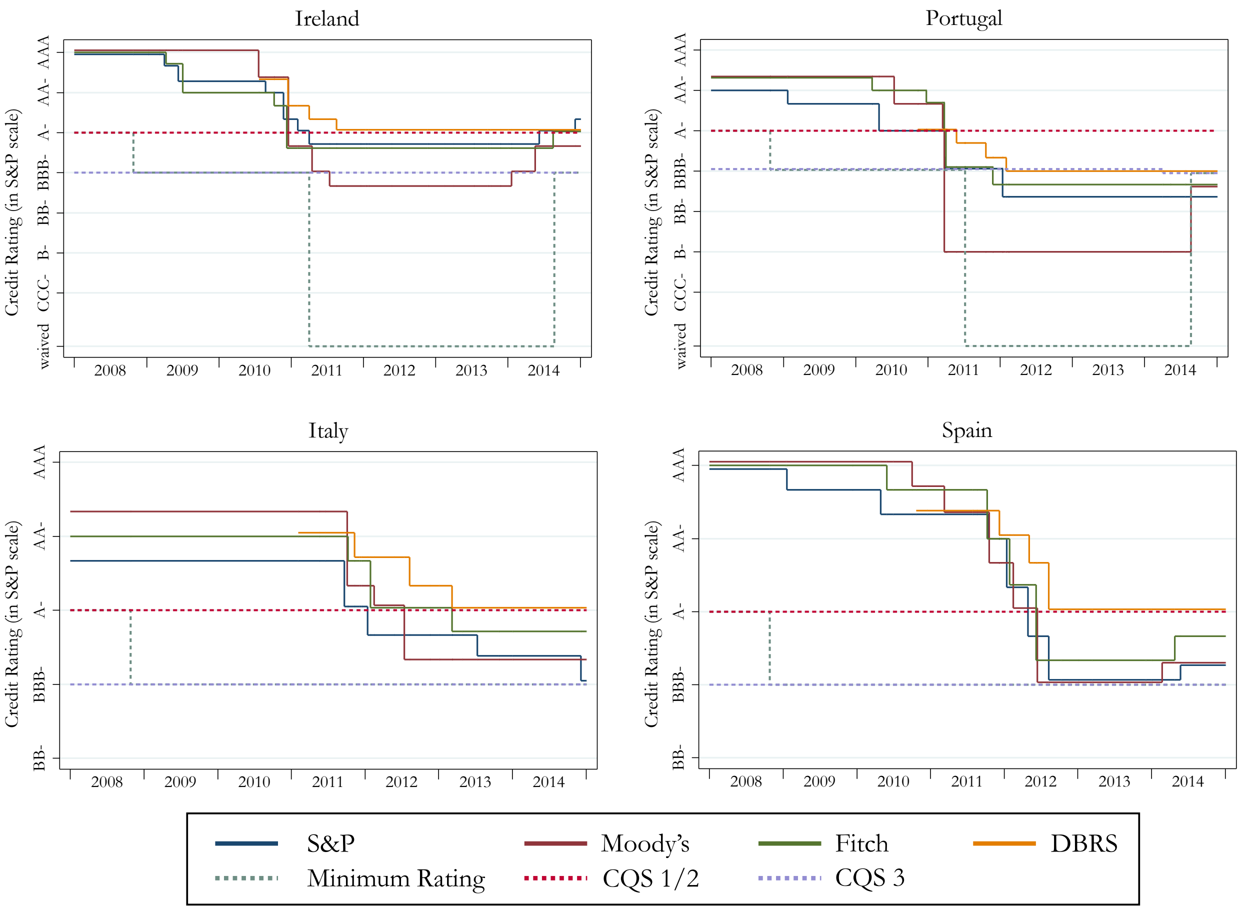
108 DBRS itself states that it has been accepted as an ECAI since January 1, 2008. However, DBRS appeared as accepted ECAI for the first time in a Guideline of October 2008 (*ECB/2008/13)* which came into force on February 1, 2009.

109 E.g. T. W. Martin and G. Tan, "Private Equity Firms Vie for DBRS," *Wall Street Journal*, November 18, 2014, `http://www.wsj.com/articles/private-equity-firms-vie-for-dbrs-1416331896`.

and Spain. It becomes clear that the ratings of DBRS have actually been pivotal.[110] Italian (from March 2013 to December 2014) and Spanish (from August 2012 to December 2014) government bonds could only be pledged at the (cheaper) refinancing conditions of CQS 1/2 due to the DBRS rating. From August 2011 to December 2014, Irish government bonds were only eligible collateral applying the regular requirements of the Eurosystem, i.e. rated at least within CQS 3, due to the DBRS rating. For the Portuguese government or government-guaranteed assets, the minimum credit rating requirement had been waived from July 2011 to August 2014 (cf. Section 4.3.2). When Portugal intended to leave the umbrella of the EU/IMF program in early 2014 and seek market financing again, the eligibility of its sovereign bonds as collateral at the Eurosystem was crucial for this endeavor. DBRS provided the pivotal rating of BBBL at the time, although this was insufficient for eligibility. As Table 4.2 reveals, only the combination of the pivotal DBRS rating with the introduction of BBBL into CQS 3 in April 2014 sustained the central bank eligibility and thus market financing for Portugal.

Figure 4.5: Long-Term Credit Ratings for Selected Sovereigns

The figure shows the long-term local currency credit ratings for the Irish, Portuguese, Italian and Spanish sovereign, as provided by the four ECAIs, over time. DBRS temporarily provided the pivotal credit rating to all four countries. This affected eligibility as such for Portugal and made the classification into CQS 1/2 possible for Ireland, Spain and Italy.



Source: author's compilation; ECB; S&P; Moody's; Fitch; DBRS.

[110] The importance of DBRS is quantified by Nyborg (2015), who calculates the increased collateral value (see Section 4.5.2) due to pivotal ratings from DBRS for the respective sovereigns to EUR 200 billion to EUR 300 billion. However, banks also profited from the credit ratings of DBRS, as Brendel et al. (2015) document.

The application of the first-best rule is particularly relevant as for government-guaranteed debt instruments, where the rating of the guarantor, i.e. the government, in reality is often decisive (cf. Section 4.2.4.3). Within the pecking order, the rating of the guarantor was upgraded to the second step in October 2013, as described above. Moreover, the Eurosystem has been accepting own-use government-guaranteed debt instruments with close links involved since February 2009, cf. Section 4.2.4.1. This date coincides with the official acceptance of DBRS as fourth ECAI.

In December 2011, the Eurosystem gave the NCBs room to idiosyncratically decide on eligibility criteria for credit claims.[111][112] This action was called framework for additional credit claims (ACCs). NCBs were conferred the right to set up their own eligibility criteria and risk control measures for accepting such bank loans, which subsequently only had to be approved by the ECB Council. This requirement for approval was eased in September 2012 when the ECB declared its prior approval not necessary in "exceptional circumstances", provided that the NCBs applied eligibility criteria and risk control measures established by another NCB and which had already been approved by the ECB Council. Still, potential losses from this acceptance are not subject to mutualization between NCBs.[113] The NCBs of Ireland, Spain, France, Italy, Cyprus, Portugal and Austria made use of the regulation. As of January 2014, the room for idiosyncratic decisions was widened, as NCBs were allowed to accept credit claims that are included in a pool of other credit claims or backed by real estate assets in case of exceptional circumstances and further in July 2014, when they were allowed to accept short-term debt instruments issued by non-financial corporations that do not comply with general collateral criteria.

4.3.2 Changes to the Eligibility of Debt Instruments Issued or Guaranteed by Governments

This section examines the amendments to the eligibility of debt instruments issued or guaranteed by public entities with the right to levy taxes (in this dissertation referred to as governments), the development over time is depicted in Figure 4.6. Government guarantees are of importance due to two reasons: first, government guarantees for risky assets pose a risk for taxpayers in case of default; and second, government guarantees can influence the valuation of the collateral as well as its credit rating and thereby its refinancing conditions.[114] It has been discussed in Section 4.2.4.3 how the Eurosystem takes government guarantees into account for the assignment of valuation haircuts.

Although the minimum credit rating threshold for government-related assets had already been reduced to Triple B in line with the lowering of the minimum rating for all assets except ABS in October 2008, several countries kept struggling to ensure that their governments met this threshold. In order to keep debt instruments issued or guaranteed by these countries eligible, the Eurosystem successively decided to suspend the application of the minimum credit rating threshold to marketable debt instruments issued or guaranteed by these governments, i.e. for Greece (May

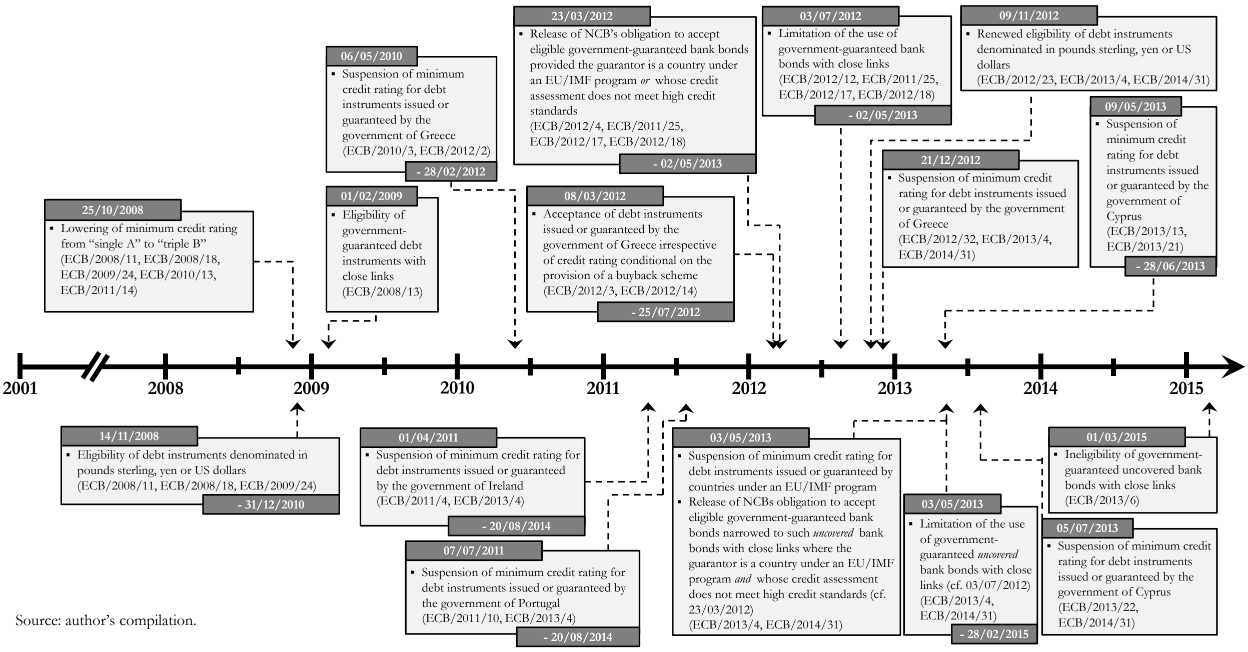
[111] Previously, NCBs were allowed to deviate from general eligibility criteria only in terms of size and handling fee, see Footnote 88.

[112] See Tamura and Tabakis (2013) for details on the collateral criteria NCBs applied to credit claims pledged as collateral.

[113] See Nagel (2012). Nonetheless, assistance between NCBs was allowed if agreed bilaterally and approved by the ECB Council, see *ECB/2012/18*.

[114] It was shown by Levy and Schich (2010), Levy and Zaghini (2010) as well as Davies and Ng (2011) that the cost of issuing a guaranteed debt instrument is mainly determined by the creditworthiness of its guarantor.

Figure 4.6: Changes to Collateral Criteria for Debt Instruments Issued or Guaranteed by Governments



2010),[115] Ireland (April 2011 to August 2014), Portugal (July 2011 to August 2014) and Cyprus (May 2013).[116]

In February 2009, the Eurosystem extended the acceptance of own-use assets (cf. Section 4.2.4.1) to all those guaranteed by governments. In principle, this makes it possible to securitize assets into bonds, which are retained and thus never assessed by the market or a rating agency and can still be used as collateral for refinancing credits due to the government guarantee. Moreover, the conditions in terms of valuation haircuts would be appealing if the rating of the guaranteeing government is higher than that of the issuer. Reactions from market participants and guaranteeing governments on this measure are presented in Section 9.5.

4.3.3 Changes to the Eligibility of Debt Instruments Traded on Non-Regulated Markets

The requirement for marketable assets to be admitted to trading on accepted regulated and non-regulated markets has already been incorporated in the initial General Framework.[117] The Eurosystem successively modified its acceptance criteria, thereby increasing the number of eligible non-regulated markets over time.[118] The development of the acceptance of non-regulated markets

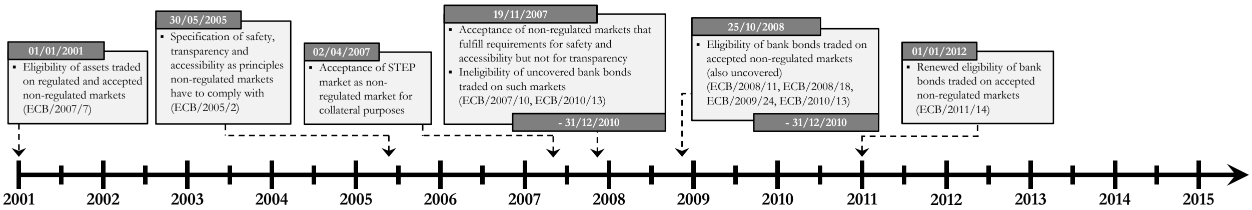
[115] The suspension for Greece was repealed in February 2012. However, the general acceptance of debt instruments issued or guaranteed by Greece was re-introduced in March 2012. The acceptance of such debt instruments was conditional on the ability of the Greek government to provide collateral enhancement in the form of a buy-back scheme to NCBs. In December 2012, the suspension was again made unconditional.

[116] The suspension for Cyprus was repealed in June 2013 but soon re-introduced in July 2013.

[117] For a market to be considered as "regulated", it had to comply with criteria as defined according to the Investment Services Directive (*93/22/EEC*) while accepted non-regulated markets have to comply with certain requirements defined by the Eurosystem itself; see below for a detailed description.

[118] In January 2007, the list of accepted non-regulated markets comprised 18 markets from 11 countries. MTS Slovenia was accepted in February 2009 and the Irish Global Exchange Market in January 2013.

Figure 4.7: Changes to Collateral Criteria for Assets Traded on Non-Regulated Markets



Source: author's compilation.

with particular reference to the market for STEPs (see below) as a controversial example of such a market is illustrated in Figure 4.7.

In line with its endeavor to create a comprehensive collateral framework, the Eurosystem refined the standards accepted non-regulated markets had to comply with in May 2005. The Eurosystem explicitly referred to three principles upon which it evaluated non-regulated markets: *(i)* safety, *(ii)* transparency and *(iii)* accessibility.[119] At the same time, the Eurosystem made clear that it would not aim at assessing the intrinsic quality of each market.

As a step towards expanding the eligibility of assets traded on non-regulated markets, the Eurosystem brought into force an amendment in November 2007 after first signs of distress in interbank markets.[120] It continued accepting marketable assets which had been issued prior to May 2007 on certain non-regulated markets not fully complying with the three principles. More specifically, these were non-regulated markets which fulfilled the requirements for safety and accessibility, but not for transparency.

Therefore, uncovered bank bonds issued on such markets – which had become generally ineligible as of June 2007 with the introduction of the Single List – were not included in this rule and remained ineligible. However, as distress in interbank markets increased in October 2008, uncovered bank bonds (and more general, all bank bonds issued on accepted non-regulated markets) became eligible subject to an add-on haircut. The eligibility was prolonged two times in December 2008 and January 2010 and subsequently adopted in the General Framework in January 2011 (albeit without an add-on haircut).[121]

Whenever the acceptance of non-regulated markets is sufficiently strict, the risk for the Eurosystem from the eligibility of assets traded on those markets should not differ significantly from the eligibility of assets traded on regulated markets. However, at least two arguments question that this holds: first, the Eurosystem itself declared that it would not pursue the objective of assessing the intrinsic quality of each non-regulated market; and, second, the application of the three principles which the Eurosystem laid down to accept non-regulated markets may be challenged. More specifically,

[119] According to Guideline *ECB/2005/2*, the principle of safety meant certainty regarding transactions, in particular concerning the validity and enforceability of transactions. Transparency was interpreted as unimpeded access to information on the market's rules of procedures and operation, the financial features of the assets, the price formation mechanism and the relevant prices and quantities. Finally, accessibility referred to a market's rules of procedures and operation that allowed the Eurosystem to obtain information and conduct transactions when needed for these purposes.

[120] The is amendment was prolonged in October 2009 and was valid until December 2010.

[121] For an extensive discussion of the evolution of eligibility criteria applied to bank bonds, see Section 4.3.4.

the application of the principle *transparency* which should guarantee the Eurosystem "unimpeded access to information on the market's rules of procedures and operations, the financial features of the assets, the price formation mechanism and the relevant prices and quantities" (*ECB/2005/2*) was not only repeatedly suspended (see above) but also not rigorously applied (see below).

4.3.3.1 The Short-Term European Paper Market

A very recent and controversial example of an accepted non-regulated market is the STEP market, which the Eurosystem included in its list of eligible non-regulated markets in April 2007.[122] For a STEP to be eligible, it had to comply with the eligibility criteria for the specific asset class.[123] Although STEPs in general were eligible as collateral, papers issued by banks had always been excluded from eligibility. The Eurosystem revoked this derogation in October 2008.

The STEP market may serve as an indication for why the acceptance of non-regulated markets for collateral purposes could pose substantial risk to the Eurosystem's collateral pool. It is managed by a sub-organization of the European Banking Federation and is supervised by Banque de France. Detailed data on STEPs traded is only provided by Euroclear France to the Banque de France, but not fully reported to the ECB. This lacking disclosure of information stands in contrast to the principle of transparency described above. The development of the Eligible Collateral Pool and the STEP market following the Eurosystem's acceptance decisions is discussed further in Chapter 9. It is not obvious from the data published by the ECB, as STEPs are captured in more than one collateral category (LC), depending on the type of issuer (see Footnote 123).

4.3.4 Changes to the Eligibility of Bank Bonds

STEPs issued by banks are simply one special type of bank bonds that the Eurosystem accepts as collateral. More generally, bank bonds are marketable assets and hence the general eligibility criteria for marketable assets as described in Section 4.3.1 apply. In addition, specific eligibility criteria were established for bank bonds, the development of which is discussed in the following and depicted in Figure 4.8. One can further differentiate bank bonds as covered or uncovered. Within covered bank bonds, an important difference is made regarding the compliance of the bond with the UCITS Directive. Furthermore, both covered and uncovered bank bonds can have close links up to the degree of own-use bonds.

4.3.4.1 Initial Eligibility Criteria

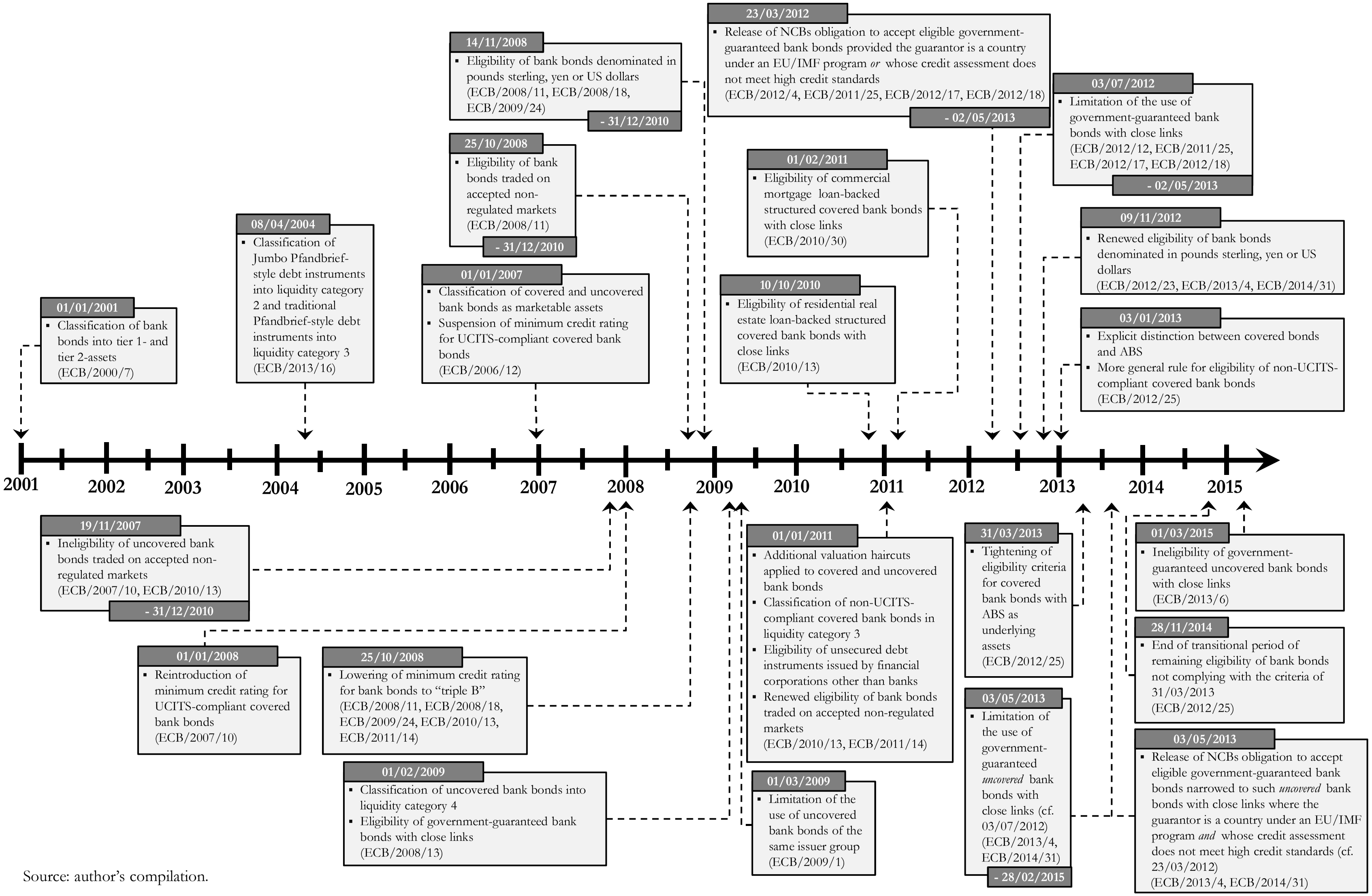
Initially, covered bank bonds had to comply with the UCITS Directive (see Section 4.2.2) to be eligible within tier 1. In this case, they were classified into either LC 2 or 3. While "jumbo Pfandbrief-style debt instruments" were included into LC 2,[124] "traditional Pfandbrief-style debt instruments" and all other eligible covered bank bonds were assorted in LC 3. For these assets,

[122] See ECB, "First Publication of Short-Term European Paper (STEP) Yield Statistics," *Press Release*, April 2, 2007, together with ECB, "Assessment of STEP for Collateral Purposes in Eurosystem Credit Operations", *Press Release*, September 15, 2006.

[123] According to the ECB Eligible Assets Team, STEPs fall into the asset categories "uncovered bank bonds", "corporate bonds" and "other marketable assets", depending on the type of issuer.

[124] "jumbo Pfandbrief-style debt instruments" were defined as debt instruments with an issuing volume of at least EUR 500 million and for which at least two market-makers provide regular bid and ask quotes.

Figure 4.8: Changes to the Collateral Criteria for Bank Bonds



Source: author's compilation.

haircuts differed between categories in addition to coupon structure and residual maturity. Non-UCITS-compliant covered bank bonds were only eligible provided that NCBs included them into their tier-2 list. These bank bonds were subsequently subject to an add-on haircut. Owing to a similar structure, covered bank bonds were initially considered equivalent to ABS but not vice versa.[125] Uncovered bank bonds could initially only be eligible as tier 2.

4.3.4.2 Development of Eligibility Criteria

The Eurosystem deviated from the equivalent treatment of covered bank bonds and ABS for the first time in May 2006 by clarifying that additional specific eligibility criteria were to be met for ABS other than covered bank bonds (see Section 4.3.5).[126] Moreover, with the introduction of the Single List in January 2007, UCITS-compliant covered bank bonds did not have to meet the minimum credit rating threshold between January 2007 and December 2007. Furthermore, uncovered bank bonds ("debt instruments other than covered bank bonds that are issued by credit institutions," cf. *ECB/2006/12*) were defined eligible by the Single List, at that time provided that they were admitted to trading on a regulated market.

Amendments to the liquidity classifications of marketable assets were undertaken in February 2009 and January 2011. In February 2009, "jumbo covered bank bonds" were marked as LC 2,[127] "traditional covered bank bonds" as LC 3 and all uncovered bank bonds ("credit institution debt instruments, unsecured") were classified from LC 3 into 4, with the respective haircuts applied. In January 2011, unsecured debt instruments issued by financial corporations other than banks were also included in this fourth LC (from previously 3) within marketable assets. Furthermore, all non-UCITS-compliant covered bank bonds (i.e. structured covered bonds and multi-issuer covered bonds) were explicitly included into LC 3 of marketable assets.

Although the Eurosystem was successful in increasing the availability of eligible collateral, it had to cope with the potential decline in the quality in the collateral pool stemming from the acceptance of bank bonds guaranteed by crisis-stricken countries without requiring minimum credit rating standards (see Section 4.3.2). Therefore, it exempted NCBs from their former obligation to accept any eligible bank bonds guaranteed by countries under an EU/IMF program *or* by countries whose credit assessments did not meet the Eurosystem's high credit standards as of March 2012.[128] This attempt to mitigate risk was alleviated in May 2013, when the exemption was narrowed to only *uncovered* bank bonds *with close links* guaranteed by countries whose credit assessments do not meet high credit standards *and* who are under an EU/IMF program.[129] Hence, NCBs reobtained the obligation to grant refinancing credits for all other bank bonds guaranteed by these countries.

[125] The major differences between covered bonds and ABS are that covered bonds usually remain on the issuer's balance sheet and are typically more regulated while ABS are generally tranched.

[126] However, the Eurosystem has explicitly been distinguishing between covered bonds and ABS only since January 2013 when it emphasized that "for the purpose of the Eurosystem legal framework related to monetary policy, covered bonds are not considered asset-backed securities" (*ECB/2012/25*).

[127] The requirements for a debt instrument to be classified as "jumbo covered bank bonds" (before: "jumbo Pfandbrief-style debt instruments") were modified as follows: The issuing volume was increased from EUR 500 million to at least EUR 1 billion and at least three market-makers (formerly two) had to provide regular bid and ask quotes; compare also Footnote 124.

[128] For instance, the Bundesbank declined uncovered bank bonds from Greece, Portugal and Ireland as of May 2012, cf. Nagel (2012).

[129] As of March 2015, uncovered bank bonds with close links became ineligible altogether such that this exemption from obligation lapses.

On the same lines of risk mitigation, the use of uncovered bank bonds as collateral has been limited in March 2009. Since then, uncovered bank bonds of the same issuer group (i.e. identical issuer or closely linked issuers) could only be pledged to the extent that the haircut-adjusted value of these bonds had not been exceeding 10% of the total value of the collateral submitted by the counterparty. Hence, an overly exposure to one bank and its affiliates is prohibited and thus potential mutual provision of collateral between two banks is limited.[130] However, government-guaranteed uncovered bank bonds have been excluded from this limitation.[131] Finally, the limitation was generalized to all unsecured debt instruments (i.e. issued by credit institutions and also by any other institution) in October 2010 and included as a means of risk control in the Eurosystem's General Framework (see also Section 4.5).

In March 2013 the Eurosystem restricted the use of covered bank bonds as collateral by introducing additional eligibility criteria for these bonds. Since then, the Eurosystem has in principle been prohibiting the underlying pool of covered bank bonds to contain ABS. However, at the same time, exemptions were made and several specific types of ABS remained usable.[132] Moreover, these new requirements do not apply to covered bank bonds which have been on the list of eligible ABS by November 2012. These bonds remained eligible until November 2014.

4.3.4.3 Eligibility of Bank Bonds with Close Links

The eligibility of marketable debt instruments with close links was already generally discussed in Section 4.2.4.1. These general eligibility criteria have also been applied to bank bonds with close links, in the most extreme case, own-use bank bonds, i.e. bonds which are issued and pledged by the same bank. However, beyond that, the Eurosystem applied specific criteria to such bank bonds, the development of which is captured in Table 4.1 and discussed in the following.[133]

In October 2010, the Eurosystem broadened the eligibility of covered bank bonds with close links. Whereas previously only UCITS-compliant covered bank bonds were deemed eligible if close links were involved, eligibility was subsequently extended to certain non-UCITS-compliant covered bank bonds. Specifically, residential real estate loan-backed structured covered bank bonds became eligible. The set of eligible non-UCITS-compliant covered bank bonds was extended to such backed by commercial mortgage loans in February 2011. Finally, a more general rule was established in January 2013. It referred to any "covered bank bonds for which all criteria set out in Part 1, Points 68 to 70 of Annex VI to Directive 2006/48/EC are complied with, except for the limits on guaranteed loans in the cover pool," cf. (*ECB/2012/25*).

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[130] Note that own-use of uncovered bank bonds is per se not eligible and thus mutual buying of bonds and subsequent pledging for refinancing credit might seem appealing. The limitation was tightened to 5% in January 2012 and generalized to all unsecured debt instruments (i.e. issued by any institution, not only banks) in October 2010.

[131] Also, the limitation has not been applied to uncovered bank bonds with a total value not exceeding EUR 50 million (again, after haircuts) and bonds already submitted as collateral before January 20, 2009 were excluded. The latter exception lasted until March 1, 2010.

[132] Specifically, the following ABS are still allowed in the underlying pool of covered bank bonds: *(i)* ABS that comply with the requirements laid down in Directives *2006/48/EC* and *2006/49/EC*; *(ii)* ABS that are originated by a member of the same consolidated group of which the issuer of the covered bonds is also a member; or *(iii)* ABS that are used as a technical tool to transfer mortgages or guaranteed real estate loans from the originating entity into the cover pool.

[133] As the Eurosystem did not distinguish explicitly between covered bank bonds and ABS in terms of collateral purposes before January 2013, changes to the application of close links to covered bank bonds are indicated also as changes to ABS (but not vice versa) until that date.

Government-guaranteed bank bonds with close links became eligible in February 2009, together with all government-guaranteed debt instruments with close links (see Section 4.3.2). Thus far, they were excluded from any limitation and thus substantially pledged with the Eurosystem.[134] Consequently, the Eurosystem limited the use of such bonds in July 2012 to the nominal value of the bonds submitted by July 3, 2012 (i.e. the day the guideline entered into force). However, again the Eurosystem softened this restrictive measure, making deviations from the limitation possible subject to Council approval.[135] Moreover, the Eurosystem narrowed the limitation to government-guaranteed *uncovered* bank bonds with close links in May 2013. Finally, as of March 2015, the Eurosystem has no longer accepted as collateral government-guaranteed uncovered bank bonds with close links as well as covered bonds with such bank bonds in the cover pool. Thus, from then onwards, uncovered bank bonds with close links have not been eligible at all, while covered bank bonds with close links remained eligible under the provisions described.

4.3.5 Changes to the Eligibility of Asset-Backed Securities

ABS are, as covered bank bonds, a possible way for banks to free up their balance sheets and receive fresh liquidity. However, banks have preferred covered bank bonds over ABS for two reasons: first, covered bank bonds can be used as collateral by the same issuer (own-use); and second, lower haircuts have been applied to covered bank bonds compared with ABS (see Section 4.5). It was discussed in Section 4.3.4 that the Eurosystem did not entirely differentiate between ABS and covered bank bonds before January 2013.[136] Therefore, it will be presumed that eligibility criteria specified for covered bank bonds (see Section 4.3.4) also apply to ABS but not vice versa. However, as of May 2006, the Eurosystem additionally set out ABS-specific eligibility criteria which are discussed in the following and captured in Figure 4.9.

The development of the specific eligibility of ABS is a story of both tightening and loosening. During a first period between May 2006 and January 2011, the Eurosystem limited the eligibility of ABS as collateral but substantially lowered its requirements thereafter to broaden the amount of ABS eligible for collateral purposes. Since January 2013, it has started to introduce a tight accompanying monitoring of underlying assets.

4.3.5.1 Tightening the Eligibility of Asset-Backed Securities (2006–2011)

In May 2006, the requirement that debt instruments had to have a fixed and unconditional principal amount to be eligible was specified not to be valid for ABS. Moreover, specific requirements were laid down for the assets underlying the ABS: they had to be legally acquired in accordance with the laws of an EU member state and a "true sale" that had to be enforceable against any third party and was beyond the reach of the originator and its creditors.[137] Furthermore, two types of ABS were excluded from eligibility: ABS comprising credit-linked notes and ABS issued by entities

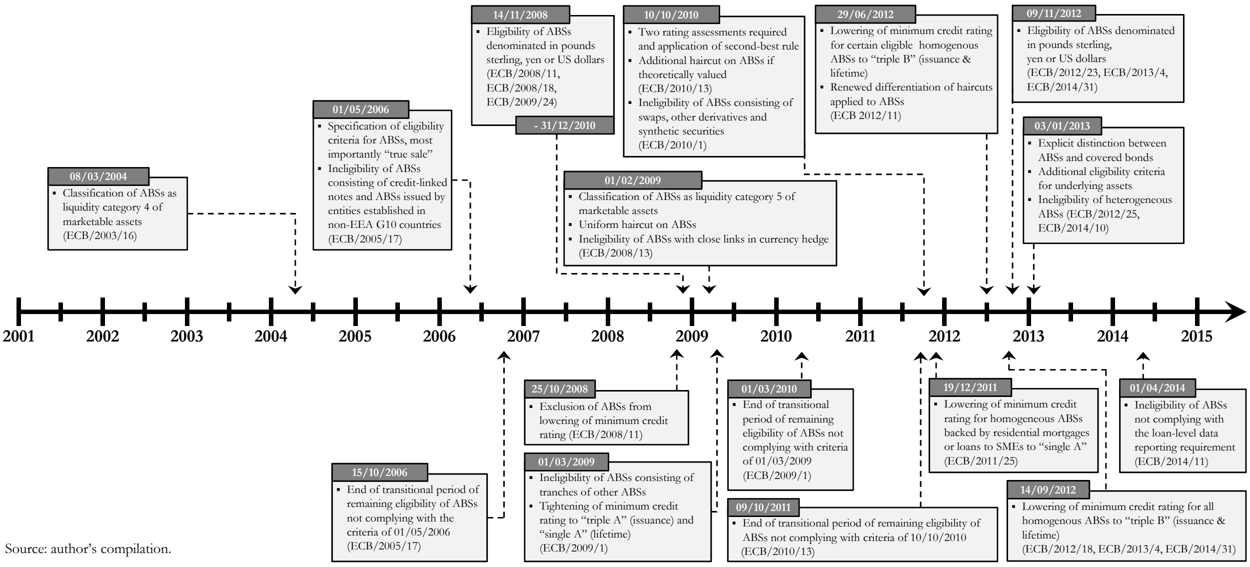
[134] See Section 9.5, Footnote 389, as well as Sinn (2014b).

[135] This change was initially only temporarily valid until September 2012 but later prolonged until March 2013.

[136] ABS were not explicitly included in the initial General Framework. They were mentioned for the first time in March 2004 and classified into LC 4, i.e. the lowest category possible at that time. This classification was irrespective of the issuer or the rating of the specific ABS.

[137] "True sale" means that the underlying assets are transferred by the seller to an SPV, such that the SPV becomes entitled to the cash flows that are generated by the underlying assets (including those resulting from a subsequent sale of the assets).

Figure 4.9: Changes to the Collateral Criteria for Asset-Backed Securities



Source: author's compilation.

established in non-EEA G10 countries, i.e. the US, Canada, Japan and Switzerland. ABS not complying with these additional criteria remained eligible until October 2006.

ABS were shifted to (the lowest) LC 5 when uncovered bank bonds were introduced as the sole fourth LC in February 2009. Moreover, a uniform haircut has subsequently been applied (and in January 2011 increased) to all ABS irrespective of the maturity or coupon structure, cf. Section 4.5.4.2.

When the Eurosystem lowered the minimum credit rating threshold for marketable and non-marketa-ble assets from Single A to Triple B in October 2008, it explicitly excluded ABS from this lowering. Soon after, the minimum credit rating requirement for ABS was even tightened in March 2009. The Eurosystem defined its high credit standards for ABS as Single A over *lifetime* of the ABS. Additionally, the highest possible credit rating of Triple A had to be obtained at *issuance*. At the same time, the Eurosystem once more restricted the requirements for the underlying assets. Multiple securitization was excluded by preventing the underlying assets to comprise tranches of other ABS. ABS which did not meet these additional requirements but were issued before March 1, 2009 remained eligible for another year.

In October 2010, the Eurosystem required at least two credit assessments from accepted ECAIs to fulfill the beforehand defined high credit standards for ABS. It has thereby been applying the "second-best rule" according to which not only the best available credit rating has to comply with the minimum credit quality threshold, but also the second-best one.[138][139] With respect to

[138] The application of this second-best rule is in contrast to the treatment of all other assets for which the less strict first-best rule is applied, see Section 4.2.4.3.

[139] Depending on the date of issuance, the Eurosystem implemented the following regimes: For ABS issued before March 1, 2010 with only one credit assessment, an additional assessment had to be obtained before 1 March 2011; for ABS issued before March 1, 2009, both credit assessments had to meet a rating of at least Single A over lifetime; for ABS issued between March 1, 2009 and February 28, 2010, the first-best credit assessment had to comply with Triple A at issuance and Single A over lifetime and the second-best assessment with Single A both at issuance and over lifetime.

underlying assets, the Eurosystem also demanded ABS not to comprise swaps, other derivatives or synthetic securities.[140]

4.3.5.2 Loosening the Eligibility of Asset-Backed Securities (2011–2013)

In December 2011, the Eurosystem changed course and quit its restrictive collateral policy with respect to ABS. It lowered the minimum credit rating threshold for specific ABS which consisted only of one sort of assets, i.e. homogeneous ABS.[141] For ABS backed by only loans to SMEs or only residential mortgages, the minimum rating threshold was lowered to a second-best rating of Single A at issuance.[142] These ABS were considered eligible provided that they fulfilled additional criteria.[143] The lowering of the rating threshold was thought to remain in place temporarily until September 2012.

However, this was not the case: the threshold was even further lowered in June 2012 to Triple B both at issuance and over lifetime, which corresponds to CQS 3. Moreover, this lowering was not made exclusively for ABS only backed by loans to SMEs or residential mortgages as before, but it also applied to homogeneous ABS with commercial mortgages, auto loans as well as leasing and consumer finance as underlying assets and heterogeneous ABS comprising loans to SMEs and residential mortgages.[144] In July 2014, credit card receivables have been added to the list of accepted underlying assets. The measures of loosening eligibility meant to foster the use of ABS as collateral were in the beginning only temporarily valid and have been prolonged in September 2012 and May 2013. At the end of 2014, they had been in place without an expiration date.

4.3.5.3 Tightening the Monitoring of Eligible Asset-Backed Securities (from January 2013)

Since January 2013, ABS have taken an exceptional position within the class of marketable assets. An explicit differentiation has been made between "common eligibility requirement" and "additional eligibility criteria applicable to ABS."

Importantly, the "loan-level reporting initiative" has been gradually introduced, which aims at making ABS in general and particularly the underlying assets more transparent. Therefore, the Eurosystem demands comprehensive and standardized loan-level data on the pool of underlying assets.[145] Owing to this, ABS must be backed by homogeneous assets, as otherwise, the underlying

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140 This requirement did not prevail for swaps used in ABS transactions strictly for the purpose of hedging. ABS which did not comply with this requirement but had been eligible before October 2010 kept eligibility for another year.

141 The Eurosystem thereby made a move towards accepting only ABS considered as "plain vanilla", i.e. ABS made from a single pool of underlying assets.

142 The minimum rating requirement over lifetime remained at Single A.

143 First, the counterparty pledging the ABS or any third party with close links was not allowed to provide an interest-rate hedge to the ABS; and second, the underlying assets were prohibited to contain loans which were non-performing at issuance nor structured, syndicated or leveraged at any time.

144 Initially, this lowering was temporarily valid until September 2012. However, it was prolonged in September 2012 until March 2013. In March 2013, it was included in the General Framework and at the end of 2014 in force without expiration date.

145 The loan-level reporting requirements were introduced for residential mortgage-backed securities (RMBS) as well as ABS backed by loans to SMEs on January 1, 2013. Since March 1, 2013, the requirements have also been demanded for commercial mortgage-backed securities (CMBS). For consumer finance ABS, leasing ABS and auto ABS, the requirements became obligatory as of January 1, 2014 and as of April 1, 2014 for credit card ABS.

assets could not be reported in accordance with the loan-level reporting requirement.[146] This implies that heterogeneous ABS have been ineligible since January 2013 and ABS not compliant to the loan-level reporting requirements have been ineligible since April 2014.

4.3.5.4 Eligibility of Asset-Backed Securities with Close Links

For ABS with close links, not only the general eligibility criteria discussed in Section 4.2.4.1 but also asset-specific criteria were put into force, see Table 4.1. As there had not been an explicit differentiation between covered bank bonds and ABS until January 2013, it is presumed that the development of the eligibility of covered bank bonds with close links, as described in Section 4.3.4.3, is also relevant when discussing the eligibility of ABS with close links.

4.3.6 Changes to the Eligibility of Corporate Bonds

Corporate bonds have been labeled as "debt instruments issued by corporate and other issuers" (*ECB/2003/16*),[147] and have always been eligible for collateral purposes provided that they complied with the general eligibility criteria for marketable assets. Thus, corporate bonds were also subject to all general changes of the eligibility criteria applied to marketable assets extensively discussed in Section 4.3.1, while no specific provisions have been made.

4.4 Summary of Changes to Eligibility Criteria

Thus far, the aim has been to analyze the Eurosystem's collateral policy with respect to eligibility criteria and present collateral rules and their evolution in a narrative database, structured by asset classes. Table 4.3 sums up the most important changes to eligibility criteria made by the Eurosystem between 2001 and 2013. In addition, the actions are classified as tightening or loosening of eligibility criteria.

The table conveys the impression that *(i)* the Eurosystem intensified collateral policy activity in response to the crisis and that *(ii)* this activity was predominantly directed at loosening eligibility criteria accompanied by a broadening of the eligible collateral pool. This impression arises from a qualitative consideration. However, it can be reinforced once a quantitative dimension complements the analysis, as provided in Figure 4.10.

The left panel of Figure 4.10 shows how the changes discussed throughout this chapter thus far scatter over time. Before the outbreak of the financial crisis, changes were mainly directed at harmonizing and standardizing the collateral framework across the euro area. The Eurosystem substantially increased activity in collateral policy-making since 2007. Another increase in the number of changes can be identified in 2011, which was triggered by the intensification of the European debt crisis. Moreover, as a first response to the crisis, the Eurosystem rather undertook general changes but refined its policy-making over the years towards the alteration of asset-specific

[146] In order to be reported in accordance with the loan-level requirement, the underlying assets have to be reported using a single template for the specific asset class. This cannot be fulfilled for heterogeneous ABS, i.e. ABS comprising more than one type of assets.

[147] The name was changed in January 2011 to "debt instruments issued by non-financial corporations and other issuers" (*ECB/2010/13*).

Table 4.3: Summary and Classification of Major Changes to Collateral Criteria

The table consolidates the narrative database of the Eurosystem collateral framework by pointing out and classifying the most significant changes. The table conveys the overall impression that *(i)* the Eurosystem intensified amending policies to the collateral framework throughout recent years of crisis and that *(ii)* activity was predominantly directed at loosening collateral criteria.

Date	Amendment	Classification	
		Tightening	Loosening
30/05/2005	Ineligibility of equities	•	
01/01/2007	Abolition of idiosyncratic collateral criteria (introduction of Single List)	•	
15/09/2008	Collapse of Lehman Brothers		
25/10/2008	Lowering of minimum credit rating for all assets except for ABS from Single A to Triple B; Eligibility of bank bonds traded on STEP market		• •
14/11/2008	Eligibility of marketable debt instruments issued in GBP, JPY or USD		•
01/02/2009	Eligibility of own-use government-guaranteed debt instruments; DBRS accepted as fourth ECAI		• •
01/03/2009	Increase of minimum credit rating for ABS from Single A to Triple A at issuance	•	
05/2010	Intensification of European sovereign debt crisis		
06/05/2010, 01/04/2011, 07/07/2011, 03/05/2013, 09/05/2013	Suspension of minimum credit rating for debt instruments issued or guaranteed by the governments of Greece, Ireland, Portugal; later by governments under an EU/IMF program and Cyprus		•
19/12/2011	Idiosyncratic acceptance of credit claims by NCBs; Lowering of minimum credit rating for specific ABS from Triple A to Single A at issuance		• •
29/07/2012	Lowering of minimum credit rating for all ABS from Single A to Triple B at issuance and over lifetime		•
03/01/2013	Ineligibility of heterogeneous ABS	•	
01/04/2014	Ineligibility of ABS not complying with the loan-level reporting requirement	•	

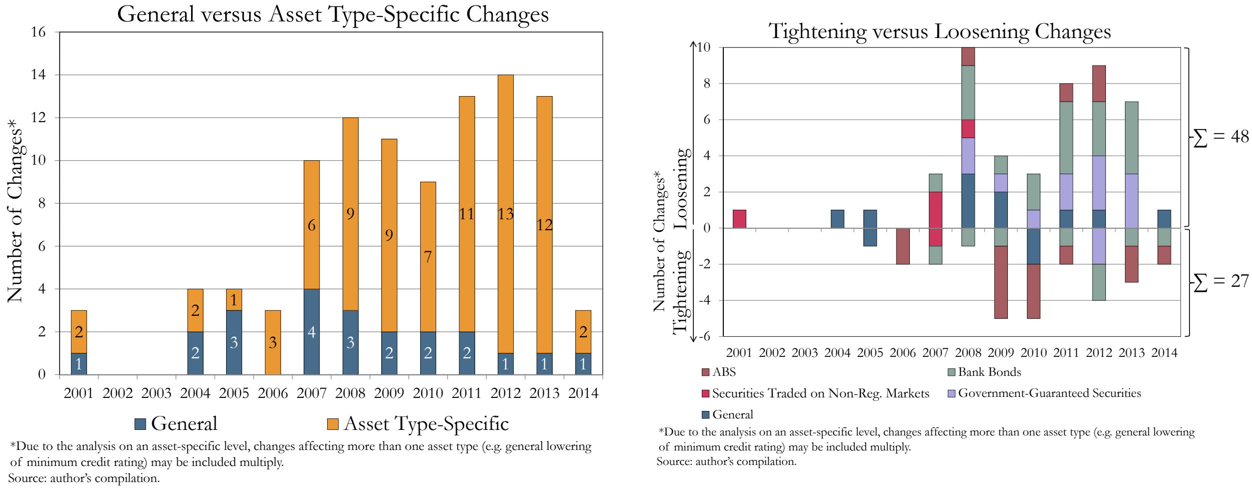
Source: author's compilation.

criteria. Before the crisis, only six official documents affecting collateral rules were released. However, after the outbreak of the crisis in 2008, this number increased by more than seven times to 44. Furthermore, the number of changes increased from 25 before to 74 after the Lehman event.

In the right panel of Figure 4.10, these changes are classified as either tightening or loosening measures. Changes that could not be classified in this sense are neglected. The bars sum up changes in either direction differentiated by asset class. Both in response to the financial crisis (especially in 2008) and in response to the European sovereign debt crisis (since 2010), the loosening measures prevail. Overall, 48 loosening and 27 tightening amendments can be counted since the introduction of the collateral framework in 2001. 42 of the loosening and 21 of the tightening changes were made after the collapse of Lehman.

Figure 4.10: Temporal Distribution of Classified Changes to Eligibility Criteria

The figure reveals the chronological distribution of changes to collateral criteria from 2001 to 2014 according to the author's compilation. The left panel differentiates between changes applying to all assets ("general") and changes to specific asset types ("asset type-specific"). The Eurosystem ramped up activity as of 2007 and refined activity over the years towards amending asset type-specific criteria. The right panel shows the author's classification of the changes as either tightening or loosening. The panel indicates that loosening changes prevail during both the financial crisis and the European sovereign debt crisis.



4.5 Haircuts in the Eurosystem's Collateral Framework

This section complements the narrative database of collateral policy measures of the Eurosystem with an in-depth analysis of the Eurosystem's haircut specification. The set of risk control measures of the Eurosystem is described and haircuts pronounced as the key instrument within (Section 4.5.1). Haircuts hold particular importance for collateral policy as they determine *(i)* the size of the pledgable collateral value, i.e. the maximum loan amount under full allotment and *(ii)* the value level of the refinancing conditions compared to the market. Before the specification of haircuts by the Eurosystem is described comprehensively (Section 4.5.4), including the general principles applied, as well as the qualitative and quantitative development over time, a normative perspective on haircut specification works out seven propositions (Section 4.5.3). These are later used to evaluate the Eurosystem's haircut-setting (Section 4.5.6). A key insight of the analysis is the Eurosystem's practice of segmentally pooling haircuts (clustering approach) along three of four dimensions of the haircut specification (Section 4.5.7). Quality effects and distribution effects emerging from this segmental pooling are later described in Chapters 7 and 8.

4.5.1 The Set of Risk Control Measures

The Eurosystem applies a set of measures to mitigate collateral risk, which are summarized in Table 4.4 (see also European Central Bank, 2015, and the General Documentation of the ECB).[148] Prior to the introduction of the Single List in January 2007, the Eurosystem established uniform risk control measures for tier-1 assets and NCBs were responsible for taking control for assets that they accepted in tier 2. The initial set of risk control measures comprised "valuation haircuts", "initial

[148] Cf. Bindseil (2009a), Bindseil et al. (2009a), Bindseil and Papadia (2009), Chailloux et al. (2008b), Gonzáles and Molitor (2009), and Tabakis and Weller (2009) for general discussions and contributions to central bank risk mitigation.

margins", "variation margins", "limits in relation to issuers/debtors or guarantors", "additional guarantees" and "exclusion". The Eurosystem restricted the set of disposable risk control measures to "valuation haircuts" and "variation margins" in March 2004. It announced to perform a biennial review of its risk control measures in 2008 in response to amendments to the collateral framework and developments in financial markets. Since then, valuation haircuts have been repeatedly updated (see Section 4.5.4) and partly adapted to collateral pool and market developments. Moreover, the Eurosystem revoked its restriction of the set of risk control measures in February 2009 such that all risk control measures could be applied "at any time if required to ensure adequate risk protection" (*ECB/2008/13*). The Eurosystem successively introduced two additional means to address collateral risk in February and March 2009, namely the "application of supplementary haircuts" and "limits in relation to the use of uncovered bank bonds".[149] The latter measure has quantitatively limited the use of uncovered bank bonds with close links that were deemed eligible if they were guaranteed by a government (see Section 4.3.4). Hence, uncovered bank bonds of the same issuer group (i.e. identical issuer or closely linked issuers) could only be pledged to the extent that the haircut-adjusted value of these bonds would not exceed 10% (later 5%) of the total value of collateral submitted by a counterparty as of March 2009. This limitation was generalized to unsecured debt instruments with close links in October 2010 and explicitly added to the set of risk control measures. The implementation of the ACC framework in December 2011 enabled NCBs to establish idiosyncratic risk control measures that could deviate from those applied within the collateral framework. The application of idiosyncratic risk control measures was made subject to approval of the Governing Council. This approval was considered unnecessary in exceptional circumstances as of May 2013 under the provision that the risk control measures would have been established by another NCB and approved by the Council.

Valuation haircuts and variation margins are the only risk control measures applied during the entire period under investigation here, from January 2001 to December 2014. Valuation haircuts imply that the market or a theoretical value assigned to an eligible asset is deducted by a fraction ("haircut") to determine the collateral value. Valuation haircuts reflect expectations about the liquidation value of collateral in case of counterparty default. Variation margins subsequently ensure that this expected liquidation value is maintained over time. Amendments to the collateral framework making eligible more types of assets of different credit quality called for repeated adjustments to valuation haircuts, thus rendering them key to the collateral policy of the Eurosystem due to their importance as a layer of the value-level dimension, defining operational conditions, as described in Section 2.1, see also European Central Bank (2015).

4.5.2 Haircuts as the Key Risk Control Measure

The analysis of valuation haircuts as the key risk control measure of the Eurosystem is important for two reasons. First, haircuts are applied as a discount to the value of an eligible asset such that they determine the amount of liquidity that the Eurosystem supplies for eligible assets (the collateral value) as one parameter of operational conditions within collateral policy (cf. Table 2.1). Second, haircuts are a crucial element determining refinancing conditions, as is elaborated in Chapter 6. Therefore, their definition influences the refinancing decision of a bank and its decision to make investment-financing loans.

[149] "Supplementary haircuts" were explicitly introduced as a risk control measure in October 2010, see Table 4.4.

Table 4.4: Eurosystem Risk Control Measures

The table provides an overview of the risk control measures applied by the Eurosystem. Valuation haircuts and variation margins are the most important measures and they were applied over the entire period.

Measure	Description	Period
Valuation Haircuts	The collateral value is calculated as some value of the asset less a certain percentage (haircut).	01/2001 – present[a]
Supplementary Haircuts	Haircuts that are applied beyond valuation haircuts if considered necessary.	10/2008 – present[a,b]
Initial Margins	Counterparties have to pledge collateral at least equal to liquidity plus the value of the initial margin.	01/2001 – 03/2004; 02/2009 – present[a]
Variation Margins	The haircut-adjusted value of collateral has to be maintained over time and if it falls below a threshold, the Eurosystem calls for additional collateral.	01/2001 – present[a]
Limits in Relation to Use of Unsec. Debt Instruments	Limitation of the pledge of unsecured debt instruments with close links as described in Section 4.3.4.	03/2009 – present[a,c]
Limits in Relation to Issuers/Debtors/Guarantors	Limitation of the exposure vis-à-vis issuers /debtors/guarantors in general or vis-à-vis specific counterparties.	01/2001 – 03/2004; 02/2009 – present[a]
Additional Guarantees	Additional guarantees can be required from counterparties to accept certain assets as collateral.	01/2001 – 03/2004; 02/2009 – present[a]
Exclusion	Certain assets and/or counterparties can be excluded.	01/2001 – 03/2004; 02/2009 – present[a]

[a] In this context: The end of 2014.
[b] The Eurosystem applied supplementary haircuts to e.g. assets within CQS 3 since October 2008. Supplementary haircuts for risk control were mentioned in February 2009 in the collateral framework. They were explicitly included as a risk control measure in October 2010.
[c] The measure was first specified for uncovered bank bonds in March 2009 and generalized to unsecured debt instruments in October 2010.
Source: author's compilation; ECB.

There is relatively little work on haircut-setting within collateral frameworks of central banks. Jokivuolle and Peura (2000) provide an investigation of central bank haircuts on bank loans and Ashcraft et al. (2011) analyze the role of haircuts in collateralized central banks loans. European Central Bank (2014a) has recently extended European Central Bank (2013a) and presents insights into the role of haircuts within the Eurosystem collateral framework, comparing haircut ranges of the Eurosystem with the segment of the repo market cleared by central clearing counterparties (CCPs). Moreover, European Central Bank (2015) emphasizes the role of haircuts in Eurosystem risk control and provides a sketchy overview of their development.

The value of a collateral asset is adjusted for risk control purposes by either *(i)* a haircut or *(ii)* an initial margin. For a haircut, a discount on some value of the collateral (e.g. the market value) is taken such that the asset's collateral value CV is given by[150]

$$CV \equiv (1-h)MV, \tag{4.1}$$

[150] For the general characterization of haircuts see also e.g. Choudhry (2006), Comotto (2013), Euroclear (2009), and International Capital Market Association (2012b).

with h being the haircut and MV the market value of the asset. The haircut can be expressed as

$$h = \frac{MV - CV}{MV}. \tag{4.2}$$

For an initial margin, the loan is over-collateralized, as the initial margin $m > 1$ such that CV reads as

$$CV \equiv \frac{MV}{m} \tag{4.3}$$

and the initial margin can be calculated as

$$m = \frac{MV}{CV}. \tag{4.4}$$

The difference between a haircut and initial margin is only conceptual as both instruments have equivalent effects. Using (4.1) and (4.3), the relation between a haircut and initial margin can be expressed as[151]

$$h = \frac{m-1}{m}. \tag{4.5}$$

Owing to their importance in the risk control of the Eurosystem, the focus lies on haircuts in the following.

4.5.3 A Normative Perspective on Haircut Specification

Lenders bear different risks in collateralized liquidity provision despite collateralization. They aim to minimize these risks and gain compensation for any remaining. This can be achieved by the application of two instruments, i.e. *(i)* the interest rate and *(ii)* the haircut.[152] The following discussion elaborates on the major risks in collateralized liquidity provision and emphasizes the relevant instrument to address these risks. Moreover, general principles of haircut specification are carved out.[153]

Risk from collateralized liquidity provision only materializes in case of borrower default. In this case, the lender has to liquidate the collateral to meet outstanding claims (from principal and interest). As this *counterparty risk* is solely associated with the financial soundness of the borrower, it should generally be correlated with interest rates but not with haircuts (cf. Dang et al., 2013; International Capital Market Association, 2012b). Fitch Ratings (2012) finds an indication for the absence of correlation based on empirical observations, while survey results by Bank for International Settlements (2010) suggest a correlation between counterparty risk and haircuts. Furthermore, Dang et al. (2013) find an indication for effects of counterparty risk on haircuts as they observe that borrowers pledging collateral of the same type and credit rating face different haircuts. However, Dang et al. (2013) attribute this finding to a reason other than counterparty

151 For instance, a haircut of 5% would be approximated by an initial margin of 5.26%.

152 Lenders could also restrict the set of potential borrowers, which would correspond to a prohibitively high interest rate. Likewise, lenders could define assets that are deemed ineligible as collateral, which would be equivalent to a haircut of 100%.

153 See also Gonzáles and Molitor (2009) for a discussion of central bank haircut specification and Nyborg (2015) for general features of Eurosystem haircuts.

risk, namely the risk that lenders face a better informed trader in case of collateral liquidation such that they are not compensated for their outstanding claims.[154] Hence, this risk should be addressed by the haircut.

This reflects the sequence of addressing risk in collateralized liquidity provision, i.e. counterparty and collateral risk. Counterparty risk is addressed by charging an interest rate together with demanding collateral.[155] Collateral risk only materializes in case of counterparty default. If collateral risk was adequately addressed by the haircut, no counterparty risk would have to be mitigated via the haircut. Mitigating counterparty risk through the haircut would subsequently imply an inefficient haircut increase, given that it would curtail liquidity provision (given collateral scarcity). Conclusively, the haircut should be as small as possible to prevent collateral scarcity, but as much as necessary to hedge collateral (but not counterparty) risk.

Normative propositions for the haircut specification shall be deduced along the simple participation constraint of a risk-neutral lender given by (4.6). Let $(1-p) \in [0,1]$ represent the default probability of the counterparty and $(1-z) \in [0,1]$ the default probability of collateral. The interest rate premium in collateralized lending above the market rate of interest (repo rate r) is denoted by $r_P \in [0,1]$. The market rate of interest is assumed to be at the ZLB, i.e. $r = 1$, for simplicity. $h \in [0,1]$ is the haircut on collateral that is applied to its market value MV. Collateral that the borrower has at disposal is assumed to be restricted to the eligible assets on his balance sheet A_e, such that $MV(A_e) \equiv \overline{MV}$. The lender can decide upon the utilization of available liquidity to the amount of $(1-h)\overline{MV}$ in either collateralized lending or alternative investment in the market at zero interest $(r = 1)$. The lender's participation constraint reads as

$$\underbrace{p(1+r_P)(1-h)\overline{MV} + (1-p)z\overline{MV}}_{\text{expected payoff from collateralized loan}} \quad \overset{!}{=} \quad \underbrace{(1-h)\overline{MV}.}_{\text{payoff from alternative investment}} \tag{4.6}$$

The left-hand side of (4.6) gives the expected pay-off to the lender from entering the collateralized loan.[156] The lender receives principal and interest with probability p. With probability $(1-p)$, the counterparty defaults and the lender receives collateral to the amount of $\overline{MV}$, which can be liquidated with probability z.[157] The expected payoff from collateralized lending has to put the lender in the same financial position as alternative investment. Therefore, the expected payoff from the collateralized loan has to equal the liquidity of the lender as the market offers zero interest by assumption. Solving (4.6) for r_P gives the following relationship between the interest rate r_P and

154 This reasoning is based on an utility-based measure, called information acquisition sensitivity, cf. Dang et al. (2013, 2015).

155 The demand of collateral aims at indemnifying the lender from the moral hazard of a counterparty, which is only limited liable for the repayment of the loan. The BLOOS rule – developed by Sinn (1980, 1983) – illustrates the phenomenon of an uncollateralized loan, where you cannot get "blood out of a stone." On the other hand, a collateralized loan allows you to get "blood" out of the collateral.

156 Note that (4.6) is analogous to (6.5) and could be transformed to be identical with $BL = (1-h)\overline{MV}$ and $r^{CB} = 1$ (ZLB) as well as $r^{MM} = 1 + r_P$.

157 An objection against the assumptions made by the setup of (4.6) might be that in reality, the lender is only allowed to use proceeds from the liquidation of the collateral to satisfy *(i)* principal, *(ii)* interest and *(iii)* administrative costs. However, this can easily be implemented by a second-order condition $z\overline{MV} \leq (1+r_P)(1-h)\overline{MV}$, which facilitates to $1 - \frac{z}{1+r_P} \geq h$. The second-order condition is fulfilled by all results discussed below with the corner solution of equality. Moreover, including *(iii)* administrative costs explicitly on the right hand side (RHS) of the second-order condition would increase the solution space.

the haircut h:

$$r_P = \left(1 - \frac{z}{1-h}\right)\left(\frac{1-p}{p}\right). \tag{4.7}$$

If counterparty risk is absent, i.e. $p = 1$, r_P is also equal to zero irrespective of collateral risk. However, in reality, lending is associated with counterparty risk, i.e. $p \in (0, 1)$. If both the interest rate and the haircut are available for risk mitigation, possible combinations of r_P and h that fulfill the lender's participation constraint are given by the negative and concave relationship between r_P and h implied by Equation (4.7).[158]

Furthermore, consider the case in which either only the interest rate or only the haircut is available for the mitigation of (counterparty and collateral) risk. If the haircut h is restricted to zero ($h = 0$), the interest rate depends on both counterparty and collateral risk such that $r_P = (1-z)\left(\frac{1-p}{p}\right)$. Counterparty risk affects the interest rate to the extent that collateral risk is present. If the collateral was free of risk, i.e. $z = 1$, then the interest rate would also be equal to zero. By contrast, if the interest rate is restricted to zero ($r_P = 0$), the haircut solely depends on the default probability of the collateral with $h = 1 - z$, i.e. the haircut should solely and fully reflect collateral risk. This offers a good approximation of the case of the Eurosystem. The Eurosystem sets a single interest rate as a matter of monetary policy and eliminate pitfalls from having to differentiate pricing of operations based on counterparty creditworthiness. Therefore, the market interest rate is defined by the Eurosystem and liquidity is provided to a wide range of counterparties with different default probabilities at this interest rate. Nevertheless, as discussed above, the haircut set by the Eurosystem should in this case fully (but only) reflect collateral risk.

Collateral risk is in principle determined by seven types of risk that could materialize between counterparty default and collateral liquidation,[159] i.e. *(i)* legal risk, *(ii)* operational risk, *(iii)* collateral quality (in terms of credit and liquidity risk), *(iv)* market risk (in terms of traded market and valuation risk), *(v)* interest-rate risk, *(vi)* wrong-way risk and *(vii)* exchange-rate risk. In the following, the effects of the seven properties on the haircut size are stylized and general principles of haircut specification are carved out.

First, the transfer of collateral ownership in case of counterparty default should be legally binding in terms of an easily enforceable written contract. In the absence of such a contract, the lender risks legal challenges and facing competition for collateral with other creditors, which would delay the settlement of outstanding claims. This *legal risk* should be addressed by the use of predefined contracts (Master Agreements), such as the Global Master Repurchase Agreement and the European Master Agreement. Only the lack of such a predefined contract should result in a larger haircut as the expectation of receiving the collateral quickly after counterparty default would be impaired.

Proposition 4.1 (Legal risk and haircut size). *Legal risk arising from non-standard lending contracts that might be incomplete and difficult to enforce should ceteris paribus increase the haircut size.*

158 As $\partial i/\partial h < 0$ and $\partial^2 i/\partial h^2 < 0$, concavity suggests that as both a larger interest rate and a larger haircut are costly to the borrower, the optimal solution would be to mitigate risk via either the interest rate or the haircut. A larger interest rate is costly because it lowers the margin for the borrower to the extent that the loan does not pay off. A larger haircut decreases principal as available collateral $MV(A_e)$ is restricted to $\overline{MV}$, which defines the maximum loan amount.

159 See e.g. European Central Bank (2015) and International Capital Market Association (2012b) for overviews of risk types.

This legal risk may be accompanied by *operational risk*, which could arise from vague and complex processes both prior to and after counterparty default. Prior to default, a lack of margin regulation would lead to valuation risk (for initial and variation margins, see Section 4.5.1). Even if margining is effective, there is a delay between the margin call and the actual adjustment. This operational risk should be reflected in the size of the haircut as it is conditional upon the volatility of the collateral value. The detection and formal declaration of counterparty default and legal processes after default may lead to further delays and potential complications, meaning that it should also be reflected in the haircut to the extent that they are collateral-specific.

Proposition 4.2 (**Operational risk and haircut size**). *Operational risk arising from inefficient margining should ceteris paribus augment the haircut size.*

Once the counterparty has defaulted and the collateral is with the lender, it has to be liquidated to redeem outstanding claims. The outcome of this liquidation is affected by the intrinsic *collateral quality*, which is related to the creditworthiness of its issuer and the underlying investment, i.e. the credit risk. Hence, the more likely a default of the collateral issuer or a sudden depreciation of its market value, the larger the haircut should be.

Likewise, lower liquidity of collateral should imply a larger haircut, because the "ease and speed with which a financial asset can be converted into cash" is also related to collateral quality.[160] A crucial distinction in this respect has to be made between marketable and non-marketable assets. For the latter, a buyer has to be found bilaterally.

Proposition 4.3 (**Collateral quality and haircut size**). *Collateral quality is determined by collateral credit and the liquidity risk of collateral.*

i) Higher credit risk as reflected by lower credit ratings should ceteris paribus increase the haircut size.
ii) Higher liquidity risk should ceteris paribus result in a higher haircut size.

In addition to the relationship between the quality specific to the distinct asset used as collateral and its liquidity (see above), the liquidity of marketable assets is determined by risk inherent in the market on which it is traded. This *market risk* manifests in adverse movements of the market of the collateral between collateral valuation and liquidation. In the event of a crisis and a shock to market confidence, liquidity deteriorates and sudden adverse price movements are likely. This downside volatility implies a greater risk that the lender is unable to settle its outstanding claims.[161] Market risk is lower for official and active markets than for non-regulated markets since the liquidation of collateral is easy and price movements are more transparent and predictable. Nonetheless, the more complex and scarce an asset, the less it will be traded and the more difficult liquidation is, as well as the predictability of price movements. Furthermore, there might be endogenous price movements depending on the quantity of collateral to be liquidated relative to the market size.

[160] For the definition, see ECB, "Liquidity", *Glossary*, `https://www.ecb.europa.eu/home/glossary/html/glossl.en.html`, last accessed March 9, 2016.

[161] Some of the volatility is absorbed by variation margins. However, at least the difference between the market value at time of counterparty default and the realized liquidation value has to be taken care of by the haircut as no margin calls can be made.

Moreover, the valuation of marketable assets traded in less liquid markets as well as the theoretical valuation of non-marketable assets gives rise to *valuation risk* as theoretical valuation is prone to errors.[162] It is subsequently less clear whether the intrinsic collateral quality is correctly ascertained by an unsteady or missing market assessment.

Proposition 4.4 (**Market/valuation risk and haircut size**). *Market risk manifests in the likelihood of adverse movements of the market value between collateral valuation and liquidation. Depending on the market on which assets are traded, valuation methodologies may vary and give rise to valuation risk.*

i) Higher market risk should ceteris paribus increase the haircut size.
ii) Valuation risk should ceteris paribus result in a larger haircut size.

Furthermore, collateralizing assets typically carry interest in the form of a coupon payment, which affects market valuation and implies *interest-rate risk*, such that it should thus be reflected in the haircut. Coupons can be variable or fixed-rate and are usually paid once or twice a year.[163] Consequently, market valuation increases between two coupon payments and drops on the day of coupon payment, because sellers in the market seek compensation for accrued interest between two coupon payments. The market price is called the "dirty price" and it only equals the "clean price" on days of coupon payments but is otherwise higher. Variation margins account for this erratic valuation as the collateral value is based on the dirty price. By contrast, zero-coupon bonds are traded at a discount as the interest payment is implied in the difference between the market price and nominal value. Therefore, the market price much more strongly deviates from the nominal value for zero-coupon bonds because duration in the Macaulay (1938) sense is always equal to residual maturity, i.e. maximally high.

Residual maturity is the other characteristic of collateral that drives up the duration and hence the interest-rate risk of the collateral. A longer residual maturity implies a higher degree of uncertainty about the development of the asset price. Hence, a longer residual maturity should result in larger haircuts. Moreover, zero-coupon bonds with a maturity exceeding one year bear more interest-rate risk and should receive a larger haircut.

Proposition 4.5 (**Interest-rate risk and haircut size**).

i) Interest-rate risk implied in the higher duration of zero-coupon assets (of residual maturities above one year) should ceteris paribus increase the haircut size.
ii) Interest-rate risk implied in the higher duration due to longer residual maturity should ceteris paribus increase the haircut size.

Assets that are pledged as collateral may be issued by an entity with close links to the borrower (see Section 4.2.4.1). In case of close links between the borrower and the collateral issuer, counterparty risk and collateral risk are correlated. Such a correlation implies *wrong-way risk* and it is the highest for own-use collateral as collateral also defaults in case of counterparty default. The value

[162] Additionally, margining cannot mitigate risk when assets lack a market value.
[163] However, the variability of the coupon rate is irrelevant for the haircut as they continue to be paid to the borrower.

of pledged assets in collateralized lending transactions is diminished with close links as counterparty risk implicitly finds its way into the transaction again such that a larger haircut should be applied.

Proposition 4.6 (Wrong-way risk and haircut size). *Wrong-way risk arising from close links between the borrower and the collateral issuer should ceteris paribus augment the haircut size.*

Finally, potential exchange-rate risk has to be taken into account if the lender deems eligible collateral in foreign currency. Exchange rates can move between the dates of collateral valuation and collateral liquidation such that haircuts should be larger the higher the *exchange-rate risk*.

Proposition 4.7 (Exchange-rate risk and haircut size). *Exchange-rate risk arising from the pledge of assets denominated in foreign currency should ceteris paribus increase the haircut size.*

4.5.4 The Eurosystem's Haircut Specification

This section compiles a narrative database on haircuts applied by the Eurosystem in determining the collateral value of assets. General principles of Eurosystem's haircut specification are carved out and a descriptive analysis of the development of haircuts is provided.

4.5.4.1 General Principles of the Haircut Specification

The Eurosystem lays down the haircuts that it applies to eligible assets within its collateral framework. Table 4.5 provides an overview of the dimensions according to which haircuts were differentiated at the end of 2014. Check marks indicate that haircuts were differentiated along that dimension while loops illustrate the opposite. Check marks in brackets indicate partial differentiation, i.e. not applied to all assets of the respective LC. Haircuts applied to marketable assets of (1) LCs 1 to 4 were differentiated according to *(2)* CQS, *(3)* residual maturity and *(4)* coupon and hence four dimensions.[164] The haircut applied to LC 5 (which comprised ABS only) was uniform across residual maturities and irrespective of coupon. Haircuts applied to credit claims were differentiated according to CQS as well as residual maturity in addition to the valuation method (theoretical or outstanding amount). By contrast, haircuts applied to RMBDs were uniform across residual maturities within CQS 1/2 and irrespective of the valuation method and coupon.[165]

In addition to valuation haircuts, the Eurosystem applies supplementary haircuts. These can be applied in the form of *(a)* add-on haircuts, which are simply added to the valuation haircut, as well as *(b)* valuation markdowns, which are directly applied at the level of valuation.[166] Whenever the two risk control measures are jointly applied, nominal haircuts (i.e. those that can be directly observed in the tables published by the Eurosystem) and effective haircuts (i.e. those that take into account add-on haircuts and valuation markdowns) differ. The effective haircut h_e is given by

$$h_e \equiv h_n + h_a + v - \underbrace{(h_n + h_a) \cdot v}_{\text{interaction term}}, \tag{4.8}$$

[164] The classification of assets into LC is based on the issuer and asset type and hence derives liquidity from both the asset type itself as well as the issuer. In October 2013, LCs were renamed in "haircut categories" as their purpose is the assignment of haircuts. The initial name is used for comparability in this dissertation.

[165] Only RMBDs within CQS 1/2 were deemed eligible at the end of 2014 (cf. Section 4.2.2).

[166] Add-on haircuts were e.g. applied to eligible marketable assets denominated in GBP, JPY or USD from October 2008 to December 2010. When collateral denominated in these currencies was deemed eligible again in November 2012, the add-on haircut was replaced by a valuation markdown.

Table 4.5: Differentiation of Eurosystem Haircuts at the End of 2014

The table provides an overview of the dimensions according to which the Eurosystem differentiated haircuts at the end of 2014. Check marks indicate that haircuts were differentiated along the specific dimension, while loops illustrate the opposite. Moreover, check marks in brackets indicate that differentiation was partial, i.e. it did not apply to all assets of the respective LC.

	LC	CQS		Residual Maturity						Coupon[a]		Valuation		Close Links[c]	Denomination[d]
		1/2	3	0–1	1–3	3–5	5–7	7–10	>10	zero	fixed	theoretical[b]	outstanding amount		
Marketable Assets	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	O	O	O	✓
	2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	(✓)	O	(✓)	✓
	3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	(✓)	O	(✓)	✓
	4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	(✓)	O	O	✓
	5	✓	✓	O	O	O	O	O	O	O	O	(✓)	O	O	✓
Non-Marketable Assets	Credit Claims	✓	✓	✓	✓	✓	✓	✓	✓	O	O	✓	✓	O	O
	RMBDs	✓	O	O	O	O	O	O	O	O	O	O	O	O	O

[a] Debt instruments with variable-rate coupons were treated as debt instruments with a fixed-rate coupon and 0-1 year residual maturity in the relevant LC. Specific haircuts are applied to inverse floating-rate debt instruments.
[b] A supplementary haircut in terms of a valuation markdown was applied to theoretically valued covered and uncovered bank bonds as well as ABS.
[c] A supplementary haircut in terms of a valuation markdown was applied to own-use covered bank bonds, which differed across CQS.
[d] As of November 2012, a supplementary haircut in terms of a valuation markdown was applied to all marketable debt instruments denominated in foreign currency. It differed between JPY and other foreign currencies, i.e. GBP and USD.
Source: author's compilation; ECB.

with h_n being the nominal haircut, h_a the add-on haircut and v the valuation markdown. The effective haircut h_e comprises four components, i.e. *(i)* the (nominal) valuation haircut, *(ii)* the add-on haircut, *(iii)* the valuation markdown and *(iv)* an interaction term between the three. The interaction term leads to an alleviation of the effective haircut, which is the greater, the larger the haircut applied. In practice, this means that the effective haircut is more strongly alleviated the higher the risk associated with an asset used as collateral. In effect, effective haircuts are relatively minimally reduced for higher-quality collateral but relatively significantly reduced for lower-quality collateral, fostering the alignment of refinancing conditions that will be further discussed in Section 4.5.7. The effects of this are theoretically analyzed in Chapters 7 and 8, where this practice lies at the basis of the segmentally-pooled refinancing conditions. The pledgable value CV is increased by the sequential application of valuation markdowns and haircuts analogously to (4.8):

$$CV = (1 - h_n - h_a)(1 - v)\overline{MV} = \big(1 - h_n - h_a - v + \underbrace{(h_n + h_a) \cdot v}_{\text{interaction term}}\big)\overline{MV}. \tag{4.9}$$

In light of the normative discussion of the haircut specification (Section 4.5.3), this sequential application is remarkable, as it suggests that risks captured by the valuation markdowns interact with the risks captured in nominal haircuts and add-on haircuts. Moreover, this interaction leads to a decreasing consideration of risks captured by valuation markdowns when risks captured by nominal and add-on haircuts increase, which seems even more counter-intuitive. On the other hand, the normative suggestion would be that independent risks should simply add up in the effective haircut.[167]

4.5.4.2 Development of the Haircut Specification

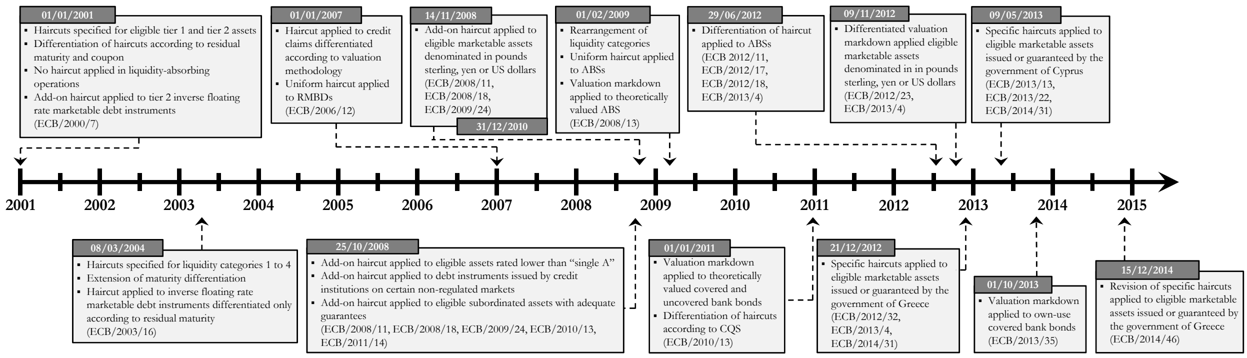
The development of Eurosystem haircuts is illustrated in Figure 4.11 and explained hereafter (see also European Central Bank, 2015). Haircuts were already an important part of the initial collateral framework in January 2001 when they were specified for tier-1 and tier-2 assets. Haircuts for tier-1 assets were differentiated according to the type of coupon (fixed-rate, floating-rate, inverse floating-rate) and residual maturity (four clusters: 0 to 1 year, 1 to 3 years, 3 to 7 years and more than 7 years). The same clustering of residual maturity was applied to assets eligible in tier 2 and haircuts were specified for assets with limited liquidity and special features, as well as non-marketable assets.

This basic framework was first modified in March 2004, the features of which still prevailed at the end of 2014. Tier-1 assets were allocated into LCs according to the issuer and asset type. Two allocations were made irrespective of the issuer, namely ABS were included in the lowest LC and jumbo Pfandbrief-style debt instruments (later: jumbo covered bank bonds) were summarized in the second LC. Haircuts were differentiated more precisely according to residual maturity as the number of clusters increased from four to six (0 to 1 year, 1 to 3 years, 3 to 5 years, 5 to 7 years, 7 to 10 years and more than 10 years). Moreover, haircuts were differentiated according to whether the coupon was fixed or zero. For assets with identical properties in terms of residual

[167] Take the (fictive) example of an asset of high quality assigned a nominal haircut of 5%, no add-on haircuts, but (e.g. due to foreign currency denomination) a valuation markdown of 3%: rather than an effective haircut of 8%, the effective haircut according to (4.8) results as only 7.85%. Moreover, if this same asset was of a lower quality, such that the applicable nominal haircut would amount to 10%, not only would the effective haircut be calculated to 12.7% rather than 13%, but also the delta between normative and positive solution would be .3 percentage points for this lower quality compared to the delta of .15 percentage points for higher quality.

Figure 4.11: Changes to Eurosystem Haircuts

The figure illustrates the development of Eurosystem haircuts from 2001 to 2014. While haircuts became more differentiated prior to the financial crisis, they were only partly adapted to the development of the collateral pool as well as market developments during the financial and sovereign debt crisis. Moreover, the Eurosystem introduced supplementary haircuts to specifically mitigate risk from the extended eligibility of assets.



Source: author's compilation.

maturity and coupon, haircuts were decreasing in liquidity, i.e. haircuts increased from LC 1 to 4. Haircuts applied to tier-1 inverse floating-rate instruments were uniform over LCs, depending only on residual maturity. The haircut applied to debt instruments with variable-rate coupons was that applied to a debt instrument with 0 to 1 year residual maturity and fixed-rate coupon within the relevant LC. Haircuts applied to tier-2 assets were elaborated accordingly by including more cluster of residual maturity as well as differentiating between zero and fixed-rate coupon.

The two-tier system was phased out in May 2007 with the introduction of the Single List (cf. Section 4.2.3), which has drawn a distinction between marketable and non-marketable assets. Marketable assets comprised former tier-1 assets and the respective haircuts were applied. Haircuts imposed to credit claims with fixed-rate coupon were differentiated according to the residual maturity and valuation method, while haircuts applied to those with variable-rate coupon were irrespective of the valuation method.[168] A uniform haircut was imposed to RMBDs.

Amendments to haircuts in response to the financial crisis in October 2008 and November 2008 took the form of supplementary haircuts (cf. Section 4.3). First, a uniform add-on haircut was introduced to all eligible assets rated lower than Single A as the minimum credit rating threshold was lowered from Single A to Triple B. Second, a uniform add-on haircut was imposed to newly-eligible bank bonds traded on accepted non-regulated markets. Third, a uniform add-on haircut was applied to subordinated assets that were deemed eligible with adequate guarantees. Fourth, a valuation markdown was implemented for theoretically valued subordinated assets. Fifth, the Eurosystem charged a uniform add-on haircut to assets denominated in GBP, JPY or USD that were deemed eligible for the first time from November 2008 to December 2010. Eligibility was re-introduced in November 2012 and the former uniform add-on haircut was replaced by a valuation markdown, which was larger for JPY than for GBP or USD.

In February 2009, LCs were rearranged with uncovered bank bonds allocated to the fourth and ABS to the fifth LC (cf. Section 4.3.5). Haircuts on ABS were harmonized, i.e. they were no

[168] This held for credit claims with interest payments with a resetting period shorter than one year. Otherwise, credit claims were considered to have a fixed-rate coupon and the respective haircut was applied.

longer differentiated with respect to residual maturity, while a uniform valuation markdown was introduced to theoretically valued ABS. This valuation markdown was extended to theoretically valued covered and uncovered bank bonds in January 2011. At the same time, the Eurosystem lowered the minimum credit rating threshold to Triple B in the General Framework and replaced the add-on haircut on such assets by more graduated haircuts. More specifically, credit quality was introduced as a fourth dimension of haircut differentiation (besides liquidity, residual maturity and coupon). However, differentiation according to credit quality was limited as only two segments of credit quality were taken into account with CQS 1/2 (Segment 1) and 3 (Segment 2). The limited differentiation of haircuts with respect to credit quality was also implemented for inverse floating-rate debt instruments and credit claims with fixed interest payments. The lowering of the credit rating requirement for homogenous ABS in June 2012 was accompanied with the introduction of larger haircuts for these newly-eligible ABS within CQS 3, which were differentiated with respect to underlying assets.[169] Furthermore, a valuation markdown was imposed to own-use covered bank bonds in October 2013, which was differentiated according to credit quality.

Section 4.3.2 revealed that the collateral criteria of bonds issued or guaranteed by governments were subject to substantial amendments and that country-specific criteria were introduced in May 2010 when the minimum credit rating was suspended for bonds issued or guaranteed by the government of Greece. This step was repeated for Ireland (April 2011), Portugal (July 2011) and Cyprus (May 2013). Specific and considerably larger haircuts were adopted for government bonds and government-guaranteed bank bonds as well as non-financial corporate bonds issued in Greece and Cyprus, but not for Ireland and Portugal, although the credit ratings of these two countries have occasionally fallen below the minimum credit rating threshold of Triple B (cf. Figure 4.5). The specific haircuts were revised and lowered throughout 2014.

4.5.5 Descriptive Analysis of Haircuts Applied by the Eurosystem

After the general principles and the development of the haircut specification of the Eurosystem have been presented, this section elaborates on the quantitative development of haircuts. A comprehensive picture of the quantitative development of haircuts is drawn in two steps along the different components of effective haircuts applied by the Eurosystem: *(i)* the (nominal) valuation haircut h_n and *(ii)* supplementary haircuts, i.e. add-on haircuts h_a and valuation markdowns v.

4.5.5.1 (Nominal) Valuation Haircuts

The following analysis of nominal haircuts suggests four broad phases of haircut development:

- PRE-CRISIS PHASE: April 2004 to September 2008;
- FINANCIAL CRISIS PHASE: October 2008 to December 2010;
- SOVEREIGN DEBT CRISIS PHASE: January 2011 to September 2013;
- REMITTENT SOVEREIGN DEBT CRISIS PHASE: October 2013 to December 2014.

The timing of the phases suggests that the Eurosystem responded to the onsets of the financial and the sovereign debt crisis with delays, whereby the response was faster for the former rather

[169] For ABS that did not have two ratings of at least Single A, the haircut was differentiated with respect to underlying assets, whereby those ABS backed by commercial mortgages were subject to a larger valuation haircut than other eligible ABS. The haircuts were lowered in October 2013.

than the latter. Despite being the major risk mitigation tool, adjustments to haircuts were scarce and infrequent, as well as not always being specifically related to events during the phases (see also Nyborg, 2015). For instance, haircut adjustments during the sovereign debt crisis phase were only secondarily addressed to government-related assets.

Figure 4.12 provides a comprehensive picture of the quantitative development of nominal haircuts applied by the Eurosystem from March 2004 to December 2014 to assets in LCs 1 to 5, inverse floating-rate debt instruments, credit claims as well as RMBDs, arranged by CQS.[170] Based on the information illustrated in Figure 4.12, haircuts applied during the four phases are characterized according to the following two properties:[171] first, the average haircut seizes on the level of haircuts; and second, the haircut range illustrates the spread of haircuts between the smallest and largest haircut. The range is defined as the difference between the haircuts applied to assets with the shortest (0 to 1 year) and the longest (more than 10 years) residual maturity.

Pre-Crisis Phase The Eurosystem did not change haircuts within this first phase. Only assets of high quality, i.e. rated within CQS 1/2, were eligible and Table 4.6 indicates that initial average haircuts as well as haircut ranges were moderate and increased with diminishing liquidity of assets. Haircuts applied to ABS were still differentiated according to residual maturity, while a uniform haircut of 20% was applied to all eligible RMBDs.

Table 4.6: Nominal Valuation Haircuts during the Pre-Crisis Phase

The table characterizes haircuts applied prior to the financial crisis, indicating that initial average haircuts as well as haircut ranges were moderate and increased with decreasing liquidity.

	Average Haircut (Percent)	Haircut Range (Percentage Points)
LC 1	2.83	5
LC 2	4.08	6.5
LC 3	5	7.5
LC 5[a]	6.25	10
Inverse Floater	12.17	23
Credit Claims	11.5	10
RMBDs	20	0

[a] ABS made up for LC 4 at that time are indicated as LC 5 into which they were classified in February 2009.
Source: author's calculation; ECB.

Financial Crisis Phase Turmoil in financial markets predominantly impaired the quality of bank bonds, which were comprised in LCs 2 (jumbo covered bonds) and 3 (traditional covered

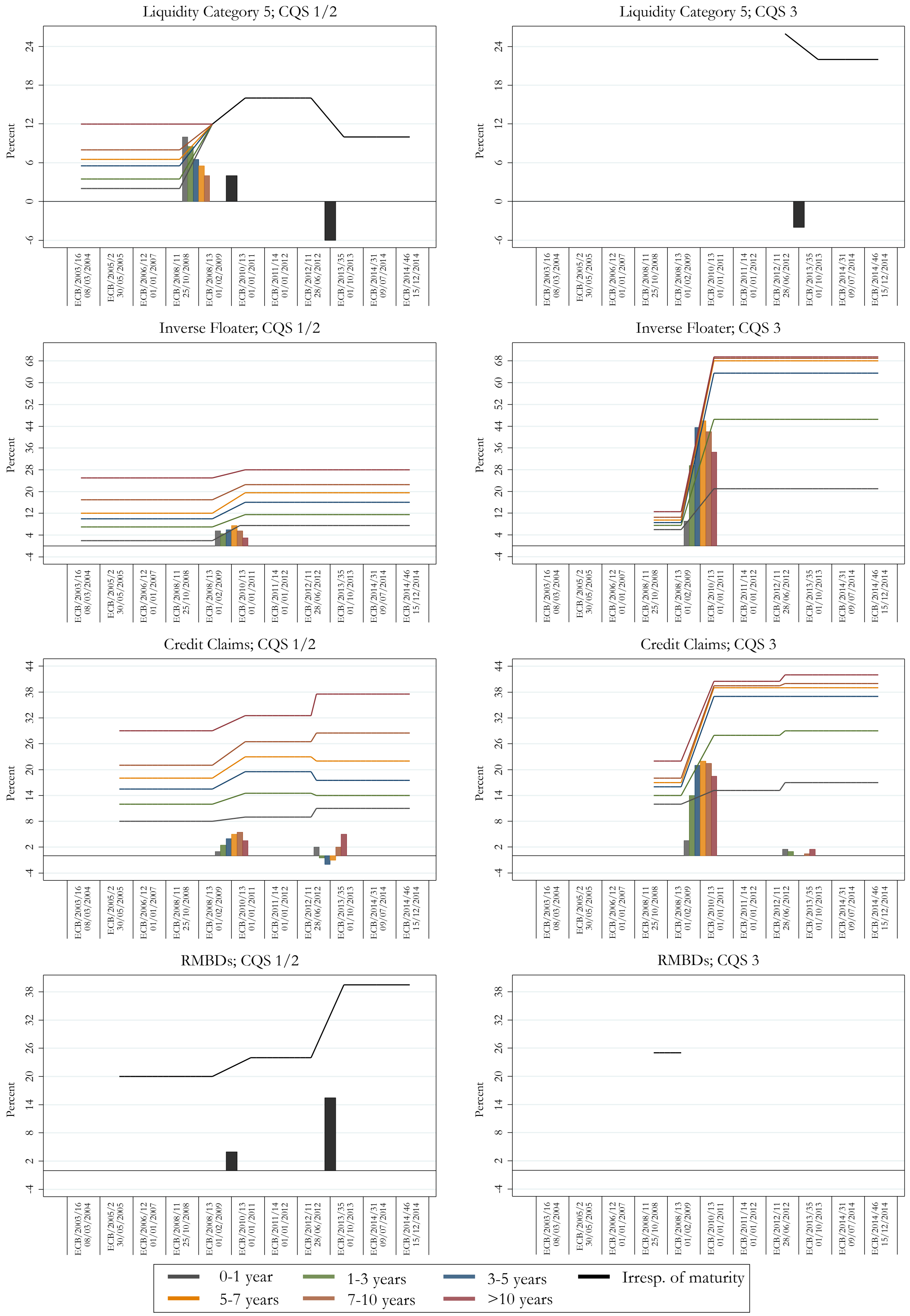
[170] The figures illustrate the quantitative development of nominal valuation haircuts imposed on collateral with fixed-coupon payments. Bars mark the percentage change between two points in time. For credit claims, the average of the haircut applied to theoretically valued credit claims and those valued according to the outstanding amount is shown. The add-on haircut applied to eligible collateral in CQS 3 from October 2008 to December 2010 is treated as a nominal valuation haircut for the sake of comparability. All other supplementary haircuts are neglected.

[171] Haircut properties are given for collateral with fixed-rate coupon and theoretical valuation in case of credit claims.

Figure 4.12: Quantitative Development of Nominal Valuation Haircuts

Source: author's compilation; ECB.

Figure 4.12: Quantitative Development of Nominal Valuation Haircuts (Continued)



Source: author's compilation; ECB.

bonds and uncovered bonds) at the time. Moreover, the market for ABS almost completely dried up. Higher credit risk as well as lower liquidity owing to the distressed market environment should according to Proposition 4.3 have called for larger haircuts on bank bonds and ABS.

While the Eurosystem promptly reacted to the turmoil by adapting its collateral framework in October 2008 and the subsequent months, amendments to haircuts were initially small. The lowering of the minimum credit rating threshold was accompanied by applying an add-on haircut of 5% to the newly-eligible assets of lower quality within LCs 1 to 3. However, initial haircuts were not adjusted until February 2009 when the Eurosystem reacted to the changing market environment by reclassifying uncovered bank bonds in LC 4 and ABS in LC 5. The average haircut applied to uncovered bank bonds was raised from 5% to 10%, while the range remained at 7.5%, i.e. uncovered bank bonds were effectively deducted by another add-on haircut of 5% irrespective of residual maturity as of February 2009. Haircuts applied to ABS (LC 5) – which had hitherto been differentiated according to residual maturity – were harmonized to the haircut formerly applied to ABS with the longest residual maturity (more than ten years). Therefore, the haircut increase was greater the shorter the residual maturity of ABS, while the average haircut increased from 6.25% to 12%.

Sovereign Debt Crisis Phase While the European sovereign debt crisis intensified in the course of 2010, the Eurosystem did not amend haircuts until January 2011. The debt crisis mainly affected government bonds that were eligible as collateral within LC 1 as well as government-guaranteed assets and bank bonds eligible in LCs 2 to 4. Larger haircuts should have been imposed on these assets according to Proposition 4.3 as credit quality and liquidity deteriorated. However, changes were not specifically directed at government-related assets but predominantly owed to the revision of the uniform add-on haircut of 5% applied to eligible assets of lower credit quality (CQS 3) in LCs 1 to 4. The uniform add-on haircut was replaced by more graduated haircuts, which were differentiated according to residual maturity and coupon (see Section 4.5.4.2). Table 4.7 provides an overview of the modifications that can be tracked in Figure 4.12. The comparison of Tables 4.6 and 4.7 indicates that haircuts applied to government bonds (incorporated in LC 1) were not subject to change. By contrast, modifications implied substantial increases in haircuts applied to assets within LCs 2 to 4 in CQS 3, which were larger in absolute terms for higher LCs (i.e. less liquid assets). Residual maturities within LCs were treated differently, as indicated by the pattern of change in Table 4.7 and tracked in Figure 4.12. The general impression is that absolute increases in haircuts mainly reflected an inverse u-shaped pattern, implying that increases were large for assets of medium (3-5 and 5-7 years) but small or zero for those with short (0-1 and 1-3 years) and long (7-10 and larger than 10 years) residual maturity. Average haircuts increased for all assets aside from those in LC 1 and high-quality assets (i.e. CQS 1/2) in LC 2. The credit quality and liquidity of bonds issued or guaranteed by several countries further impaired throughout 2011 with the aggravation of the sovereign debt crisis. The Eurosystem thus suspended (or extended the suspension) of the minimum credit rating for bonds issued or guaranteed by Greece, Ireland, Portugal and Cyprus. Declining credit quality and liquidity of government-related collateral in those countries was accompanied by specific modifications to haircuts applied to government-related assets from Greece and Cyprus. For Greece, the average haircut increased from 9.4% to 43.3% (government bonds) and from 22%

to 53.3% (government-guaranteed bonds). For Cyprus, the average haircut increased from 9.4% to 37.5% (government bonds) and from 22% to 47.5% (government-guaranteed bonds).

Table 4.7: Changes to Nominal Valuation Haircuts during the Debt Crisis Phase

The table provides an overview of the changes to nominal haircuts during the sovereign debt crisis phase, which can be tracked in Figure 4.12. The changes implied substantial increases in haircuts applied to assets within LCs 2 to 4 in CQS 3. Increases were larger in absolute terms for higher LCs, i.e. less liquid assets. Residual maturities within LCs were treated differently, as indicated by the pattern of change.

	Haircuts in CQS 1/2			Haircuts in CQS 3		
	Ø[a]	Range[b]	Pattern	Ø[a]	Range[b]	Pattern
LC 1	2.8	5	no change	7.8	5	no change
LC 2	4.1	6.5	no change	14.9	14	inverse u-shaped increase[c]
LC 3	5.9	9.5	increase	23	21.5	inverse u-shaped increase
LC 4	11.6	10.5	strict increase	32.7	24.5	inverse u-shaped increase
LC 5	16	0	increase[d]	n/a	n/a	n/a
Inverse Floater	17.5	20.5	inverse u-shaped increase[e]	56.3	48.5	uniform increase
Credit Claims	15.1	12.5	inverse u-shaped increase	33.3	25	inverse u-shaped increase
RMBDs	24	0	increase[d]	n/a	n/a	n/a

[a] Percent.
[b] Percentage points.
[c] The inverse u-shaped pattern implies that the change is large for assets with medium (3-5, 5-7) but small or zero for assets with short (0-1, 1-3) and long (7-10, >10) residual maturity.
[d] Irrespective of residual maturity.
[e] Except for inverse floaters with residual maturity between 0 to 1 year.
Source: author's compilation; ECB.

Remittent Sovereign Debt Crisis Phase The Eurosystem reacted cautiously to the calming of financial markets, which suggested the remittance of the sovereign debt crisis as it did not modify haircuts until the end of 2014. The improved market environment in terms of improved credit quality and liquidity of government-related assets should have resulted in a reduction of haircuts (Proposition 4.3). In fact, haircuts were modified for all LCs as well as credit claims and RMBDs in October 2013. However, the modifications were small in magnitude relative to increases in haircuts performed during the previous (debt crisis) phase. Unlike previously, modifications were also directed at government bonds (or LC 1, respectively) such that haircuts were lowered for government bonds of high credit quality (CQS 1/2) but strictly increased for lower-quality assets (CQS 3). Exceptions were ABS (LC 5) for which the uniform haircut was lowered by more than it was increased in the previous phase, as well as RMBDs, for which the haircut was further increased. The overall pattern of modifications was more divergent than previously, as Figure 4.12 indicates and Table 4.8 summarizes. Haircuts were predominately modified in a u-shaped pattern, i.e. changes were mainly directed to assets of shorter and longer residual maturity. As modifications were small in magnitude, average haircuts and ranges did not vary substantially relative to the previous phase. Moreover, the Eurosystem considerably lowered the specific haircuts applied to bonds issued or guaranteed by the government of Greece. The average haircut on Greek government bonds decreased to 21.8% (from 43.4%) and the haircut applied to bonds guaranteed by the Greek government fell to 30.3% (from 53.3%). Special haircuts for collateral related to the Cypriot government were not altered.

Table 4.8: Changes to Nominal Valuation Haircuts during the Remittent Debt Crisis Phase

The table provides an overview of the changes to nominal haircuts during the remittent sovereign debt crisis phase, which can be tracked in Figure 4.12. Modifications were small in magnitude relative to haircut increases during the previous phase. Changes were also directed at government bonds (or LC 1, respectively). Inverse floaters are neglected as no changes were made.

	Haircuts in CQS 1/2			Haircuts in CQS 3		
	Ø[a]	Range[b]	Pattern	Ø[a]	Range[b]	Pattern
LC 1	2.2	4.5	u-shaped decrease[c]	9.4	7	increase
LC 2	3.5	7	constant decrease[d]	14.9	15.5	u-shaped modification[e]
LC 3	4.6	9.5	u-shaped decrease	19.5	19.5	decrease
LC 4	11.6	10.5	no change	30.1	24.5	u-shaped decrease
LC 5	10	0	decrease[f]	22	0	decrease[f]
Credit Claims	15.1	12.5	u-shaped modification[g]	33.3	25.5	u-shaped increase
RMBDs	39.5	0	increase[f]	n/a	n/a	n/a

[a] Percent.
[b] Percentage points.
[c] The u-shaped pattern implies that the change in haircuts is small or zero for assets with medium (3-5, 5-7) but large for assets with short (0-1, 1-3) and long (7-10, >10) residual maturity.
[d] Except for assets with residual maturity of more than 10 years, for which the haircut was increased.
[e] Increase only for assets of the shortest (0-1) and longest (>10) residual maturity.
[f] Irrespective of residual maturity.
[g] Increase only for assets of with residual maturity 0-1, 7-10 and more than 10 years.
Source: author's compilation; ECB.

4.5.5.2 Supplementary Haircuts

Section 4.5.4 has revealed that besides nominal haircuts, the Eurosystem also applies supplementary haircuts. Accordingly, this section briefly reviews and summarizes the quantitative development in the application of the two types of supplementary haircuts: *(a)* add-on haircuts, i.e. h_a and *(b)* valuation markdowns, i.e. v. Table 4.9 provides an overview of add-on haircuts and valuation markdowns applied by the Eurosystem from 2001 to 2014 together with the affected collateral, haircut size and the period of application. It reveals that the Eurosystem applied add-on haircuts in particular after the onset of the financial crisis and the following quantitative and qualitative broadening of eligible collateral. The Eurosystem later replaced former add-on haircuts and shifted towards the application of valuation markdowns.

Table 4.9: Overview of Supplementary Haircuts Applied by the Eurosystem

The table provides an overview of supplementary haircuts, i.e. add-on haircuts and valuation markdowns, applied by the Eurosystem from 2001 to 2014. It reveals that the Eurosystem applied add-on haircuts in particular during the financial crisis but later turned to valuation markdowns.

Affected Collateral	Type	Value	Application Period
Eligible assets rated lower than Single A	add-on	5%	25/10/2008–31/12/2010
Bank bonds traded on non-regulated markets	add-on	5%	25/10/2008–31/12/2010
Foreign currency collateral	add-on	8%	14/11/2008–31/12/2010
Subordinated assets	add-on	10%	14/11/2008–31/12/2010
Theoretically valued subordinated assets	markdown	5%	14/11/2008–31/12/2010
Theoretically valued ABS	markdown	5%	01/02/2009–present[c]
Theoretically valued covered and uncovered bank bonds	markdown	5%	01/01/2011–present[c]
Foreign currency collateral	markdown	16%/26%[a]	09/11/2012–present[c]
Own-use covered bank bonds	markdown	8%/12%[b]	01/11/2013–present[c]

[a] 16% for GBP and USD; 26% for JPY.
[b] 8% for bank bonds in CQS 1/2 and 26% for those in CQS 3.
[c] In this context: The end of 2014.
Source: author's compilation; ECB.

4.5.6 Evaluation of the Eurosystem's Haircut Specification

Building on the previous analysis of haircuts, the Eurosystem's haircut application is evaluated against the normative principles of haircut specification carved out in Section 4.5.3.[172]

Proposition 4.1 explains the relationship between legal risk and the haircut size and postulated that legal risk arising from non-standardized lending contracts calls for larger haircuts as these contracts might be incomplete or difficult to enforce. The Eurosystem uses the European Master Agreement for its relevant transactions and ensures that no legal risk arises from the contractual framework of a transaction (European Central Bank, 2006). Hence, there is no necessity for larger haircuts owing to legal risk.

Proposition 4.2 addresses the link between operational risk and haircuts indicating that operational risk from e.g. inefficient margining should imply larger haircuts. The Eurosystem applies variation margins according to which counterparties have to maintain the collateralization of principal over time (see Section 4.5.1). Recalculation is performed daily and includes accrued interest. A variation margin of 0.5% of principal is usually used as a trigger point for a margin call.

Proposition 4.3 describes the influence of collateral quality on haircut size and concludes that collateral of lower credit quality and liquidity should have larger haircuts. The Eurosystem effectively distinguishes three clusters of credit quality (CQS 1, 2 and 3) in its collateral framework. Haircuts

[172] See also Nyborg (2015) for an assessment of Eurosystem haircuts.

are even only differentiated between two credit quality segments (CQS 1/2 and CQS 3). Hence, the haircut application of the Eurosystem only partially meets Proposition 4.3 with respect to the effect of credit quality on haircut size. The Eurosystem takes the collateral quality dimension of liquidity into account. Haircuts are differentiated according to five LCs and moreover, differing haircuts are applied to eligible non-marketable assets. Assets are assigned to LCs depending on their type and issuer. Hence, the development of haircuts applied to marketable assets is only partially differentiated according to liquidity. For effects of this clusterization approach see also the following section.

Proposition 4.4 suggests an effect of market risk on haircut size and claims that assets subject to valuation risk should bear larger haircuts. The Eurosystem applies a valuation markdown of 5% to theoretically valued covered and uncovered bank bonds as well as ABS to address valuation risk. In addition, different haircuts are applied to credit claims depending on the valuation method. Market risk was respected also in the past. Bank bonds traded on non-regulated markets were applied an add-on haircut to these assets from October 2008 to December 2010. However, the Eurosystem refrained from applying a supplementary haircut when bank bonds traded on non-regulated markets were deemed eligible for the second time, as of January 2012.

Proposition 4.5 asks for larger haircuts in case of higher interest-rate risk, e.g. due to longer residual maturity of collateral. Eurosystem haircuts are differentiated with respect to six clusters of residual maturity. Generally, haircuts increase with residual maturity to recognize the higher interest-rate risk associated with longer duration. However, similar to the clustering approach with respect to haircut differentiation along credit quality and liquidity, in the Eurosystem's haircut specification, residual maturity does not have a continuous effect on haircut size. Haircuts only changes stepwise with residual maturity reaching the next cluster. Hence, Proposition 4.5 is met with restrictions. The Eurosystem applies haircuts to zero-coupon assets that are at least as high as for fixed-coupon assets. No difference is made in case of collateral maturing within one year as the duration does not significantly differ for these assets. The difference subsequently increases in residual maturities, LCs and CQSs from 0.5 to 6.5 percentage points. Only for ABS (LC 5) is no difference made. Variable-rate coupons are treated like fixed-rate coupons and haircuts are applied according to residual maturity, which corresponds to the resetting period of the variable-rate coupon.

Proposition 4.6 postulates an effect of wrong-way risk on haircut size. It suggests larger haircuts the closer the connection between the counterparty and collateral issuer. In fact, the Eurosystem applies a supplementary haircut in terms of a valuation markdown of 8% to own-use covered bank bonds rated in CQS 1/2 and 12% in CQS 3. However, other assets eligible with close links (especially own-use government-guaranteed uncovered bank bonds) are not subject to a supplementary haircut.

Proposition 4.7 addresses exchange-rate risk and claims haircuts to be higher in case of foreign currency denominations. The Eurosystem has accepted collateral denominated in GBP, JPY or USD from November 2008 to December 2010 and again as of November 2012. It applied a uniform add-on haircut during the first period, which was replaced by a differentiated valuation markdown in November 2012.

To summarize, the Eurosystem's haircut specification in principle addresses all rules set out by the normative propositions in Section 4.5.3. Some risks such as the wrong-way risk and the market risk are only incompletely respected, inter alia because haircut regulations respecting them have been abolished at some point. However, the evaluation along the lines of several propositions showed that a clustering approach is applied, which only incompletely incorporates the individual risks associated with a distinct asset and its quality. In particular, collateral is clustered along the dimensions of *(i)* liquidity, *(ii)* residual maturity and *(iii)* credit quality.[173] This approach naturally leaves some information behind and leads to the effect described in the following section. Haircuts and thus the conditions for the pledging of assets of different qualities and with different risks attached, are aligned or segmentally pooled.

Moreover, the haircut specification suffers from its rigidity. Developments in the market or the financial system – including phenomena such as a turmoil, a crisis or a bubble – are not at all dynamically included in the haircut determination.[174] Chapter 7 touches upon the effects of this in the analysis of overly optimistic and overly prudent market sentiments. Furthermore, the revisions of the haircut specifications take place infrequently and beyond a recognizable pattern. Nyborg (2015) confirms the impression of seldom updates from Sections 4.5.4 and 4.5.5, stating the average time between revisions at three years.

4.5.7 Effects of the Clustering Approach: Segmental Pooling

Of the four dimensions of haircut specification (coupon, residual maturity, liquidity and credit quality), three are clustered. The five LC installed to cover *liquidity* differences comprise twelve different asset types, which by itself might already be clustered into generic terms. LC 1 covers two asset types, LC 2 includes four asset types, LC 3 comprises three asset types, LC 4 subdivides into two asset types and only LC 5 is a synonym for ABS. However, the latter are a good example of a generic term covering all kinds of securitized claims (the different underlyings). An infinite number of different *residual maturities* is clustered into six residual maturity categories. Five of these categories cover the first ten years of residual maturities, while the sixth includes all residual maturities beyond that duration. Most pronounced is the clustering of *credit qualities*. Essentially, the Eurosystem differentiates between credit qualities in CQS 1, CQS 2, CQS 3 and a credit quality step including all quality levels below that. However, effectively, CQS 1 and CQS 2 are not distinguished, further extending the segmental pooling described in further detail in the following. In the reminder of this dissertation, segmental pooling is solely exemplified along the dimension of credit quality. Nevertheless, the clustering approaches along the other two dimensions described have similar impacts.

Figure 4.13 illustrates how segmental pooling encompasses different credit quality levels. Exemplifying, the rating scale of S&P is used, which can be translated into the harmonized rating scale of the Eurosystem (cf. Section 4.2.4.3). The S&P rating scale encompasses 21 rating notches above "default", which the Eurosystem clusters into four segments. Ratings from Triple A, i.e. AAA, to Double A, i.e. AA-, constitute CQS 1, ratings of Single A, i.e. from A+ to A-, CQS 2 and ratings of Triple B, i.e. BBB+ to BBB-, CQS 3. The investment grade ends at BBB-, ratings

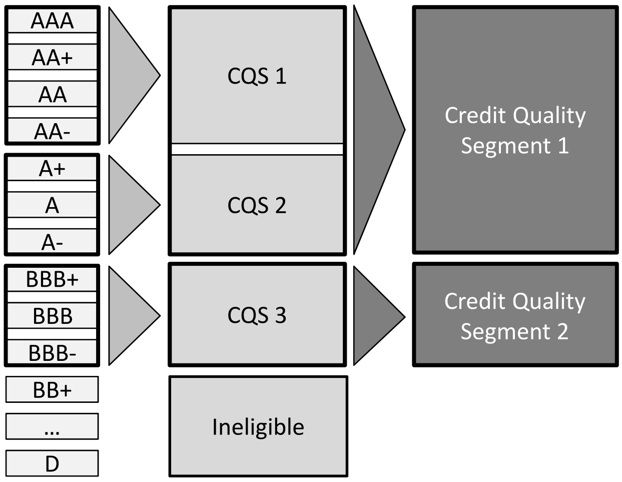
[173] The fourth dimension of haircut specification – coupon – covers all potential coupon structures and is assessed here as not clustered in the discussed respect.

[174] By contrast, the market updates (increase) its haircuts in times of crashes, as e.g. Jurek and Stafford (2011) show for the recent financial turmoil. They also argue that haircut increases were justifiable given collateral quality.

below are as a general rule not eligible from the Eurosystem's perspective. As haircuts are not differentiated between CQS 1 and 2 (see above), seven rating notches in the S&P scale build the first pooled credit quality segment. CQS 3 comprises three rating notches and is equivalent to Segment 2. For instance, an eligible covered bank bond with a fixed-rate coupon and residual maturity of ten months that carries an S&P rating of AAA, featuring an "extremely strong capacity to meet financial commitments" (Standard and Poor's, 2012, p. 5) receives the same haircut and refinancing conditions as an eligible covered bank bond with a fixed-rate coupon and residual maturity of ten months, which only carries an S&P rating of A-, thus being "susceptible to adverse economic conditions and changes in circumstances", see Standard and Poor's (2012, p. 5). Moreover, for government or government-guaranteed bonds from sovereigns that have been exempted from the minimum credit rating threshold, Segment 2 is either extended – such that pooled conditions apply to an even greater range of even lower credit qualities – or if special ratings have been defined, these apply to the large cluster of all eleven credit rating notches below BBB-.

Figure 4.13: Clustering of Asset Credit Qualities

This figure stylizes the clustering of asset credit qualities into credit quality segments, exemplified for the rating scale of S&P. It illustrates how the Eurosystem clusters asset credit quality in two steps: first, rating notches are subsumed into CQSs; and second, CQSs are summarized into credit quality segments. Haircuts are segmentally pooled along the credit quality dimension.



Source: author's illustration.

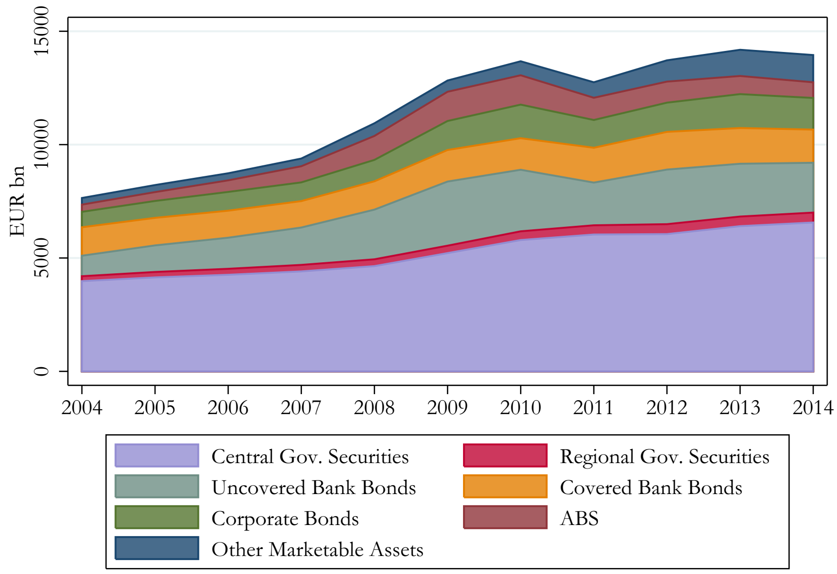
The clustering approach is in line with the Eurosystem's goal to define haircuts such that the "main [...] risk differences, in as few dimensions as possible" (European Central Bank, 2015, p. 29) are incorporated. However the segmentally-pooled conditions lead to significant effects in the markets. Chapter 7 presents quality effects of the approach, resulting from the positive (and negative) subsidization of different collateral qualities. Chapter 8 deducts distribution effects within a central bank jurisdiction that hold particular relevance in a monetary union. The pooling of conditions has already been criticized prior to the financial crisis by Buiter and Sibert (2005). They disapprove the equal treatment of government bonds of EMU member countries, which in reality are of quite different credit quality.

4.6 Developments in the Eligible Assets Pool

There is only limited information and in particular only coarse historical information offered publicly by the ECB on the development of the eligible collateral pool. The information provided is depicted in Figure 4.14. Historical information is only provided on a yearly basis until 2011 and quarterly since 2012.[175] Moreover, the data is aggregated for the entire Eurozone, whereby no national information is available at the level of the Eurozone member countries. Furthermore, the data is aggregated into asset types, as specified by the ECB. Information on the quality structure of the eligible collateral pool is not available. The only lesson to be drawn from the picture is the significant overall increase over the depicted period by 82.5%. The development of the structure by asset types is not easily connectable to collateral policy measures described above, owing to the low frequency of data updates.

Figure 4.14: Published Information on Eurosystem Eligible Collateral Pool

The figure shows the publicly available information on the development of the eligible collateral pool of the Eurosystem by asset type from 2004 to 2014. The pool grew by 82.5% over the depicted period.



Source: author's illustration; ECB.

With the help of the Eligible Assets Database, provided to the author by the Deutsche Bundesbank, a refinement of the development of the eligible assets pool is presented in the following. The Eligible Assets Database is the list of all eligible marketable assets on ISIN-basis and has been made available to the author on a monthly basis for the period from May 2007 to December 2013.[176] It provides information on the asset's liquidity category (LC), type of asset, reference market, issuer, guarantor, coupon and valuation haircut.[177] In May 2007, the database comprised 25,348 marketable assets

[175] Data in Figure 4.14 is thus exclusively shown on a yearly basis, to retain comparability.

[176] Since April 2010, the list of eligible marketable assets has also been published daily (but not historically) by the ECB. Moreover, in contrast to the Eligible Assets Database used in this dissertation, the published data does not include information on nominal values of the assets.

[177] The type of asset in the Eligible Assets Database is differentiated between *(i)* bond, *(ii)* medium-term note, *(iii)* (treasury) bill/commercial paper/certificate of deposit, *(iv)* jumbo covered bond, *(v)* traditional covered bond, *(vi)* ABS, *(vii)* multi-cédula and *(viii)* structured covered bond. The information has been transformed into the asset type categorization of Figure 4.14, to make it comparable for the analyses in this dissertation.

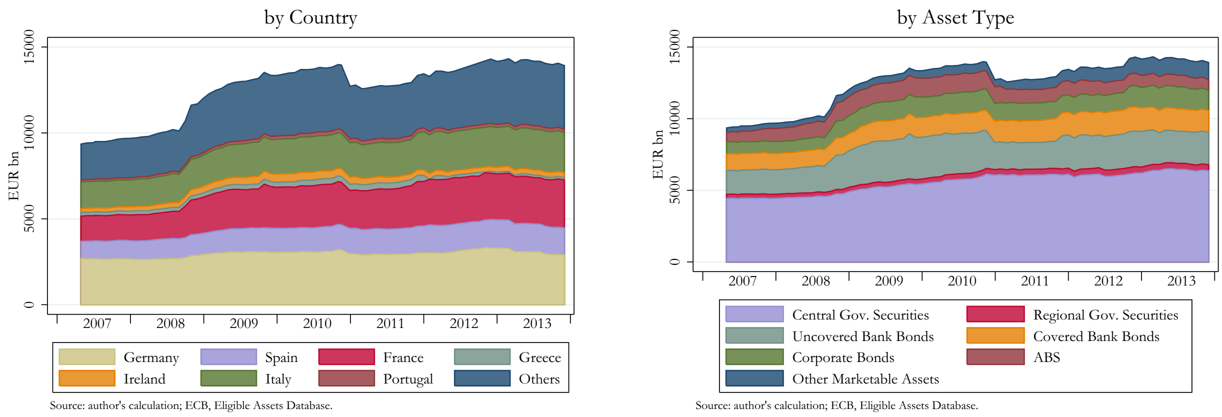
of a combined nominal value of EUR 9.9 trillion. The number of marketable assets increased in the aftermath of the financial crisis to e.g. 51,374 in November 2008 (combined nominal value: EUR 11.6 trillion) and stops at 36,930 assets of combined nominal value of EUR 13.9 trillion in the last month contained in the database, December 2013.

4.6.1 Development According to Asset Type and Country

Figure 4.15 refines the information publicly available from the ECB in two ways. First, in the left panel the Eurosystem Collateral Pool is sliced into national collateral pools by distinguishing the origin countries of eligible assets. While the size of the German pool remained relatively constant, a large part of the increase noted above falls upon the French pool. Furthermore, the pools of other crisis-stricken countries increased over time. An in-depth analysis of the national collateral pools is conducted in Section 8.5.2 in the course of analyzing the distribution effects connected to differences within them. Second, the development of the structure of eligible asset types depicted in the higher monthly frequency in the right panel allows an easier connection of developments to policy changes. The pronounced increase of the pool from 2008 to 2009 visible from Figure 4.14 is clearly relatable in Figure 4.15 to the package of loosening collateral policy measures conducted in October 2008 (cf. Section 4.4), whereby most of the additionally-eligible assets obviously were bank bonds. The same is true for the temporary reduction of the pool size in January 2011 due to the temporary ineligibility of bank bonds traded on unregulated markets – which were not eligible during 2011 but again from 2012 – and the temporary ineligibility of foreign currency-denominated assets from January 2011 to November 2012. The overall impression from this first refinement is that while amendments to the collateral framework were broadly defined and affected all asset types, their effects on the eligible asset pool obviously differed across countries and asset types.

Figure 4.15: Refined Information on the Collateral Pool by Country and Asset Type

The figure refines Figure 4.14 by showing the collateral pool and its development by country (left panel) and asset type (right panel). The right panel confirms the previous observation that the collateral pool substantially increased, as well as helping to connect changes in the asset type structure to the time of collateral policy measures. Moreover, the left panel reveals that the composition by country changed asymmetrically over time.



4.6.2 Development According to Credit Quality

The Eurosystem does not publicly offer information on the quality of the eligible collateral pool.[178] Furthermore, the Eligible Assets Database described above does per se not contain any information on credit quality. In principle, three procedures are possible to gain insights into the development of credit quality of eligible assets. First, the development of the average haircut applied to eligible assets can be used as a proxy for credit quality (e.g. Mancini et al., 2015). However, Section 4.5 indicates that this proxy would be flawed as haircuts are subject to exogenous changes (irrespective of credit quality), which would affect the average haircut detached from credit quality. Second, credit assessments from rating agencies could be obtained, although this procedure proves impracticable as neither are all assets rated by rating agencies nor is there a historical record on credit ratings available. Therefore, a third approach is elaborated that combines information provided in the Eligible Assets Database and a self-compiled comprehensive database of haircuts applied by the Eurosystem to all potentially eligible asset types from 2007 to 2013 (see also Section 4.5.5).

The application of this inductive identification strategy provides the first outside-in analysis of credit quality of marketable assets eligible with the Eurosystem in refinancing operations between 2007 and 2013.[179] Section 4.5.4.1 shows that the Eurosystem essentially determines haircuts based on four factors: *(i)* liquidity, *(ii)* coupon, *(iii)* residual maturity and *(iv)* credit quality. Moreover, supplementary haircuts on e.g. foreign currency assets are applied (cf. Section 4.5.5.2). Taking advantage of information on the first three factors provided in the Eligible Assets Database, *credit quality* is inferred as the missing fourth factor from information on haircuts contained in the self-compiled database. In order to achieve this, this database had to contain up to 35,916 identifiers, comprising the above-named asset characteristics determining the effective haircut. For example, an uncovered bank bond with a fixed coupon and a residual maturity of two years but no characteristics resulting in add-on haircuts could be assigned a haircut of either 8.5% (if rated within CQS 1/2) or 27.5% (if rated within CQS 3) in December 2011. The knowledge of the effective haircut that had been assigned allows matching to a unique identifier revealing the CQS. Summing up, the analysis derives the Eurosystem's understanding of credit quality clustered into CQSs.

Figure 4.16 shows the deduced quality structure of the Eurosystem collateral pool over time. While the right panel breaks up the stock of eligible assets into CQSs, the left panel adds the monthly flow of newly-eligible assets and their respective credit quality distribution.[180] Since the lowering of the minimum credit rating threshold in October 2008, a significant fraction of assets of lower credit qualities has built up. In December 2013 it reached a share of 9.1% of the pool. Lower qualities are either of credit qualities Single A to Triple B (red area) or below Triple B (blue area).[181] However, the fraction of lower collateral built up gradually over time. The left panel shows that apart from the first two months of eligibility (October and November 2008), only small shares of newly-eligible

[178] A fortiori not on the national level, see Section 8.5.3 for an analysis of credit qualities of national collateral pools.

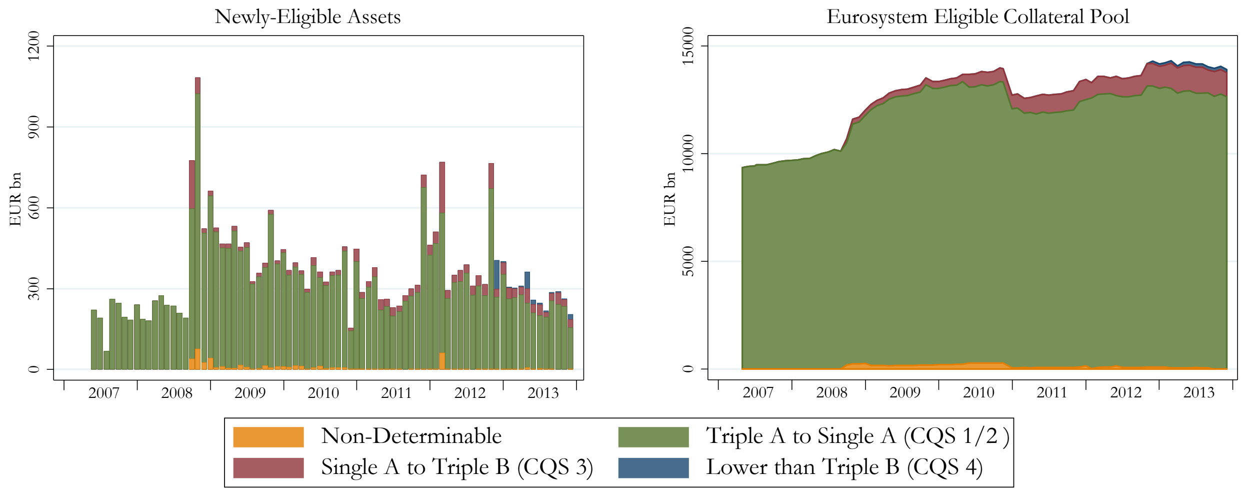
[179] About 99% of eligible marketable assets could be unanimously matched over the entire time horizon by this technique. No more than 5% of assets could not be matched at any point in time.

[180] In this dissertation, newly-eligible assets in the Eurosystem eligible collateral pool are those that appear in the pool in one month but have not appeared in the previous one. Analogously, newly ineligible assets are part of the pool in one month but will not be in subsequent month. A correction for maturing assets is made.

[181] Collateral rated lower than Triple B was only deemed eligible in case of specific government-related assets for which the credit rating requirement was waived or within the ACCs framework (cf. Section 4.3.2). In case of ACCs, these assets are referred to as CQS 4 with a default probability of up to 1.0%, see e.g. Maharaj et al. (2012). As only eligible marketable assets are considered here, credit claims are not reflected in the figures.

Figure 4.16: Newly-Eligible Marketable Assets and the Collateral Pool by Credit Quality

The figure illustrates the development of credit quality of newly-eligible marketable assets (left panel) and the Eurosystem Collateral Pool (right panel). While CQS 3 already became eligible in October 2008, credit quality deteriorated particularly following the onset of the European debt crisis in 2010. In December 2013 it reached a share of 9.1% of the eligible assets pool.



Source: author's calculation; ECB, Eligible Assets Database.

assets were of lower credit qualities; rather, most of them became eligible over the course of the intensifying European sovereign debt crisis. Chapter 9 will elaborate more on this observation. Moreover, the quality development of national eligible assets pools is viewed in Section 8.5.3.

4.6.3 Development According to Denomination

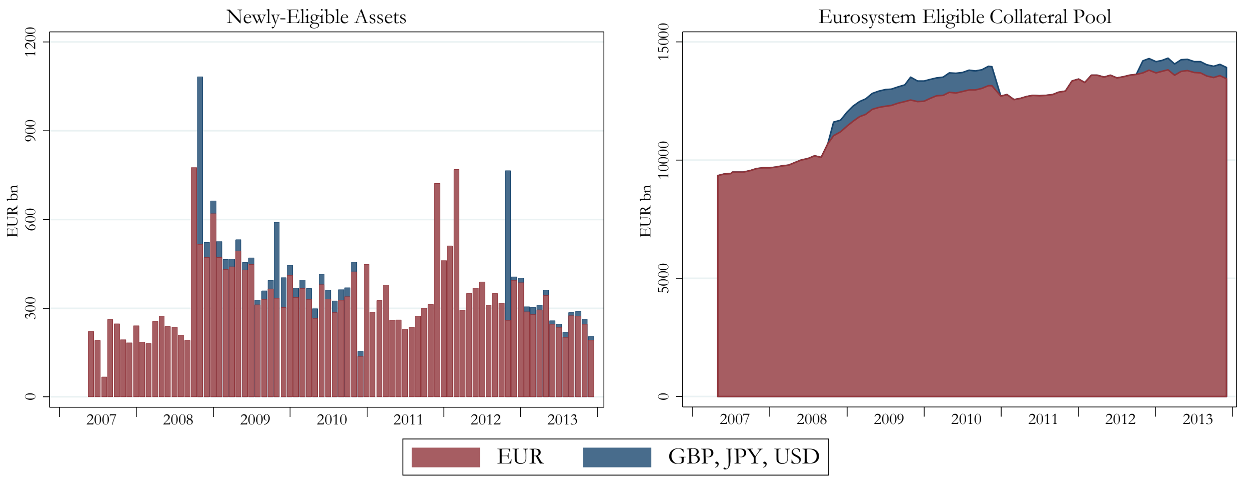
The Eligible Assets Database compiled by the author furthermore allows a detailing of the information on the Eurosystem eligible collateral pool according to denomination. The extension of eligibility to assets of foreign currencies is a classical LOLR measure and was conducted by the Eurosystem twice (cf. Section 4.3.1.2). It is depicted in Figure 4.17. On both occasions – *(i)* in November 2008, within the reaction to the financial market turmoil in fall 2008 and *(ii)* in November 2012, during the European debt crisis – the share of foreign currency-denominated on all newly-eligible assets (in the respective month) was, with around 50% or more, significant. However, measured against the overall collateral pool, the fraction of eligible foreign currency-denominated assets never exceeded 6.2%, as the right panel illustrates.

4.6.4 Development According to Reference Market

With respect to the markets upon which assets have to be traded to be eligible, the Eurosystem's regulation can be trisected. *(i)* Marketable assets traded on regulated markets, *(ii)* marketable assets traded on non-regulated markets and *(iii)* non-marketable assets (see Section 4.3.3) are accepted. Figure 4.18 shows insights into the Eurosystem Collateral Pool with respect to the reference market, which extend beyond the information published by the ECB. It was described in Section 4.3.3 that the Eurosystem both increased the number of accepted non-regulated markets and deemed eligible additional asset types traded on those non-regulated markets. The two policy directions show their impact in Figure 4.18. Assets traded on non-regulated markets make up a significant share of newly-eligible assets, especially in the months after the Lehman default.

Figure 4.17: Newly-Eligible Marketable Assets and the Collateral Pool by Denomination

The figure shows the development of newly-eligible collateral (left panel) and the collateral pool (right panel) according to denomination from 2007 to 2013. EUR denomination is distinguished from eligible foreign currencies (GBP, JPY and USD). Eligibility of foreign currency assets contributed to the broadening of the eligible collateral pool twice, at the eligibility decision in fall 2008 and with the renewed eligibility in November 2012.



Source: author's calculation; ECB, Eligible Assets Database.

Furthermore, the fraction of assets traded on non-regulated markets on the eligible collateral pool increased relatively and peaked at 12.8% in October 2012.

A quantification of the last-named *(iii)* eligible non-marketable assets is eo ipso extremely difficult, if not impossible, whereby the Eligible Assets Database of the Eurosystem – which is the basis for the analyses in this dissertation – does not contain non-marketable assets.[182] However, it is known from data published by the ECB that the fraction of non-marketable assets used as collateral in refinancing operations with the Eurosystem is quite significant, especially during the European sovereign debt crisis, when it peaked at 27% (or EUR 668.4 billion) in the third quarter of 2012.[183]

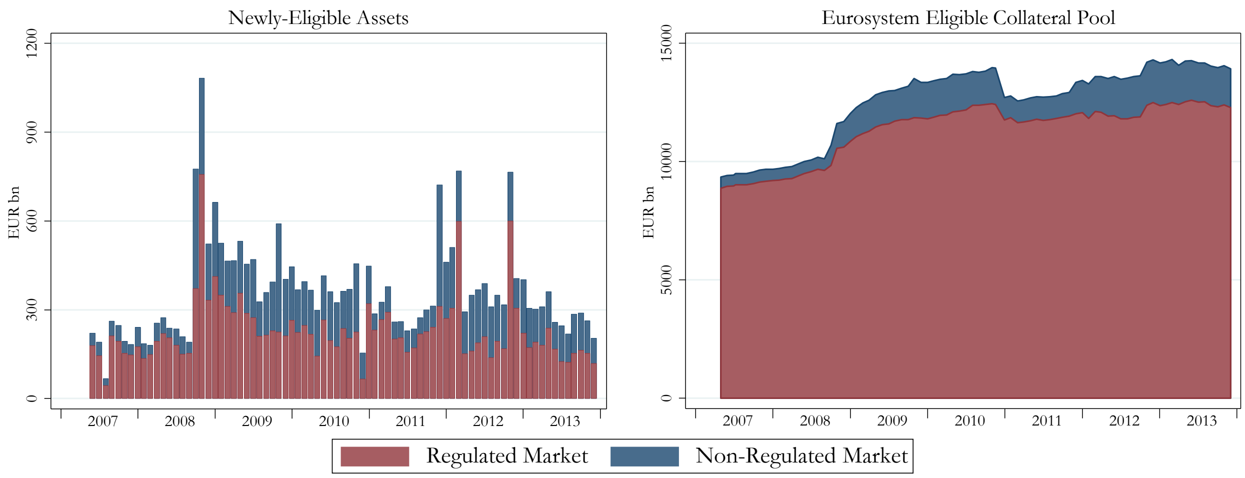
4.6.5 Development According to Residual Maturity

The collateral policy measures conducted by the Eurosystem led to a changing residual maturity structure of the assets contained in the eligible collateral pool, as Figure 4.19 reveals.[184] Eligible assets have been of an average residual maturity of 5.5 years in May 2007, which has reduced over the crisis years to 4.6 years in December 2013. The reduction can be the result of either a lower average duration of assets deemed additionally eligible, or a changed issuance behavior in the market, towards assets of shorter durations. The red line in Figure 4.19, showing the average residual maturity of newly-eligible assets, indicates a combination of both. While the acceptance of STEPs as of October 2008 (cf. Section 4.3.3.1), explains much of the reduction, the still-reduced average residual maturity during 2011 (when STEPs were temporarily ineligible) shows that newly-issued assets were also of a relatively low duration compared to pre-crisis levels, see also Section 9.5.

[182] See Section 4.3 for details on the development of eligibility criteria for non-marketable assets.
[183] See ECB, "Use of Collateral and Outstanding Credit", *Eurosystem Collateral Data*, `https://www.ecb.europa.eu/paym/coll/charts/html/index.en.html`, last accessed March 14, 2016; cf. also Figure 4.21.
[184] The figure shows the nominal value-weighted average residual maturity. Moreover, 57 government bonds, covered and uncovered bank bonds as well as corporate bonds – which were denoted to mature in 9999 – have been excluded from the analysis to avoid a distorted picture.

Figure 4.18: Newly-Eligible Marketable Assets and the Collateral Pool by Reference Market

The figure shows the development of newly-eligible collateral (left panel) and the collateral pool (right panel) according to the type of the reference market the collateral is traded on. Regulated and non-regulated markets are differentiated. Especially in the reaction to the financial crisis, a lot of collateral traded on non-regulated markets became eligible. The fraction of the eligible collateral traded on non-regulated markets increased to 12.8% in October 2012.

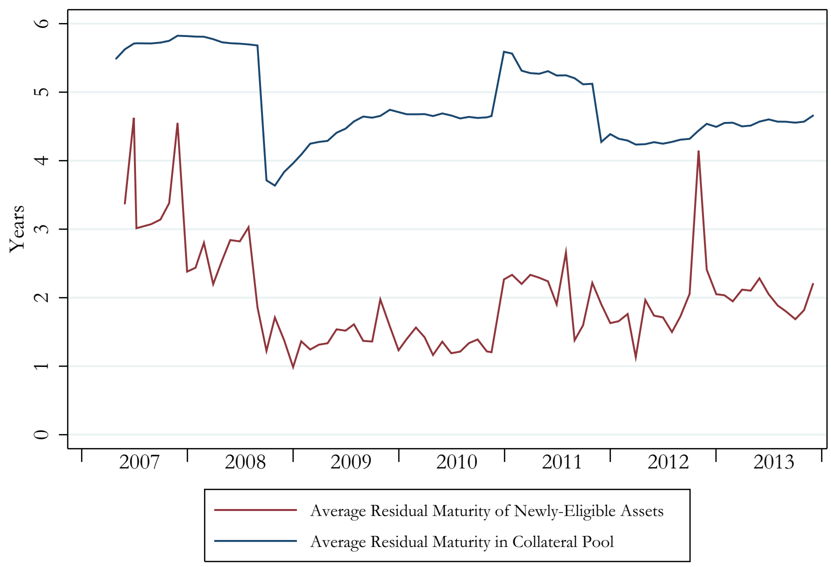


Source: author's calculation; ECB, Eligible Assets Database.

Newly-eligible assets had an average residual maturity of 3.4 years in May 2007, which reduced to 2.2 years in December 2013. The spike of the red line in late 2012 is due to the renewed eligibility of foreign currency-denominated assets (cf. Section 4.3.1.2), which were of all kinds of residual maturities.

Figure 4.19: Average Residual Maturity of (Newly-)Eligible Marketable Assets

The figure shows the average residual maturity of newly-eligible marketable assets and in the Eurosystem Collateral Pool. It decreased from 5.5 years in May 2007 to 4.6 years in December 2013 for the pool. The figure for only newly-eligible assets fluctuated considerably, reflecting both changing collateral criteria and changing issuance behavior. The latter were of an average residual maturity of 3.4 years in May 2007, which reduced to 2.2 years in December 2013.



Source: author's calculation; ECB, Eligible Assets Database.

4.6.6 Summary: Horizontal and Vertical Broadening of the Eligible Assets Pool

The descriptive analysis of the previous sections shows that the collateral policy measures conducted by the Eurosystem between fall 2008 and the end of 2013, as summarized in Section 4.4, mirror in the development of the Eurosystem eligible collateral pool. The pool changed both in size and composition. In particular, it was broadened at the extensive (horizontal dimension) as well as at the intensive margin (vertical dimension), i.e. with respect to the quantity of eligible assets but also their quality. Figure 4.20 offers an impression of the relative importance of the dimensional increases. The pre-crisis level of the pool size in September 2008 – measured by its nominal value – has been set to 100. Based on that level, the blue line shows the broadening along the horizontal dimension. It includes the eligibility of new asset types as well as the eligibility of foreign currencies and the eligibility of assets traded on non-regulated markets. The blue line sharply increases after the breakout of the financial crisis and has subsequently remained at a high level. The exception is a dip in 2011 and a slightly lower level for most of 2012 owing to the temporary ineligibility of STEPs and foreign currency denominations. This confirms the role of the ECB as a LOLR – which it took during the heyday of the financial crisis – if one applies the categorization introduced along the lines of Table 2.2. Both the contributions of foreign currency denomination and non-regulated markets are additionally depicted explicitly in dashed lines. Of course, to the extent that foreign currency-denominated assets or those traded on non-regulated markets are of lower credit qualities, they are also included in the vertical broadening, depicted by the red line. The red line – showing how the qualitative broadening of eligibility criteria finds its way into the eligible assets pool – increases much more slowly than the blue one. Hence, although the lowering of the minimum credit rating threshold was already undertaken for most assets in October 2008, the deterioration of the quality in the collateral pool proceeded rather gradually. The shifting of the intensive margin of the pool – in other words, the vertical broadening – represents the MMOLR role along the lines of Table 2.2, which the Eurosystem took in particular in managing the European debt crisis. From 2010 onwards, measures to qualitatively extend the collateral pool and loosen collateral policy, e.g. the suspension of the minimum credit rating threshold for some crisis countries, led to an intensification of the increase of the red line. In addition, a changing market behavior reacting to the collateral policy of the Eurosystem contributed to the increase of the eligible assets pool. This market impact is elaborated in Chapter 9.

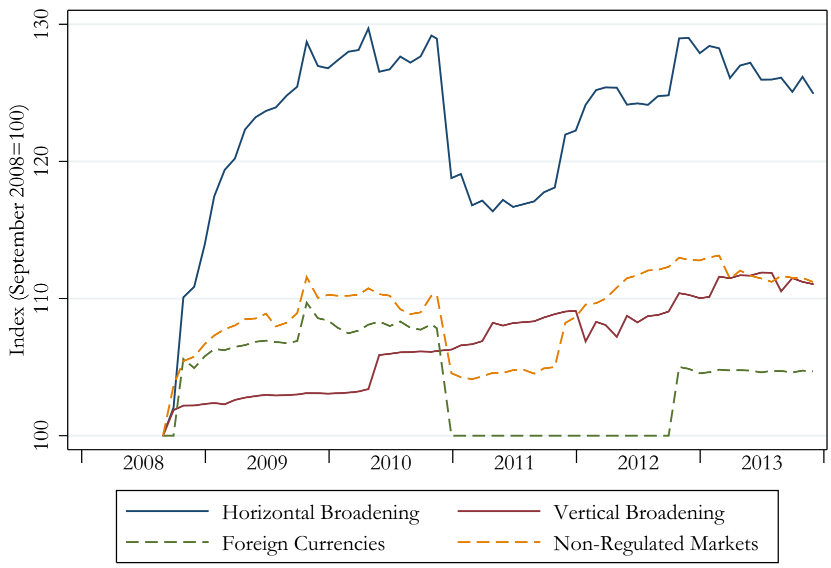
4.7 Findings Regarding the Objectives Pursued by the Eurosystem

In order to summarize the insight on the objectives (cf. Part I), the Eurosystem targeted through its collateral policy, the information provided throughout this chapter is now classified according to Table 2.2.

At the horizontal dimension of the range of eligible asset types, the Eurosystem already maintained a very broad eligible assets pool before the financial crisis broke out. Nevertheless, with the acceptance of foreign currency denominations in November 2008, a horizontally-broadening LOLR measure was made. Other horizontally-broadening measures in the aftermath of the Lehman event, were selectively targeted, in particular to the banking sector and included both marketable assets (e.g. bank bonds on non-regulated markets) and non-marketable assets (e.g. fixed-term deposits). Later on – and especially throughout the European debt crisis – the MMOLR character grew due to

Figure 4.20: Horizontal and Vertical Broadening of the Eurosystem Collateral Pool

The figure shows the broadening of the collateral pool along the horizontal and the vertical dimensions (cf. Table 2.2), which resulted from the collateral policy measures conducted by the Eurosystem. Quantitatively-broadening (increasing the range of eligible assets) and qualitatively-loosening collateral policies are thus covered and quantified in the figure. In addition, the broadenings by accepting additional non-regulated markets and foreign currencies, which were described above, are shown separately (dashed lines). While quantitative broadening is driven by the LOLR measures, which took strong effect early after the breakout of the financial crisis, the qualitative broadening happened more gradually, as the Eurosystem acted as a MMOLR in particular during the European sovereign debt crisis.



Source: author's calculation; ECB, Eligible Assets Database.

the selective targeting of asset types. This has been illustrated by Figure 4.10. The first peak of horizontal broadening in Figure 4.20 can thus at least be partially attributed to LOLR behavior, while the second follows MMOLR activity.

Prior to the financial crisis, the quality of the eligible collateral pool was restricted to assets of CQS 1, the highest step according to the Eurosystem's harmonized rating scale (cf. Figure 4.2.4.3), thus in line with the Eurosystem's monetary stability objective. However, collateral policy along the vertical dimension of asset qualities also gained importance throughout the European debt crisis period, as illustrated by Figure 4.20. Although the lowering of the minimum credit rating threshold already took place in October 2008, the qualitative broadening particularized only later. While the initial measure might have been intended as following the inertia principle during the turmoil – also indicated by the initial time limitation – the focus on fiscal and economic stability gained strength because the qualitative lowering was prolonged and spurred by the selective suspension of minimum credit rating thresholds, the maceration due to the acceptance of DBRS and the introduction of idiosyncratic criteria.

There is no restriction of the asset ages targeted by the collateral policy of the Eurosystem along the time dimension, which is in line with the COMPR role. However, a LOLR would like to primarily target already-issued assets. Through the acceptance of own-use assets (both covered and uncovered), as well as the acceptance of non-marketables, the Eurosystem might to the contrary have rather encouraged new issuances. Section 9.5 digs out confirmatory evidence from the eligible assets pool.

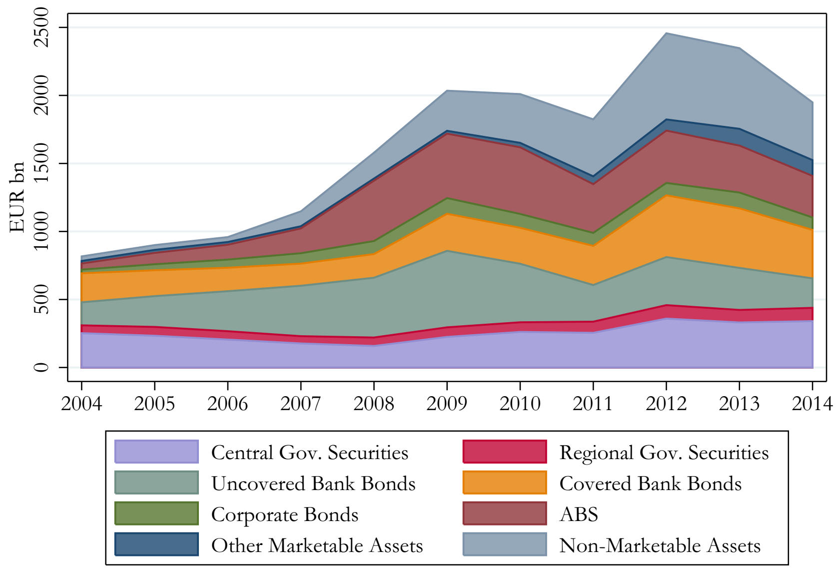
The operational conditions adjusting the value level of eligible collateral relative to the market are soft with respect to the acceptance of theoretical valuation, pooling systems for collateral maintanance and close links allowance. Only occasionally – and only since 2009 – have restrictions on the maximum pledgability of an asset type been made, such as for uncovered bank bonds (see Section 4.3.4.2). Furthermore, the impact power of collateral policy was fueled by the abolition of variable-rate tenders (auctions) in behalf of full allotment at a low fixed policy rate without a premium in liquidity-providing operations of increasing frequency, the extension of loan maturities, as well as the ever prolonged and ultimately permanent offering of these conditions. The specification of haircuts has a crucial and role-distinguishing (with respect to Table 2.2) importance in this context, even more since the Eurosystem does not lend at a premium and has refrained from auctioning funds since the outbreak of the financial crisis. The Eurosystem's practice of haircut-setting was described in detail in Section 4.5 and evaluated in Section 4.5.6. While in principle all normative propositions are met by the Eurosystem's haircut specification, the clustering approach – which does not precisely take asset characteristics into account and leads to segmental pooling (cf. Section 4.5.7) – is likely to favor some assets relative to the market while discriminating others. Furthermore, the haircut specification suffers from its rigidity, i.e. market developments and turmoil are not dynamically included. For instance, a reaction in terms of haircut-setting to the financial turmoil of the fall of 2008 only occurred in February 2009 and a general revision was not undertaken before January 2011. However, even though European sovereigns were in the midst of a debt crisis at the time, haircuts on government securities of all assets were not changed. Chapters 7 and 8 will elaborate upon the effects of the Eurosystem's segmentally-pooled haircuts in further detail, arguing that resulting refinancing conditions are likely to undercut market conditions for some assets, such that market-making towards fiscal and economic stability would prevail.

It is difficult to infer from the counterparties' choice of pledged collateral on the relation of Eurosystem operational conditions to market conditions, because published information on pledged collateral is scarce, as Figure 4.21 reveals.[185] The data is only available on a yearly frequency, not detailed regionally, nor by quality. The analyses in Part III will thus make theoretical predictions, as well as inferring on the regional and quality distributions of collateral pledged to the Eurosystem. Moreover, Chapter 9 uses available information on market developments to detect changes in market behavior that could identify an impact of the Eurosystem's collateral policy. The comparison of Figure 4.21 with the published data on the eligible collateral pool (Figure 4.14) highlights the following notable aspects. First, in 2008, the fractions of bank bonds (45%) and ABS (32%) pledged are much higher than the respective fractions in the eligible collateral pool (bank bonds: 31%, ABS: 10%), while the fraction of government securities pledged (15%) is much lower than in the pool (45%). As 2008 is overwhelming a non-crisis year,[186] this indicates rather attractive operational conditions for the first-named assets compared to government securities. Second, while ABS loose importance in the pledged data (remind the initially tightening collateral policy on ABS), the fraction of bank bonds pledged increases to 48% during the first financial crisis year. This confirms the impression from the description of the supportive collateral policy with respect to bank bonds.

[185] The comparison is easier for other central banks, which offer more details, as shown in Chapter 5.
[186] Depicted data refers to end of month averages.

Figure 4.21: Published Information on Pledged Collateral

The figure shows the (scarce) publicly available data on collateral pledged to the Eurosystem. In comparison to Figure 4.14, the overproportional use of bank bonds during the financial crisis and government assets during the European debt crisis stand out. The declining fraction of ABS and the increasing fraction of non-marketables (including credit claims) are also remarkable.



Source: author's illustration; ECB.

An increasing fraction of non-marketable assets (including credit claims) adds to the impression of attractive conditions for the bank assets. Third, the fraction of government securities pledged more than doubles and peaks at 25% during the European debt crisis. This, also confirms the impression from this chapter that selective collateral policy favored (lower-quality) government assets.

Finally, the dimensions of flow-back and access window (cf. Table 2.2) yield the following. The Eurosystem exclusively offers liquidity as a counter-asset in its refinancing operations. This is related to the uniformity of the collateral framework regarding operations. There are neither differing collateral sets nor special facilities targeted at different central bank objectives, as will be presented for other central banks in Chapter 5. Moreover, the Eurosystem did not sterilize its liquidity provision. Therefore, from the perspective of the flow-back dimension of collateral policy, a classification into only one of the three central bank objectives is difficult. The policy rather fits all three objectives if assessed along this dimension. Solely the establishment of swap arrangements with other central banks in order to additionally provide liquidity in foreign currency can be clearly attributed to a LOLR role. Similarly, the wide set of eligible counterparties defined by the Eurosystem best matches the financial stability objective.

Chapter 5

A Comparative View on International Collateral Policy in Crisis

The financial turmoil of 2007 and 2008 and the subsequent Great Recession affected financial markets and economies worldwide. Therefore, this chapter takes a closer look at responsive collateral policy measures of important international peers of the Eurosystem, namely the Fed (Section 5.1), the BoE (Section 5.2) and the BoJ (Section 5.3). In the following, the importance of collateralized lending (relative to outright purchases) at these three central banks, the state of their collateral frameworks before the breakout of the financial crisis and the collateral policy measures since then (until the end of 2014) are unrolled. Moreover, the collateral policies of the three considered central banks are evaluated along the lines of the normative framework established in Chapter 2. Finally, the analysis enables a comparative view of the collateral policy of the Eurosystem (Section 5.4), which has been described in Chapter 4.[187] The findings are condensed into six observations: *(i)* Collateral policy played differing roles among central banks, the greatest at the Eurosystem, temporarily pronounced but generally minor at Fed and BoE and a relatively constantly secondary role at the BoJ. *(ii)* Central banks started from collateral frameworks of diverse peculiarities in 2007. Uniform and wide frameworks at the Eurosystem and the BoJ contrasted a uniform and narrow framework at the BoE and a differentiated framework at the Fed. *(iii)* The central banks discussed in this dissertation focused on diverging objectives: while the BoE and the Fed used collateral policy as a LOLR and at most took the role of a catalytic MMOLR in a subordinated way, the Eurosystem and the BoJ can be attributed a stronger MMOLR role in the sense of Table 2.2. *(iv)* All considered central banks but the Eurosystem developed some kind of differentiation within their collateral policy, such that different collateral sets and/or different (special) facilities emerged. This empowered them to partition their role-taking. *(v)* Moreover, the approach on definitions of operational conditions differed: BoE and Fed mostly auctioned funds or lent at a premium, diverging from the Eurosystem's and the BoJ's approaches. *(vi)* Most collateral policy

[187] Similar comparative discussions of collateral policies of international central banks can be found in e.g. Bank for International Settlements (2015), Borio and Nelson (2008), Chailloux et al. (2008a,b), Cheun et al. (2009), Nyborg (2015), and Rule (2012). Furthermore, there are contributions focusing on the collateral policy measures in certain countries, e.g. Anderson et al. (2010) on Iceland and Sweden, Debelle (2008) on Australia, Zorn and García (2011) on Canada, as well as Fuhrer et al. (2015), Gerlach and Jordan (2012), and Jordan et al. (2009) on Switzerland.

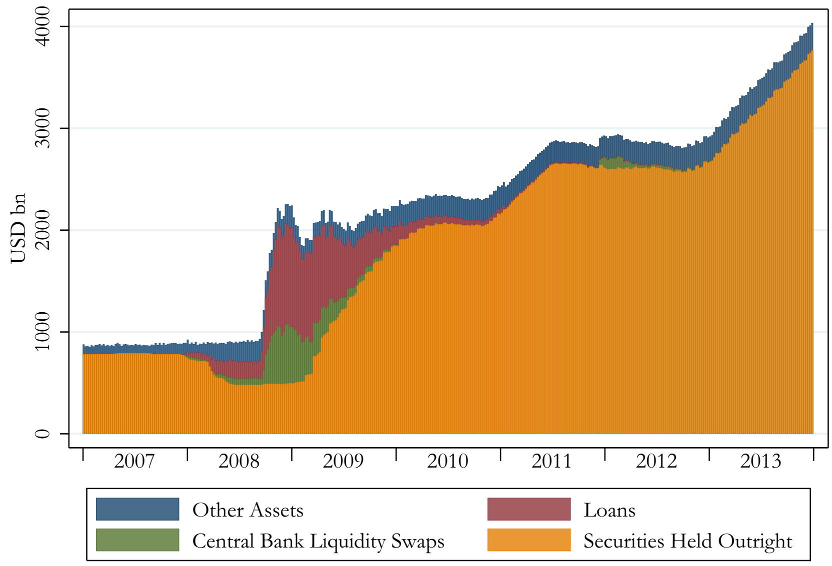
measures taken by Fed, BoE and BoJ were temporary, while the Eurosystem made many of the measures taken within its Temporary Framework permanent, as discussed in Chapter 4.

5.1 Federal Reserve System

The Fed conducts its policy primarily through outright asset purchases, cf. Figure 5.1. Prior to the recent financial crisis, the Fed conducted these purchasing-based OMOs with few primary dealers and against a relatively small range of collateral (e.g. Blenck et al., 2001).[188] The number of primary dealers has fluctuated between 17 and 46 since 1960, reaching the all-time low of only 17 eligible counterparties for most Fed operations in the crisis year of 2008. The eligible collateral for OMOs comprised Treasury securities, agency securities and agency mortgage-backed securities (MBS) and hence purely government or government-related assets, such as those issued by Federal Land Banks, the US Postal Service, Ginnie Mae, Freddie Mac or Fannie Mae. As is visible from Figure 5.1, loans played a large role in the Fed's policy compared to outright purchases during the crisis years of 2008 to 2010. Collateral requirements for these loans differed from the above-named and the Fed conducted several collateral policy measures during that time. This section will concentrate on the Fed's collateralized lending and relevant policy measures in the following.

Figure 5.1: Federal Reserve System Assets

The figure shows the development of the Fed's balance sheet from an asset side perspective between 2007 and 2013. While more than quadrupling in size, outright asset purchases are the overweighing instrument used by the Fed. However, during the crisis years of 2008 to 2010, collateralized lending played a large role, such that collateral policies hold importance during that time.



Source: author's illustration; Fed, Statistical Release, Factors Affecting Reserve Balances (H.4.1), Table 1.

The only existing facility through which the Fed was offering collateralized lending before the financial crisis breakout was the discount window. Eligible sets of counterparties and collateral for the discount window were much broader. According to Chailloux et al. (2008a), around 7,500 banks and depository institutions qualified for access before September 2008. In addition to the

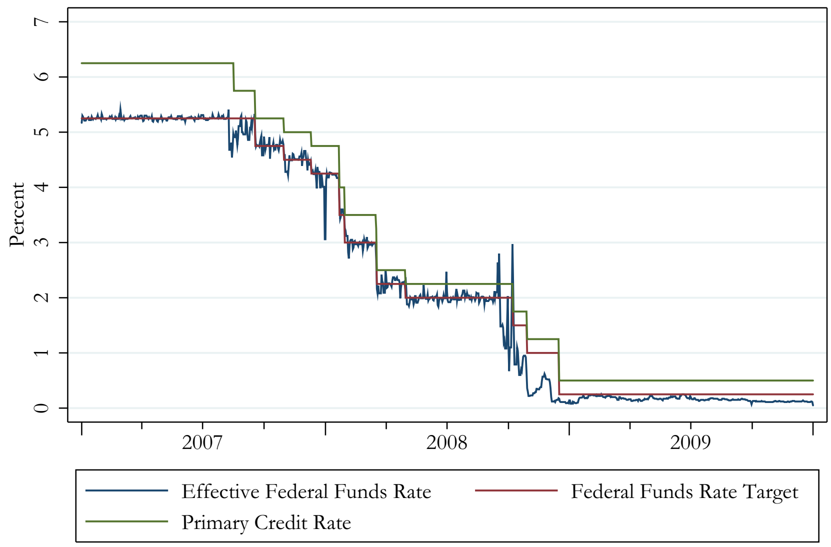
[188] Unless indicated otherwise, the information included here can be found on the websites of the Federal Reserve System and the Federal Reserve Banks, last accessed October 9, 2015.

above-named eligible collateral for OMOs, eligible collateral included investment-grade (i.e. down to Triple B-rated) assets such as state and local government securities, consumer loans, commercial and agricultural loans, mortgage notes on one-to-four-family housing.[189] In 1999 the range was expanded to investment-grade certificates of deposit, Triple A-rated CMBS and Triple A-rated collateralized mortgage obligations.

Banks have always been reluctant to borrow from the Fed's discount window due to a stigma attached to it.[190] Borrowing through the discount window was not only punished by a penalty rate, but also by non-anonymity and often special assessments and requirements. Figure 5.2 shows the development of the interbank Federal Funds Rate versus the discount rate. The Fed tried to counteract to the stigmatization in 2003 when it reformed the discount window into a no-questions-asked facility. Since then, the liquidity provision through the discount window has been organized into Primary, Secondary and Seasonal Credit. The third-named is usually granted at around 100 basis points above the Federal Funds Rate and overnight. Secondary Credit is available to banks that do not qualify for Primary Credit, at a higher rate of around 150 basis points above the Federal Funds Rate. The last-named credit is given to small depository institutions connected to agricultural companies, which are exposed to seasonal fluctuations.

Figure 5.2: Federal Reserve System Policy Rates

This figure shows the development of the Federal Funds Rate, the interbank market rate versus the level the Fed targeted for this rate and the Primary Credit Rate at the Fed discount window during the crisis period from January 2007 to December 2009. The data is daily. All rates come down to levels close to zero. At times the Effective Federal Funds Rate was higher than the discount rate, making facilities using the discount rate as the interest rate relatively more attractive.



Source: author's illustration; Fed, Federal Reserve Economic Data (FRED).
Note: Federal Funds Rate Target defined as upper limit since 16 December 2008.

The already very loose collateral requirements at the Fed's discount window were further extended in the wake of the financial turmoils, when the Fed had to fulfill its LOLR role. Primary Credit

[189] For details on the Discount Window, compare Fed of New York, *The Discount Window*, Fedpoint, July 2015, `https://www.newyorkfed.org/aboutthefed/fedpoint/fed18.html`, last accessed April 14, 2016.

[190] For descriptions of the stigma of the discount window, see e.g. Chailloux et al. (2008b), Gagnon and Hinterschweiger (2013), Gorton and Ordooez (2014), and Le Maux and Scialom (2010).

was given at only 50 basis points above the Federal Funds Rate for up to 30 days from August 2007 and for up to 90 days from March 2008. The over-collateralization requirement for longer-term credit was lowered such that rather than only 50% of the collateral value, banks could receive loans to the amount of up to 75%. Valuation of collateral was only undertaken weekly until January 2009, a favoring rule for counterparties compared to the practice of other central banks. Term Deposits banks held with the Fed could be used as collateral from May 2010, as well as US Treasury Floating Rate Notes since January 2014. From December 2009, senior unsecured debt issued under the Temporary Corporate Credit Union Liquidity Guarantee Program became eligible. This last measure also contains a MMOLR element because it aims at liquidity provision to a distinct market segment.

Nonetheless, reluctance to borrow from the discount window persisted (e.g. Jobst, 2009). Moreover, the interbank market was frozen and the transmission of credit to the economy dried up. The Fed thus manifolded its differentiated collateralized lending framework through the implementation of various special facilities to complement the discount window, stepping in as a LOLR, as well as in the role of a MMOLR, as described in the following.[191]

5.1.1 Term Auction Facility

The Term Auction Facility (TAF) was the first special lending facility that the Fed introduced in December 2007, in the wake of financial market turbulence of fall 2007.[192] It was discontinued in March 2010. The eligible collateral – including the haircuts applied – was exactly the same as in the Primary Credit program of the discount window. Furthermore, eligible counterparties were depository institutions in generally sound financial condition (judgment made by the respective District Fed) and eligible to borrow under the Primary Credit program.

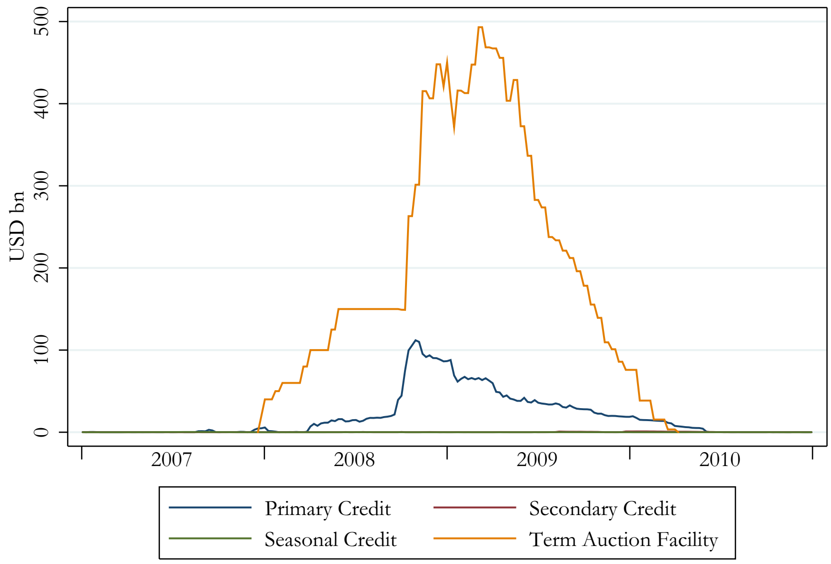
Hence, the TAF was clearly installed as an alternative to the regular discount window, which was established due to the reluctance of banks to borrow from the regular one. It was targeted at the same counterparty set at the same conditions regarding collateral criteria as the regular discount window. A notable difference is that TAF credit was auctioned every other week by volume tenders of up to USD 150 billion and an individual counterparty could at most receive a loan amount of 10% of the tender. As a result, conditions were worse compared to the standing discount window facility, although nevertheless the demand for TAF credit was higher, thus confirming the stigmatization of discount window lending (Armantier et al., 2011). Figure 5.3 shows the development of TAF credit compared to regular discount window credit. The amount provided through the TAF vastly exceeds the regular discount window, which until August 2008 is of negligible magnitude. Liquidity at the TAF was initially provided for 28 days, while from August 2008 this was prolonged to 84 days.

Although it was a special facility, the TAF genuinely supported the LOLR role of the Fed. The eligible sets of collateral (horizontal dimension, cf. Table 2.2) and counterparties (access window dimension) were wide but not specialized or even altered at all (inertia principle, vertical dimension). Operational conditions were overall similar regarding the borrowing rate and the refinancing

[191] See also Cheun et al. (2009) and Selgin (2012), who argue that the changes to the collateral framework of the Fed implied in the introduction of special facilities were necessary to fulfill the role of a LOLR in the first place.
[192] See Benmelech (2012), for a detailed discussion of the TAF.

Figure 5.3: Discount Window versus Term Auction Facility Credit

This figure shows the development of liquidity provided by the Fed through its regular discount window (primary, secondary and seasonal credit) versus the liquidity provided through the TAF (weekly averages). During the time of operation of TAF (December 2007 to March 2010), credit drawn through the special facility was always a multiple of the borrowing through the regular discount window, which was perceived as stigmatizing.



Source: author's illustration; Fed, Statistical Release, Factors Affecting Reserve Balances (H.4.1), Table 1.

conditions were even tighter compared to the regular discount window, which itself was already offered at a penalty rate (value-level dimension). Nevertheless, only through the TAF could the Fed really address the liquidity demand of banks during the financial crisis, due to a stigma prevailing at the standing discount window facility.

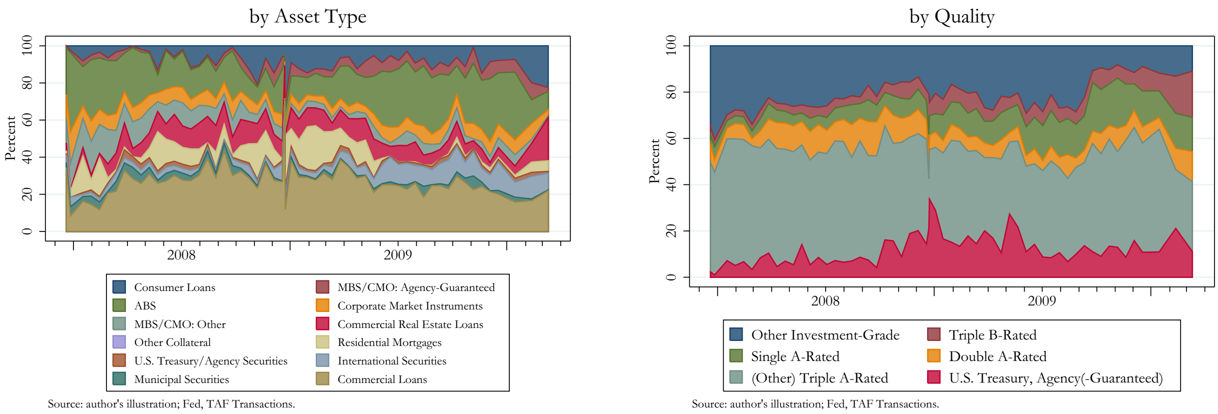
From Figure 5.3, it becomes clear that banks seemed to perceive less of a stigma during the crisis peak of fall 2008 after the experience of the TAF lending. The LOLR role seemed freed up, even through the regular discount window. The left panel of Figure 5.4 shows the distribution of collateral types pledged in TAF, reflecting the wide range of eligible collateral. Developments suggesting a preference for some collateral types cannot be seen. From the perspective of collateral quality (see the right panel of Figure 5.4), it is confirmed that as advised by the inertia principle (cf. Section 2.3) no extensions of eligible qualities were made, as all collateral qualities are represented throughout the period of the TAF. The weakly identifiable shift towards lower collateral qualities should be seen in conjunction with the decreasing amounts provided through TAF since early 2009. As banks turned to the interbank market as a liquidity supply again, they chose to use their better quality collateral there, while taking the lower qualities to the central bank. This phenomenon of collateral pledged at the central bank being adversely selected is explained in further detail in Section 7.2.

5.1.2 Primary Dealer Credit Facility

In March 2008, the Fed established the Primary Dealer Credit Facility (PDCF), which provided short-term (overnight) liquidity to the small group of primary dealers (see above) until February

Figure 5.4: Collateral Used in the Term Auction Facility

The left panel of this figure shows the asset types pledged as collateral for loans from the TAF, representing the wide range of eligible collateral. Developments suggesting a preference for some collateral types cannot be identified. However, public sector assets only make up a very small fraction of the pledged collateral. This should be seen in conjunction with the predominant role of government securities in outright asset purchases of the Fed, see Figure 5.1. A large share of pledged assets is non-marketable (loans). The right panel of this figure shows the distribution of qualities of assets pledged to the TAF. Most assets are of the highest possible quality. As the inertia principle was followed in the TAF (no further extension of eligible asset quality), all asset qualities are represented over the entire period of TAF operation. "Other Investment-Grade" marks qualities based on a credit review by a District Fed. The weakly identifiable shift towards lower collateral qualities should be seen in conjunction with the decreasing amounts provided through TAF since early 2009. As banks turned to the interbank market as a liquidity supply again, they chose to use their better quality collateral there, while taking the lower qualities to the central bank.



2010.[193] Eligible collateral for primary dealers was usually restricted to Treasury securities, agency securities and agency MBS. Given that this collateral was (more or less directly) connected to the government, quality – as measured by credit ratings – was rather high.

With the introduction of the PDCF, eligible collateral for the set of counterparties comprising primary dealers was extended to a larger set of asset types. Similarly to the discount window or the TAF, corporate market instruments and asset-backed securities were included in the eligible collateral pool of the PDCF (see left panel of Figure 5.5 for an overview of collateral types used in the PDCF). Even equities could be used in PDCF. However, all collateral had to be of an investment-grade rating restricting the eligible collateral set along the vertical dimension. The right panel of Figure 5.5 shows the distribution of credit ratings of assets used in the PDCF and reveals that a large majority of them was still of high quality until September 2008.

The collateral criteria for the PDCF were then additionally loosened after the collapse of Lehman Brothers in September 2008. Since then, closely all types of instruments that could be pledged in tri-party repo on private markets,[194] can be used (Allen and Moessner, 2012). The quantitative extension is clearly visible in the left panel of Figure 5.5, whereby especially the larger fractions of corporate market instruments and municipals, as well as the newly-appearing equities, loans and other asset types stand out. The extension of eligible collateral was also connected to a significant increase in the amount lend out through the PDCF (see Figure 5.6). In late September

193 See Adrian et al. (2009), for a detailed discussion of the PDCF.
194 See Section 7.1.1 for more details on tri-party repos.

2008, the loan amount peaked at USD 156 billion. However, most pronounced was the change in the distribution of ratings (see right panel of Figure 5.5). The fraction of collateral rated Triple A declined to below 10% from close to 100%. A large portion of assets accepted was of unknown quality and around one-third of the collateral was rated Triple B or lower, some even below investment grade.

Figure 5.5: Collateral Used in the Primary Dealer Credit Facility

The left panel of this figure shows the asset types pledged as collateral in the PDCF. Initially a lot of mortgage-backed collateral was used. After the demand slack over the summer of 2008, this changed towards more corporate debt (including equities). The development had been made possible through a further horizontal widening of the eligible collateral set in September 2008. The right panel of this figure shows the distribution of qualities of assets used in the PDCF. While most collateral was of highest quality before the demand slack in the summer of 2008, this entirely changed after the Lehman collapse. Counterparties made use of the vertically wide eligible collateral set by pledging significantly lower credit qualities to the central bank.

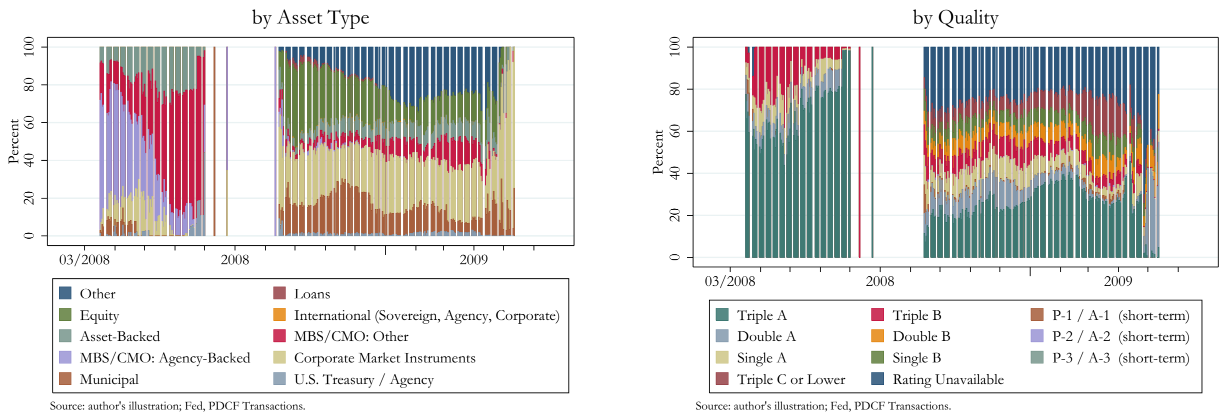


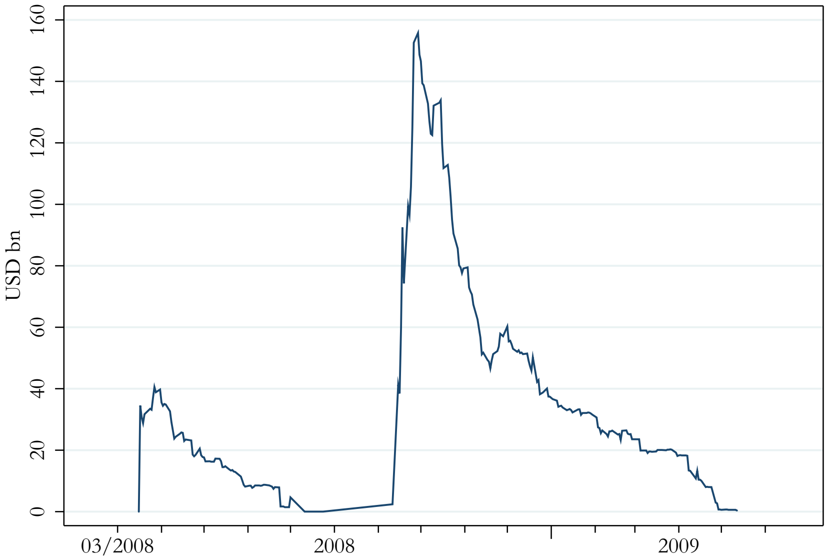
Figure 5.7 shows the average effective haircut applied to collateral pledged in the PDCF. Even though the average collateral quality was much lower after September 2008 than before and the loan volume was also higher, the level of average haircut only increases from around 7% to around 8%. Hence, in addition to the qualitatively- and quantitatively-loosening collateral policy in the PDCF, a loosening of operational conditions might have occurred.[195] Indeed, the haircuts applied under the PDCF were set "lower than those applied by private lenders in crisis times" (Adrian et al., 2009, p. 8). On the other hand, the overall conditions were designed such that the PDCF worked as a "backstop, rather than a principal source of funding", see Adrian et al. (2009, p. 8). The discount rate was used as the interest rate. Under normal conditions, this should ensure that borrowing from the Fed facility was more expensive than the private market. However, as Figure 5.2 reveals, this has not always been true in practice, where the Federal Funds Rate at times exceeded the discount rate. Moreover, the general mistrust in private markets during the crisis or particular doubts regarding the solvency of an institution may have led to a reversal of the funding order intended by the Fed.

Summing up, the PDCF contains elements of collateral policy that extend beyond the LOLR role. First, it is targeted at the rather small group of primary dealers, who receive special refinancing conditions within the differentiated collateral framework, at least in the sense of ELA for the group

[195] Unfortunately, historical documentation of haircut design, to confirm this deduction was not available to the author.

Figure 5.6: Primary Dealer Credit Facility Loan Amount

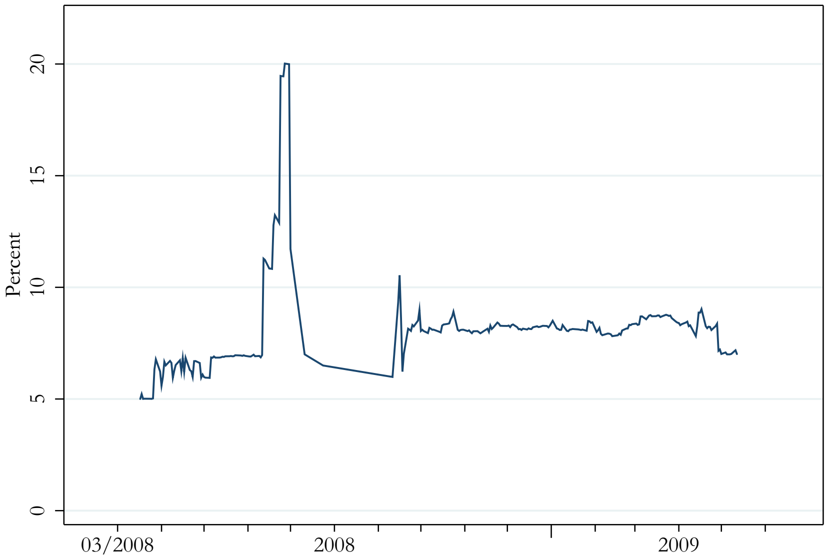
This figure shows the amount of liquidity lent out through the PDCF. Immediately after its introduction, demand soared to around USD 40 billion, before subsequently declining. A drop in demand is visible over the summer of 2008. With the collapse of Lehman in September 2008, demand for liquidity from the special facility – at an even widened eligible collateral set – skyrocketed to more than USD 150 billion. However, the backstop character of the PDCF quickly became apparent because primary dealers reduced their reliance on it over the following eight months.



Source: author's illustration; Fed, PDCF Transactions.

Figure 5.7: Primary Dealer Credit Facility Average Effective Haircut

This figure shows the average effective haircut resulting from the loans made through the PDCF. The value is calculated using the over-collateralization of loans, i.e. the difference between the total collateral market value and the loan amount. cf. also Section 4.5.2. The average effective haircut rests around a level of 7% before the drop in demand for PDCF credit (cf. Figure 5.6) and only increases to a level of around 8% afterwards, despite the significant shift towards lower-quality collateral (cf. right panel of Figure 5.5). Hence, in addition to the qualitatively- and quantitatively-loosening collateral policy in the PDCF, a loosening of operational conditions might have occurred.



Source: author's illustration; Fed, PDCF Transactions.

of primary dealers. In fact, 35% of the loans made through the PDCF went to primary dealers that did not survive the crisis (Bear Stearns, Dresdner Kleinwort, Lehman Brothers and Merrill Lynch), which confirms the doubtful solvency of counterparties. On September 15, 2008, 68% of PDCF loans were granted to Lehman Brothers, which filed for bankruptcy on that same day. Second, the quantity and particularly quality of eligible assets are extended, in contrast to the recommendations of the inertia principle. Third, the effective haircut development indicates that operational conditions might have been supportive to the eligible counterparties for the respective collateral, even though the facility was said to be operated as a backstop and indeed demand ran out almost as quickly as it had risen, cf. Figure 5.6.

In addition, the MMOLR role taken through the PDCF is confirmed by the fact that the PDCF had to be established with reference to Section 13(3) of the Fed Act. Under this section, in "unusual and exigent circumstances", the Fed can grant credit to individuals, partnerships and corporations. At least five out of seven governors on the Fed Board have to vote in favor (e.g. Buiter and Sibert, 2008). As the extended collateral eligible for PDCF loans not only contained assets providing funding to the government or government agencies (as the usual collateral eligible for OMOs) but also assets issued on private credit markets, the liquidity facility indirectly channels credit to the issuers on the underlying asset markets and thus to individuals, partnerships and corporations.

5.1.3 Term Securities Lending Facility

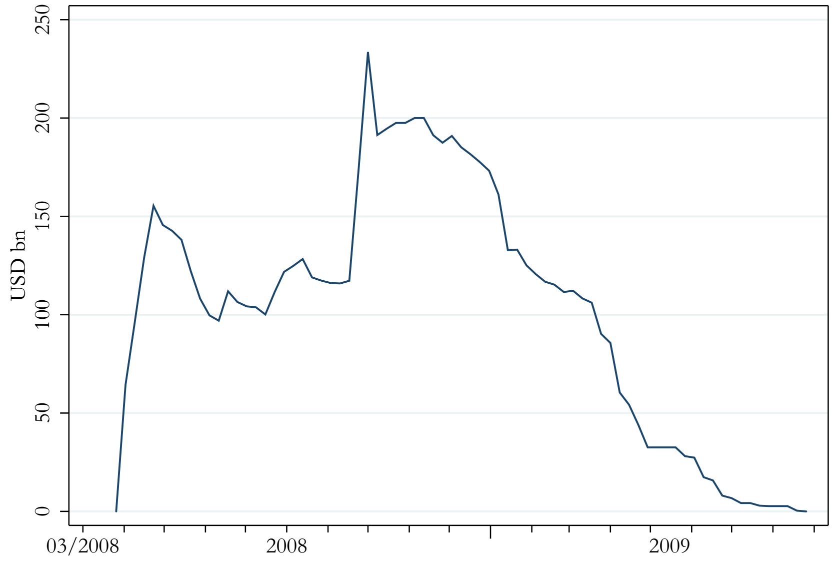
The Term Securities Lending (TSLF) was a collateral swap/lending facility that worked along the same lines as the PDCF.[196] It was active during the same period and also exclusively offered to primary dealers. Counterparties could borrow Treasury securities for one month, subject to a fee, in exchange for eligible collateral. Hence, the facility provided central bank aid for a longer period than the PDCF (which was only overnight), but was allocated through auctions and thus was more competitive. The fee was set such that the borrowing of Treasury securities in the private market would have been cheaper under normal conditions and hence the TSLF would only be attractive in exceptional times. The strong relation of primary dealers on the TSLF nevertheless makes it clear that during the exceptional times of the crisis this was not the case, see Fleming et al. (2009). The facility was differentiated into two schedules. Under Schedule 1 – which implied a lower fee – only collateral eligible for OMOs was accepted for swaps. Schedule 2 initially additionally allowed for highly rated (Triple A) MBS that were backed by private residential or commercial mortgages, as well as other ABS. For the same reasons as discussed above for the PDCF, Schedule 2 of the TSLF thus required the reference to Section 13(3) of the Fed Act. In September 2008, the eligible collateral for Schedule 2 auctions was extended to any investment-grade debt security.

Figure 5.8 shows the course of the total market value of Treasury securities lent out under the TSLF, which peaked in early October 2008 at USD 234 billion. In Figure 5.9, the distributions of asset types and ratings mirror the development of eligibility extensions. While initially only Triple A-rated government-related securities were exchanged, a strong shift towards private securities of worse qualities is visible. When the demand at the TSLF surged in fall 2008, eligible quantities and qualities also pressed into the distribution.

[196] See Fleming et al. (2009), for a detailed discussion of the TSLF.

Figure 5.8: Term Securities Lending Facility Loan Amount

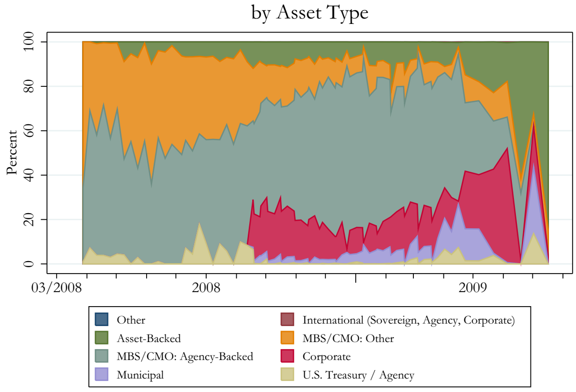
This figure shows the amount lent out through the TSLF. It shows two peaks, one after the introduction of the special facility in April 2008 at just above USD 150 billion and one at USD 234 billion after the Lehman collapse in October 2008. Demand for funds remained high for three to four months but subsequently rapidly declined before the facility was unwound.



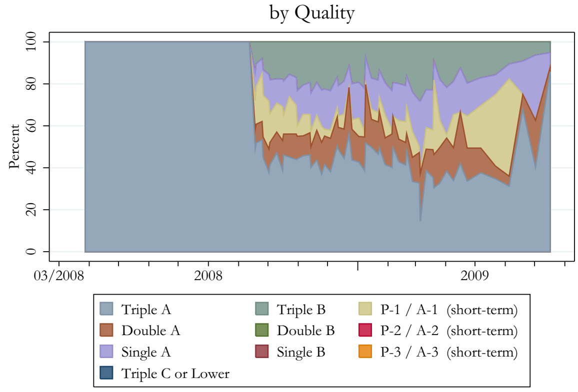
Source: author's illustration; Fed, Statistical Release, Factors Affecting Reserve Balances (H.4.1), Table 1A.

Figure 5.9: Collateral Used in Term Securities Lending Facility

The left panel of this figure shows the asset types pledged as collateral in the TSLF. While initially most collateral was mortgage-backed, after the horizontal extension of the eligible collateral set corporate collateral presses into the picture. In addition, municipal assets and ABS play an increased role. The right panel of this figure shows the qualities of assets used as collateral in TSLF. Only Triple A-rated collateral was eligible initially. With the vertical broadening of the eligible collateral pool, lower credit qualities were used more often than Triple A collateral.



Source: author's illustration; Fed, TSLF Transactions.



Source: author's illustration; Fed, TSLF Transactions.

For the same reasons as the PDCF, the TSLF contains elements stabilizing market segments, although operational conditions were tight and the facility was only temporarily offered. Moreover, the design as a swap facility explicitly aims at aligning relative prices of the swapped assets. Therefore, the collateral policy within this special facility is assigned to the MMOLR role.

5.1.4 Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility and Money Market Investor Funding Facility

Two special facilities that channeled liquidity to money market mutual funds were the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) and the Money Market Investor Funding Facility (MMIFF). In September 2008, the Fed introduced the AMLF, under which eligible counterparties (US depository institutions, US bank holding companies, US broker-dealer subsidiaries of such holding companies and US branches and agencies of foreign banks) could pledge asset-backed commercial papers that had been purchased from money market mutual funds as collateral. The collateral had to be rated at least Single A and denominated in USD. Moreover, the loans were non-recourse loans and hence equipped with very favorable conditions for counterparties. The facility was discontinued in February 2010.

Furthermore, in October 2008, the Fed offered a similar facility to SPVs, which in turn would provide liquidity to money market mutual funds, the MMIFF. However, there were never loans made through the MMIFF, which was dismantled in October 2009. Through both facilities, the Fed aimed to provide funding to a specific market segment directly, circumventing the regular transmission channels. Both facilities thus had to be established referring to Section 13(3) of the Fed Act. The market-making in this case targeted money market mutual funds and thus financial institutions, although Fed lending was also extended to the real economy directly, as described in the following.

5.1.5 Commercial Paper Funding Facility

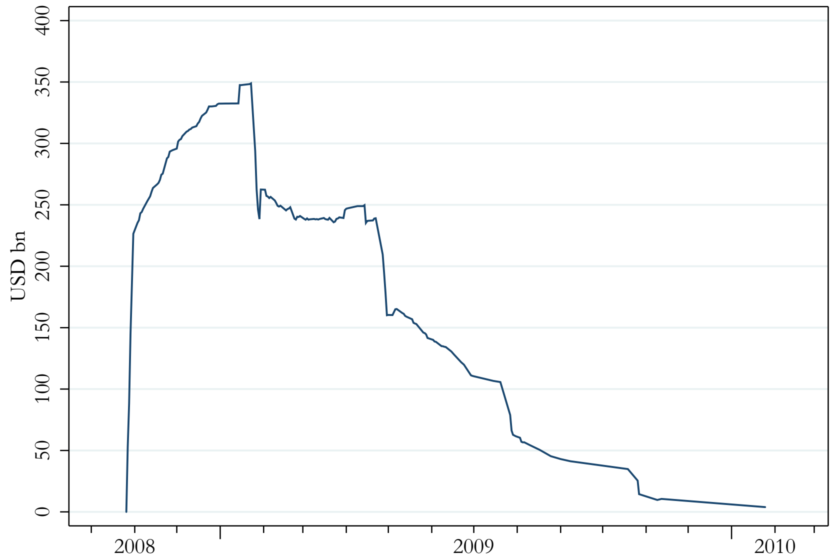
Through the Commercial Paper Funding Facility (CPFF), the Fed supported the availability of commercial credit directly and thus strived to stimulate real economic activity.[197] It was active from October 2008 until February 2010. The provisions of Section 13(3) of the Fed Act were applied. Through the CPFF, the Fed made three-month loans to the CPFF LCC, a specially-created limited liability company, i.e. an SPV. It was funded and operated by the Fed of New York. The CPFF LCC used the central bank liquidity to buy unsecured and asset-backed commercial papers, which were issued by companies on commercial paper markets. The commercial papers again served as collateral for the loans to the CPFF LCC. To be eligible, they had to be rated at least Single A and issuers had to pay a fee to be accepted. Figure 5.10 shows the credit extended to the real economy through the CPFF. It peaked in January 2009 at USD 349 billion. The financing of individual issuers of commercial papers was capped at the maximum amount the respective issuer had outstanding in commercial papers during the period from January to August 2008. Conditions were designed to encourage private market alternatives once market rates were back to normal. Interest rates at the CPFF LCC were set at 200 basis points above three-month market rates (daily three-month Overnight Index Swap rate on LIBOR).

The construction of the CPFF resembles the constructions identified in historical central bank collateral policies, cf. Chapter 3, which also used auxiliary institutions as counterparties to forward credit to distinct purposes in the real economy. As the Fed directly funded commercial activities through the CPFF LCC (circumventing the banking system), a MMOLR cannot be denied from the perspective of the selectively chosen asset types and the non-financial counterparties. Nevertheless,

[197] See Adrian et al. (2011), for a detailed discussion of the CPFF.

Figure 5.10: Commercial Paper Funding Facility Loan Amount

This figure shows the outstanding principal amount of the CPFF. Demand soared after the introduction to around USD 350 billion and subsequently gradually declined, fading out until the beginning of 2010.



Source: author's illustration; Fed, CPFF Transactions.

the dimensions of operational conditions and asset qualities were restricted through the capped amount, which was oriented at existing debt outstanding, the tight conditions and the Single A rating requirement. Furthermore, the facility was (as with all special facilities at the Fed) temporary. Hence, one could also describe the role as a LOLR for a specific segment of the real economy, which should be able to roll-over debt already outstanding in commercial papers (thus the design of the cap). The abating demand visible from Figure 5.10 has a rather catalytic impact on markets.

5.1.6 Term Asset-Backed Securities Loan Facility

The Term Asset-Backed Securities Loan Facility (TALF) complemented the CPFF as a means to "improve the functioning of key credit markets by lending directly to market participants, including ultimate borrowers and major investors", as the Fed chairman at the time Bernanke (2009b) put it.[198] It also was the latest special lending facility that the Fed introduced, operative from March 2009 to June 2010.[199] The facility was exceptional in several respects. First, the non-recourse loans that the Fed made were granted for either three or five years and thus were much longer than the credit provision through all other facilities discussed above. Second, the set of eligible counterparties was not only broad but also special. Any US person or company could receive a loan from the Fed through the TALF, although close links to the collateral were prohibited. Obviously, Section 13(3) of the Fed Act was thus applicable to the TALF. Third, eligible collateral was clearly targeted at real economic activities. However, very strict quality requirements were made, as only collateral carrying at least two Triple A ratings was eligible. Eligible asset types initially comprised newly-issued ABS backed by auto loans, student loans, credit card loans, small business loans,

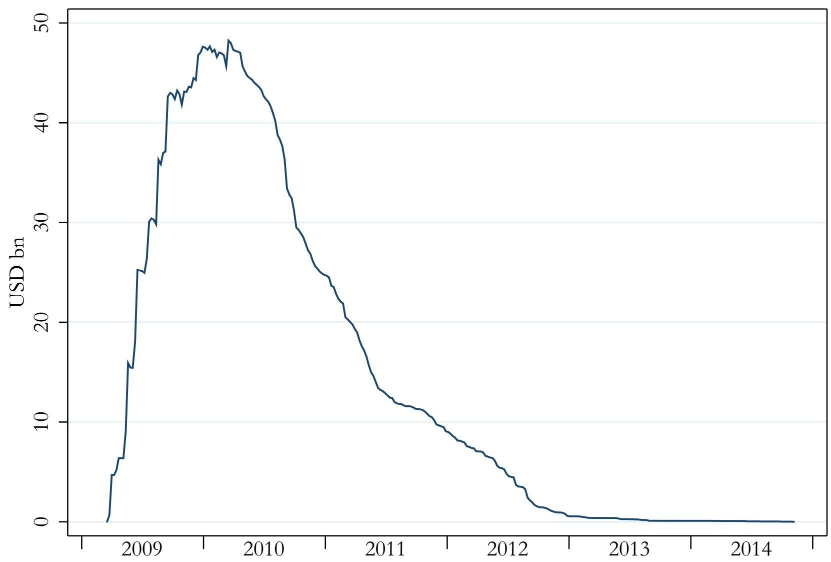
[198] See Ashcraft et al. (2012) for a detailed discussion of the TALF.
[199] Lending collateralized by newly-issued CMBS was authorized until June 2010 while new lending collateralized by all other eligible securities was terminated by March 2010.

mortgage servicing advances, loans or leases relating to business equipment, leases of vehicle fleets or floorplan loans. In May 2009, CMBS (both newly-issued and legacy) as well as ABS backed by insurance premium loans also became eligible. Requiring collateral to be overwhelmingly newly issued openly stated the aim of supporting *new* credit provision and hence new real consumption and investment, particularly concerning smaller businesses.

Conditions were set above market conditions. Interest rates carried a premium of 50-100 basis points over LIBOR swap rates, depending on the collateral type. In addition, initial haircuts were applied on the value of the collateral. Remarkably, no variation margins were applied during the lifetime of the loan, i.e. variations of the market value of the collateral during the lifetime of the loan did not trigger calls for additional collateralization. Most likely, this common provision was waived because every loan was especially made to finance the one specific collateralizing asset, which was thus not substitutable. This is the most extreme form of an earmarking system (cf. Section 2.1). Haircuts were differentiated according to the collateral type (the asset type backing the ABS) and the residual maturity (the average lifetime of the ABS) in a range between 5% and 17%. For comparison, the ECB applied an unique haircut of 12% on ABS as collateral within CQS 1/2 at that time, regardless of the residual maturity. Market reliance on TALF increased steeply after the introduction, see Figure 5.11. It was still relatively high when no new loans were being made due to the discontinuation of the facility in June 2010.

Figure 5.11: Term Asset-Backed Securities Loan Facility Loan Amount

This figure shows the amount of loans made at the TALF. The last repayment was made in November 2014, although no new loans had been made since June 2010. Initially, the demand rapidly increased, albeit at a slight premium over market interest rates. It remained at a high level close to USD 50 billion until the closing of the facility.



Source: author's illustration; Fed, Statistical Release, Factors Affecting Reserve Balances (H.4.1), Table 1.

The Fed acted as a MMOLR through TALF in several respects, cf. the collateral policy dimensions summarized in Table 2.2. For one, the set of eligible collateral was set such that credit was flowing to specific segments of the real economy, in particular consumers and small businesses, albeit the quality requirements were tight. The reason to introduce TALF was a “near-complete halt”, see

Ashcraft et al. (2012, p. 29) in the respective markets in the fall of 2008. For another, in principle the set of eligible counterparties comprised anyone, although the facility operated through TALF agents (financial institutions) and close links to the collateral issuer were prohibited for borrowers. Moreover, newly-issued assets were explicitly targeted (time dimension), such that economic expansion was supported. Finally, the operational conditions were set at a smaller premium than in previously-discussed facilities, remaining a catalytic character of the policy measure to some degree.

5.2 Bank of England

At the time of the outbreak of the financial crisis in 2007, the lending facilities at the BoE comprised overnight standing facility, OMOs (short-term and long-term repos) and intraday settlement systems needed for the functioning of the payment system (see Bank of England, 2006, for details on the pre-crisis monetary policy conduction); the latter will not be included in the following discussion. The range of eligible counterparties differed between the facilities but was only conditional on general criteria, such that access to all facilities was on demand and broad to many institutions that could apply, particularly banks and building societies.[200] In addition to the aforementioned, active intermediaries in the sterling market such as securities dealers could apply for access to the OMOs of the BoE. However, a remarkable condition for being an eligible counterparty was the requirement to maintain at least GBP 500 million in eligible liabilities. This prevented smaller banks from accessing BoE funds. Therefore, one of the collateral policy measures was to abandon this condition and broaden the set of eligible counterparties to also include smaller banks since October 2009.[201]

Figure 5.12 shows that a substantial amount of the monetary policy operations of the BoE was achieved through the lending facilities until 2009, whereas more recently the quantitative easing programs led to an overwhelming part of the BoE balance sheet comprising assets purchased outright. The targeted interest rate – the official bank rate – was only offered in short-term OMOs. The standing facility was offered at a penalty rate, i.e. a rate that would be above the official bank rate under normal circumstances. It came closest to a discount window, which was otherwise non-existent and hence banks could only tap this overnight facility in case of a liquidity shortage.[202]

The collateral framework applied by the BoE before fall 2007 was uniform across all facilities, all of which offered central bank money against collateral, i.e. no swap facilities existed. Both from a quantity and quality perspective – i.e. at the horizontal and the vertical dimension (cf. Table 2.2) – the eligible collateral set was rather narrow. Eligible asset types were UK government securities (mostly gilts), as well as BoE debt securities and (certain) sterling and EUR-denominated securities issued by EEA central governments, central banks and major international institutions. All of these assets thus were public sector assets and the collateral availability was rather limited as a result (cf. Bank for International Settlements, 2015). If the amount of collateral pledged by a counterparty

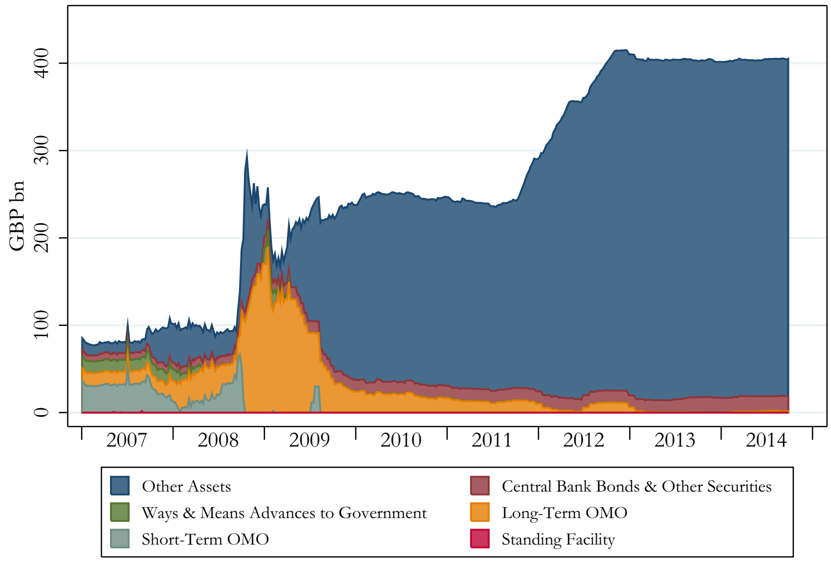
[200] Cf. in particular Bank of England (2006, Annex 1).

[201] Cf. Bank of England, "Changes to the Eligibility Criteria for Access to Reserves Accounts and Other Sterling Monetary Framework Facilities," *Market Notice*, October 10, 2009, `http://www.bankofengland.co.uk/markets/Documents/marketnotice091005smf-apf.pdf`.

[202] For a critique of the missing discount window at the BoE, see W. Buiter, "Why didn't the Bank of England Adopt the Discount Window Rule Book of the Fed or the ECB?," *Financial Times Maverecon*, September 20, 2007, `http://blogs.ft.com/maverecon/2007/09/why-didnt-the-bhtml/`.

Figure 5.12: Bank of England Assets

This figure shows the development of the BoE balance sheet from an asset side perspective. Outright purchases are included in other assets and have become the dominating part of BoE's assets over time (due to the quantitative easing policy of the BoE, which is not discussed here). However, throughout the early crisis years, collateral policy has played a significant role in long- and short-term OMOs and standing facilities, as discussed throughout this section.



Source: author's illustration; BoE, Statistical Interactive Database, BoE's Balance Sheet, Assets.

exceeded GBP 1 billion, a maximum of 25% of it was allowed to be issued by any single issuer (concentration limit), with the exception of the UK government.

The collateral quality required by eligibility criteria of the BoE had to be sustained by issuer credit ratings of at least Double A from two or more of the three major credit rating agencies, i.e. Moody's, S&P and Fitch. Hence, a second-best rule is applied regarding the collateral quality assessment. The second-best credit rating has to be of at least Double A, whereby the quality requirements thus further restricted the eligible collateral pool.

Haircuts were applied by the BoE and differentiated by residual maturity. Additional deductions were made for foreign currency denomination. All collateralizing assets were revalued daily and market prices were relevant for their valuation. A pooling system was allowed and hence the collateral pledged could be exchanged during the lifetime of the loan by the BoE.

Consequently, the collateral framework of the BoE was relatively restrictive and inflexible. Mirrored in the dimensions set out in Table 2.1, it resembled a collateral policy focused on monetary stability (cf. Table 2.2), but in particular the tight criteria on asset quality and the small number of eligible asset types as well as the exclusion of smaller counterparties from the liquidity providing lending facilities stood in the way of a satisfaction of the LOLR role needed in a liquidity crisis. Furthermore, the support of the real economic market segment or any MMOLR efforts was not visible from the setup of the collateral policy until the first half of 2007. From then onwards, the BoE conducted a series of collateral policy measures, as will be described in the following.

5.2.1 Special Long-Term Repos

During the first eruptions in financial markets, the BoE started its collateral policy measures by offering four extraordinary long-term repos – with a lifetime of three months – in September and October 2007.[203] In addition to the collateral set described above, debt securities of the US real estate financing institutions Freddie Mac, Fannie Mae and the Federal Home Loan Banking system, as well as UK and EEA covered bonds rated Triple A (without close links), UK, US and EEA credit card loan backed securities (ABS) rated Triple A, RMBS rated at least Double A and commercial papers rated at least Single A were accepted. The additionally-eligible asset types targeted especially troubled asset markets, although in most cases restrictive quality requirements were attached. Private asset types were new to the eligible collateral pool. The BoE also lowered the minimum rating threshold for EEA government bonds to Triple B and for debt issued by government-guaranteed agencies in these countries to Single A. Furthermore, it extended the rules applied to EEA countries to G10 countries. Accepted denominations now included USD, JPY[204], AUD, CAD, SEK and CHF, in addition to EUR and GBP.

Neither the GBP 10 billion special auction in September 2007 nor the three that followed in October 2007 received any demand and hence went unfilled (Chailloux et al., 2008b). See also Figure 5.12, where no increase in the amount of long-term OMOs is visible. Rule (2012) ascribes this to the operational conditions, which were too expensive compared to the market conditions. The operations offered against a horizontally broadened but vertically mostly unaltered collateral set – at above market conditions – represented a LOLR offer, which was apparently not yet necessary.

This was entirely different from December 2007 onwards. Figure 5.13 shows the demand (sum of bids) and supply (size of auction) of long-term OMOs against extended collateral. Until mid-2009, the demand for the extraordinarily offered three-month repos was always above GBP 5 billion and at times – in particular from the end of 2007 to the fall of 2008 and during the first half of 2009 – demand exceeded supply, such that only the higher bids in the auctions were served. As is visible from Figure 5.12, the strong demand for the extended collateral – together with the much greater tender volumes allocated and an increased frequency of long-term OMOs – led to a fraction in the BoE balance sheet of up to 74% and GBP 190 billion in January 2009 (cf. Anderson et al., 2010). In order to preserve its monetary stability objective, not only were short-term OMOs reduced but additionally short-term BoE bills were sold, for the sake of draining reserves and sterilizing the long-term OMOs (Tucker, 2009).

The extended collateral set accepted from December 2007 onwards differed from the one in fall 2007 described above in the sense that requirements were tightened again, especially with respect to collateral quality.[205] The BoE returned to demanding at least Double A ratings for government bonds. Agency securities guaranteed by G10 governments – particularly those of Freddie Mac, Fannie Mae and the Federal Home Loan Banking system – were only eligible provided they were rated Triple A. The same was true for the ABS and RMBS accepted. Covered bonds remained

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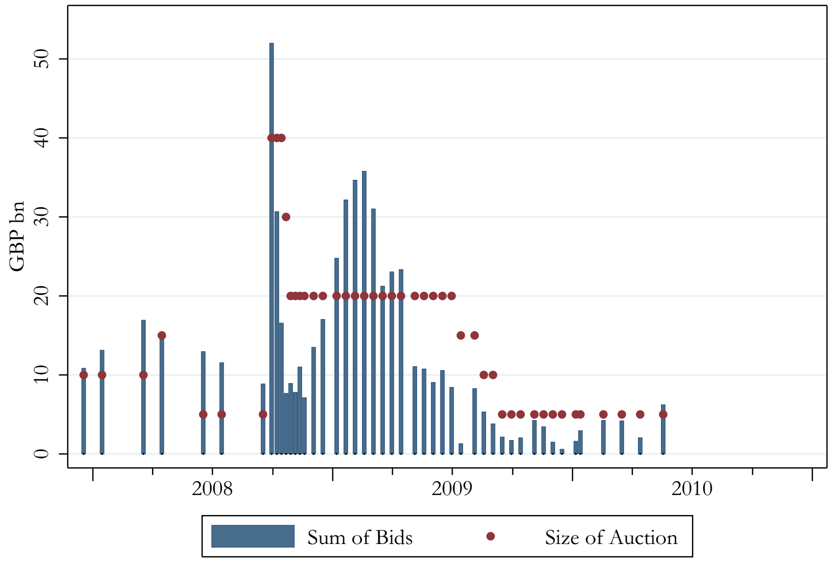
[203] Cf. Bank of England, "Term Auctions," *Market Notice*, September 21, 2007, `http://www.bankofengland.co.uk/markets/Documents/money/documentation/statement070921.pdf`.
[204] Only for government bonds.
[205] Cf. Bank of England, "Long-Term Repo Operations," *Market Notice*, December 14, 2007, `http://www.bankofengland.co.uk/markets/Documents/money/documentation/statement071214.pdf`.

eligible if rated Triple A and backed by public sector debt or mortgages. Even the own-use of covered bonds was now possible. Commercial papers were no longer included in the eligible collateral pool.

Figure 5.13: Extended Collateral Operations of the Bank of England until 2010

This figure shows the volume of extended collateral operations conducted by the BoE from 2007 to 2010. Bars mark the demand at each auction (sum of bids) and dots yield the supply (size of auction), which was pre-defined by the BoE. Until mid-2009, the demand for the extraordinarily offered three-month repos was always above GBP 5 billion and at times – in particular from end 2007 to the fall of 2008 and during the first half of 2009 – demand exceeded supply, such that only the higher bids in the auctions were served.



Source: author's illustration; BoE, Indexed Long-Term Repo Operations, Results.

When the financial market stress intensified during the fall of 2008, the BoE made extensions to the eligible collateral set and accepted additional backings of ABS (student loans, consumer loans, auto loans and certain equipment leases), CMBS as well as securitized portfolios of corporate loans and corporate bonds. All of these had to be rated Triple A.[206] In addition, asset-backed commercial papers originated in the UK, US, or EEA became eligible if at least rated Double A (to be precise: A-1+/P1/F1+; short-term ratings). Debt guaranteed under Her Majesty's Government's bank debt guarantee scheme was also made eligible.[207] The own-use of covered bonds and securities was accepted.[208]

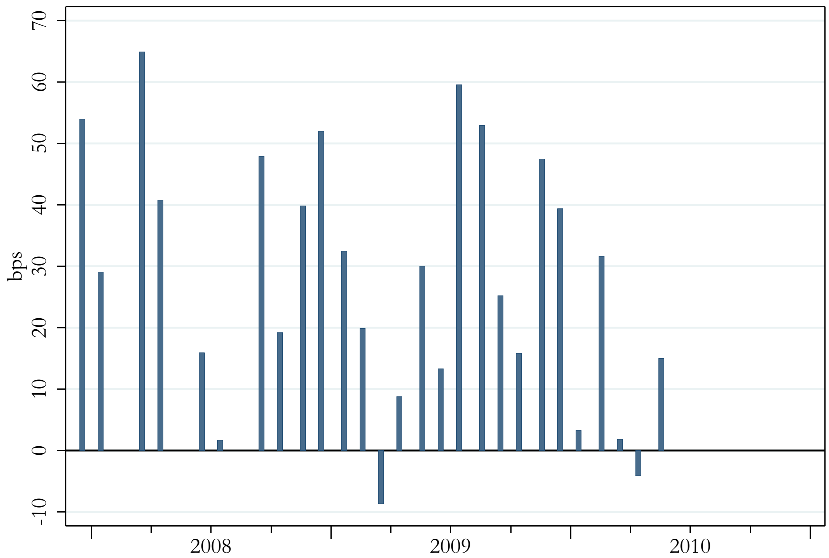
The BoE practice of auctioning long-term repos against standard (narrow) collateral set separately from the long-term repos – where collateralization criteria are extended (wider)[209] – in effect divided the facility into two parts. Not only could the BoE thus regulate the (maximum) volumes to be collateralized by each collateral set, but it also left the determination of the refinancing conditions to competitive markets. In addition to higher haircuts for the extended collateral, the interest

[206] Cf. Bank of England, "Extended Collateral Long-Term Repo Operations," *Market Notice*, October 3, 2008, `http://www.bankofengland.co.uk/markets/Documents/marketnotice081003.pdf`.
[207] Cf. Bank of England, "Sterling Long-Term Repo Operations; US Dollar Repo Operations; The Special Liquidity Scheme," *Market Notice*, October 8, 2008, `http://www.bankofengland.co.uk/markets/Documents/marketnotice081008.pdf`.
[208] Cf. Bank of England, "Extended Collateral Long-Term Repo Operations," *Market Notice*, December 15, 2008, `http://www.bankofengland.co.uk/markets/Documents/ltrmarketnotice081219.pdf`.
[209] See Section 5.2.6 for a comprehensive description of the different collateral sets defined by the BoE.

rate formed through the auction could hence reflect a premium to the standard refinancing conditions, originating in the looser collateral requirements. Consequently, the liquidity provided in the extended collateral repos has been exactly as much more expensive for banks as they themselves valued the opportunity to borrow against the extended collateral. Figure 5.14 shows the premium of the weighted average accepted rate in three months extended collateral repos over the rate in six months standard collateral repos that were conducted on the same day. Even though the longer operations typically settle at a higher rate (maturity premium), the premium for extended collateral is almost always positive. The LOLR character of the operations against the wider collateral set is thus secured.

Figure 5.14: Premium in the Extended Collateral Operations of the Bank of England

This figure shows the premium of the weighted average accepted rate in three months extended collateral repos over the rate in six months standard collateral repos that were conducted on the same day. Even though the longer operations typically settle at a higher rate (maturity premium), the premium for extended collateral is almost always positive. This reflects both the high (supply-exceeding) demand and the LOLR role in the operations.



Source: author's illustration; BoE, Indexed Long-Term Repo Operations, Results.

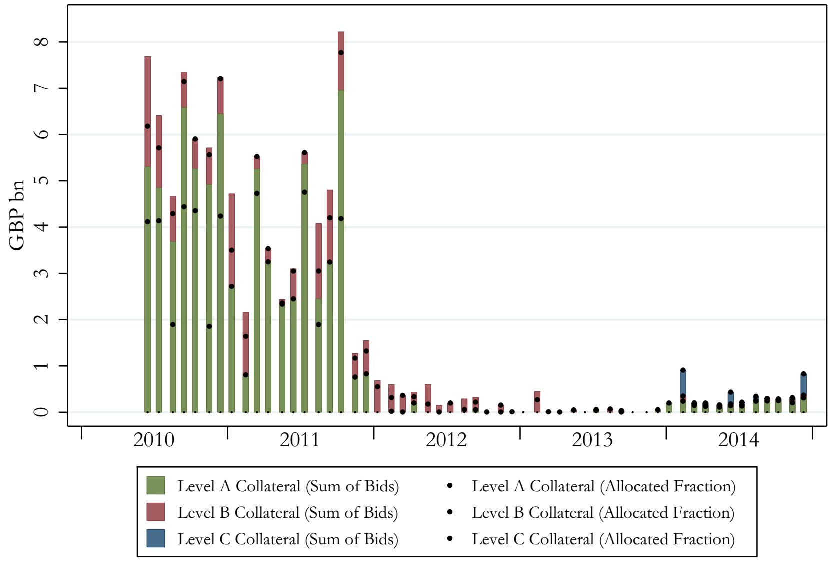
From 2010 onwards, the BoE revised the allocation method used to determine which fraction of the amount auctioned in the long-term repo to be lent out against the narrow versus the wider collateral set (cf. Bank of England, 2008; Fisher, 2011). While previously it had announced the respective amounts in advance, they became endogenous in their indexed long-term repo (ILTR) OMOs, which replaced the long-term repo operations described above. Moreover, the lending against a wider collateral set was made permanent within this renewed facility. Furthermore, the liquidity has subsequently been lent out for more than three months, because six-month ILTRs were also conducted.

The allocation made depends on the relative demands for borrowing against the respective collateral sets, whereby the higher the premium for borrowing against the wider set (see above), the more funds are allocated to the extended collateral part of the ILTR. However, the proportion is only extended if the rates bid for extended collateral borrowing come close to the fees charged in the Discount Window Facility (DWF, cf. Section 5.2.3) to secure a penalty character.

Figure 5.15 shows the ILTRs conducted from June 2010 until the end of 2014. Demand for longer-term central bank liquidity flattened out at the end of 2011. Nevertheless, borrowing against the wider collateral set did not come to a sustained halt, suggesting that some banks appreciated the opportunity to convert a wide range of collateral into liquidity at the central bank. Since 2014, ILTRs have also been conducted against the even wider range of eligible collateral as originally designed for the DWF (cf. Section 5.2.3 on the DWF and Section 5.2.6 on the different collateral sets). As Figure 5.15 reveals, the demand for repos against this collateral almost completely replaced the demand for repos against the previously-extended collateral.

Figure 5.15: Indexed Long-Term Repo Operations from 2010 to 2014

This figure shows ILTRs from 2010 to 2014. Bars mark the demand (sum of bids) for longer-term central bank liquidity, while dots indicate the respective allocated fraction (supply). Until 2014, only the wider set of collateral was eligible, whereas thereafter the even wider range of assets was eligible. The demand for repos against this collateral replaced the demand for repos against the previously-extended collateral almost completely. Initially, there was a strong demand for ILTR liquidity overall. At the end of 2011, demand for longer-term central bank liquidity flattened out. Nevertheless, borrowing against the wider collateral set did not come to a sustained halt, suggesting that some banks appreciated the opportunity to convert a wide range of collateral into liquidity at the central bank.



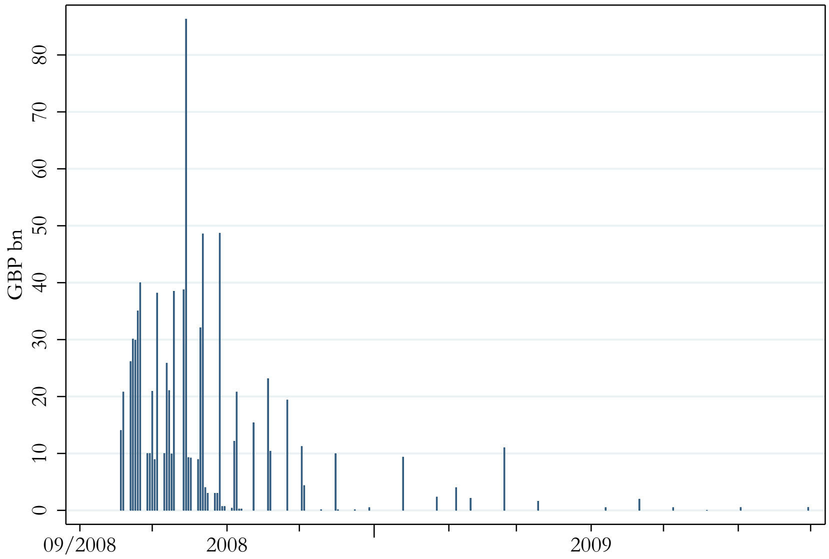
Source: author's illustration; BoE, Indexed Long-Term Repo Operations, Results.

The BoE already provided liquidity in USD since September 2008, extending the LOLR role along the dimension of counter-assets (cf. Table 2.1). This was part of a multilateral agreement on a coordinated action by several important central banks around the world.[210] The eligible collateral for the repos conducted was the same as for the GBP repos, i.e. the extended collateral set was accepted. The USD repos had maturities between one day and three months. Figure 5.16 shows the borrowed amounts. The loans accumulated at about USD 86 billion in October 2008 (Cross et al., 2010). At the end of 2014, USD repos were still offered once a week, but had not been used by counterparties since the end of 2009, while the use during the second half of 2009 was seldom and insignificant.

[210] ECB, Fed, Bank of Canada, BoE, BoJ, Swiss National Bank.

Figure 5.16: USD Repo Operations of the Bank of England

This figure shows the amount of liquidity provided by the BoE in USD, which was fully allotted. Demand was high and frequent during September and October 2008, although it flattened out during 2009. The facility has not been used by counterparties since the end of 2009 (until the end of 2014).



Source: author's illustration; BoE, US Dollar Repo Operations, Results.

5.2.2 Special Liquidity Scheme

From April 2008 to January 2009, the BoE offered the participation in the Special Liquidity Scheme (SLS) to counterparties that were also eligible to borrow from the BoE's standing facilities, i.e. banks and building societies.[211] Initially, the so-called "drawdown window" during which the counterparty could use the SLS was defined from April to October 2008, although it was subsequently prolonged until January 2009 in September 2008 after the bankruptcy of Lehman Brothers. Counterparties could only participate in the SLS during the time when the drawdown window was open ("one-off scheme"), but repeatedly if they desired. The scheme provided them with UK Treasury bills in exchange for eligible collateral, i.e. the SLS was a collateral swap facility. The BoE applied a fee of at least 20 basis points above the general collateral gilt repo rate in private repo markets for making use of the scheme and thus introduced a penalty compared to market conditions in normal circumstances to make the SLS relatively unattractive. In addition, haircuts were applied to the market value of the collateral. If a market value was not available, an add-on haircut of 5% was applied. Own-use collateral was accepted and additionally haircutted by 5%. A pooling system was introduced and hence counterparties could exchange the pledged collateral during the time when the Treasuries were lent out to them, which was for three years.

Eligible asset types in the SLS comprised RMBS and covered bonds issued in the UK or the EEA, if the latter were backed by residential mortgages, social housing loans or public sector debt, as well as ABS backed by social housing loans or credit cards from the UK, the US and the EEA. In addition, government-guaranteed bonds issued by G10 public agencies and debt securities of

[211] See John et al. (2012) for more details on the information of the SLS provided in the following.

Ginnie Mae, Freddie Mac and Fannie Mae were eligible. As a general rule, collateral had to be rated Triple A.[212]

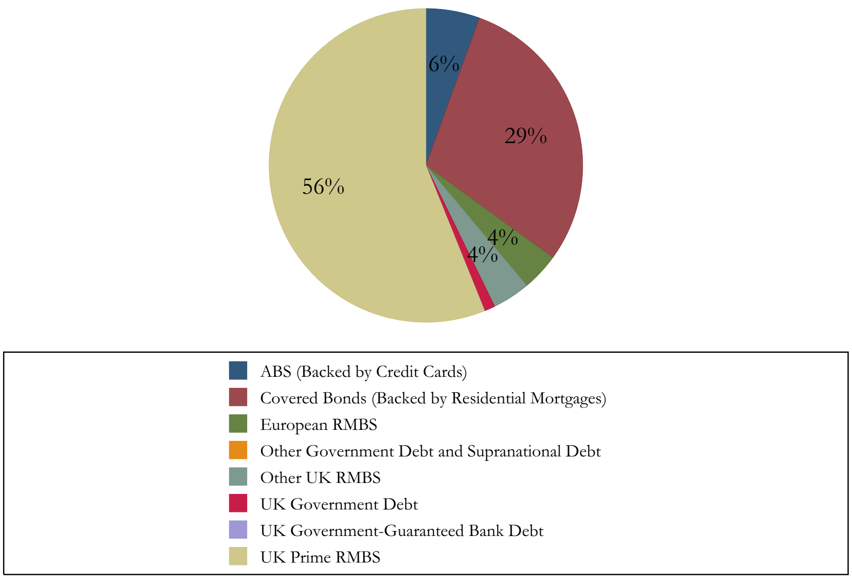
Compared to the extended collateral set described above, the eligible collateral pool of the SLS comprised a rather small range of asset types. However, the choice of eligible assets clearly followed the LOLR motive to free up large amounts of assets from bank balance sheets that were no longer tradable in private markets in exchange for fresh liquidity. Most of them reflected housing loans of long maturities made by banks that had to be liquidized to meet short-term claims of depositors. This was stressed by the decision to only accept legacy assets, i.e. assets that were already held at the end of 2007, restricting issuance dates towards present along the dimension of asset ages (cf. Table 2.1). Hence, the measure did not intend to stimulate new loan-making, as a MMOLR would have (cf. Table 2.2).

On the last day of the drawdown window in January 2009, the value of Treasuries lent out through the SLS peaked at GBP 184 billion. The SLS did not appear on the BoE's balance sheet given that it represented a pure collateral swap, which did not affect the reserve provisioning of the central bank. Owing to the size of the program, the BoE was indemnified by the UK government (Cross et al., 2010).

The distribution of the collateral pledged to the SLS is shown in Figure 5.17. More than 85% of it comprised securities backed by residential mortgages. Essentially no public securities were pledged. "The fact that the overwhelming majority of this collateral was 'own-name' " (John et al., 2012, p. 61) – i.e. own-use – confirms that the SLS mainly helped banks to liquidate existing assets of long maturities – which were difficult to market or not at all marketable in private markets – to meet short-term liabilities. The average effective haircut was quite sizable at 22%.

Figure 5.17: Collateral Pledged in the Special Liquidity Scheme

This figure shows the collateralizing asset types used in the BoE's SLS. More than 85% of it comprised securities backed by residential mortgages. Essentially no public securities were pledged.



Source: author's calculation; John et al. (2012).

[212] The BoE also accessed each asset itself and reserved the right to deviate from this rule in both directions.

5.2.3 Discount Window Facility

In October 2008, the BoE filled the gap of a lacking discount window by establishing the DWF as a standing facility that could be tapped at any time. Eligible counterparties mainly comprise banks and building societies, although broker dealers and central counterparties in the Sterling Monetary Framework can also apply for access, cf. Bank of England (2015). In contrast to the existing standing facilities – which were renamed "Operational Standing Facilities" at the same time – lending through the DWF was to be typically for 30 days and not only overnight. From February 2009, the possibility to borrow for a whole year was introduced. Like the SLS, the DWF was designed as a collateral swap facility. Eligible collateral could be swapped against UK Treasuries (gilts) against fees, making the DWF unattractive in normal times, although the BoE reserves the right to lend out cash in exceptional circumstances (Fisher, 2012). The fees (interest rate premia) were designed to increase with the amount borrowed and depend on the collateral used (see description of collateral sets in Section 5.2.6). In addition, haircuts are applied on the collateral. They increased from around 5-6% to around 45% in residual maturity and collateral type at the time of establishment of the DWF.[213] Additional haircuts of 5% each were applied for theoretical valuation, own-use and downgraded ABS, residential or CMBS and covered bonds for each rating notch below Triple A until the minimum rating requirement of Single A.

Counterparties have to apply for the bilaterally provided funds from the DWF and prove during a BoE assessment that their liquidity needs are only temporary, i.e. the DWF is not a no-questions-asked and not an anonymous facility. Resulting concerns of stigmatization and the unattractive conditions led to no loans being made through the DWF since its introduction until the end of 2014.[214] Nevertheless, a substantial amount of collateral has been pre-positioned for borrowing from the DWF, which operates a pooling system, e.g. GBP 265 billion in March 2012, cf. Fisher (2012).

From the time of its introduction in October 2008, the eligible collateral set for DWF swaps is the broadest set that the BoE has accepted over across its lending facilities, cf. Section 5.2.6. Initially, the basis was the extended collateral set as used in the special long-term repos described in Section 5.2.1.[215] However, the quality requirements for covered bonds, ABS, RMBS and CMBS were somewhat eased, insofar that a downgrade down to a rating of Single A was accepted (subject to the above-described additional haircuts) if the rating had been Triple A at issuance. This rule is a straightforward application of the inertia principle, because the issuance rating reflects the acceptance level in normal times whereas (temporary) downgrades in times of market tensions should not affect the eligibility in a LOLR facility, as which the DWF has been designed. Moreover, specific securitized loan portfolios of banks were declared eligible to the DWF, subject to the last-named rating requirements, as well as asset-backed commercial papers and corporate bonds rated Single A (or equipped with a comparable short-term rating).

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213 The BoE expresses haircuts as initial margins, which were transformed into the haircut numbers stated here.

214 See Fisher (2012) for a brief discussion of a possible stigma of the DWF.

215 Cf. Bank of England, "Operational Standing Lending and Deposit Facilities; Discount Window Facility," *Market Notice*, October 20, 2008, `http://www.bankofengland.co.uk/markets/Documents/marketnotice081020.pdf`.

In November 2010, the BoE announced that it would also accept loan portfolios directly as collateral as of April 2011, i.e. without requiring them to be securitized.[216] This was an extension of the eligible collateral set to non-marketable assets. The loans had to be residential mortgages or made for purposes of consumption (excluding credit card loans), commercial real estate or corporate loans to a non-bank (including SMEs) and denominated in GBP, EUR, USD, AUD, CAD, SEK or CHF to be eligible. Furthermore, the laws of England, Wales, Scotland or Northern Ireland have to be ruling. Debtors were to be residing in the UK or have their center of main interest in the UK.

5.2.4 Contingent Term Repo Facility

The BoE completed what it calls its "Liquidity Insurance System" in December 2011 with the introduction of the Extended Collateral Term Repo Facility. In January 2014, the facility was renamed as the Contingent Term Repo Facility (CTRF).[217] The Liquidity Insurance System of the BoE since then comprises the ILTRs, the DWF and the CTRF. The CTRF works similarly to the DWF, against the same range of collateral. Contrasting the DWF, it is not a bilateral on-demand facility but can be used at the BoE's discretion and target financial markets as a whole, i.e. providing liquidity on a larger scale. It is not a permanent or regular institution and is intended to be deployed in case of exceptional market-wide stress.

The CTRF has only been enabled once since its creation, being active as of June 2012 and throughout the second half of 2012. Seven monthly auctions provided a total of GBP 10.8 billion, although only the first tender was completely exploited by counterparties. The term of the repos was 30 days.

5.2.5 Funding for Lending and Loan Guarantee Schemes

In 2012, the BoE explicitly conducted two collateral policy measures to stimulate credit provision to the real economy and channel liquidity to households and private non-financial corporations as a MMOLR. First, in March 2012, it included all debt issued under the National Loan Guarantee Scheme in the wider eligible collateral set, i.e. making it eligible for the ILTR facility, the DWF and the predecessor of the CTRF.[218] Under the scheme, banks receive government guarantees on unsecured debt that they issue. As a result, they are able to receive cheaper financing, which they subsequently have to pass on to small businesses. The eligibility of the unsecured government-guaranteed bank debt at BoE liquidity facilities enables buyers of the bank debt to refinance at the BoE and hence help to provide the subsidized credit market. During 2012, more than GBP 5.2 billion in loans to small businesses was provided through the scheme.[219]

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[216] For the details on assessment of eligibility and conditions exercised, see Bank of England, "Expanding Eligible Collateral in the Discount Window Facility" *Market Notice*, November 30, 2010, `http://www.bankofengland.co.uk/markets/Documents/marketnotice101130dwf.pdf`.

[217] See e.g. Bank of England (2013, 2015) on the Liquidity Insurance System. For the Extended Collateral Term Repo Facility, cf. Bank of England, "Sterling Monetary Framework: Extended Collateral Term Repo Facility," *Market Notice*, December 6, 2011, `http://www.bankofengland.co.uk/markets/Documents/marketnotice111206.pdf`.

[218] Cf. Bank of England, "Sterling Monetary Framework – National Loan Guarantee Scheme," *Market Notice*, March 19, 2012, `http://www.bankofengland.co.uk/markets/Documents/marketnotice120319.pdf`.

[219] For more information on the scheme, cf. United Kingdom Debt Management Office, *National Loan Guarantee Scheme*, `http://www.dmo.gov.uk/index.aspx?page=CGS/NLGS2012`, last accessed April 18, 2016.

Second, the BoE introduced the Funding for Lending Scheme (FLS) in July 2012.[220] Although the National Loan Guarantee Scheme remains active, the FLS has been preferred over it since then. As Churm et al. (2012, p. 306) state, the FLS "is designed to [...] boost [...] lending to [...] the 'real economy' [...] at below market rates." In the collateral swap facility, counterparties exchange their loans into UK Treasury bills, which can easily be liquidated in private repo markets. Initially, the FLS was announced to end in December 2013, although it has been prolonged twice in November 2013 and December 2014 and at the time of writing it is due to expire in January 2018. Counterparties could initially pledge an amount equal to 5% of the stock of their existing loans to the real economy as of June 2012. All additional net lending made from then onwards has directly increased the maximum amount that the respective counterparty is allowed to borrow from the scheme, which is accordingly capped at a counterparty level.

Moreover, the (new) loans made are eligible collateral themselves, because the widest possible collateral set – i.e. the collateral set eligible in the DWF – is accepted in the FLS. The fee for borrowing from the FLS is equal to the lowest fee applicable in the DWF, although in contrast to the DWF the fee remains low regardless of the collateral used. Only if net lending to the real economy contracts does the fee for FLS lending increase to punish the restrictive credit provisioning of the counterparty. New loans to the real economy are hence rewarded, while a decrease in such lending is punished. Any new loan is hence incentivized in a twofold manner, by extending the maximum borrowable amount from the FLS for the counterparty and securing cheap refinancing from the central bank. FLS refinancing costs were significantly below comparable market refinancing costs at the time of the FLS launch in June 2012, cf. Churm et al. (2012). Figure 5.18 shows the usage of the FLS. The selectively defined collateral set at the horizontal dimension in combination with the explicit targeting of new loan-making to the real economy at the time dimension and the below-market (subsidized) conditions (value-level dimension) clearly identify the facility as within the MMOLR policy according to Table 2.2.[221] Nonetheless, the BoE retains control over monetary stability as a COMPR to some extent, as it capped the maximum amount that can be refinanced at a counterparty level (see above) and installed an automatic sterilization by implementing a collateral swap facility.

5.2.6 Sets of Eligible Collateral

With the introduction of its DWF, the BoE rearranged and clarified the different sets of collateral that it had created – which it had previously loosely referred to as "narrow" and "wider" (or "extended") – by establishing four levels of collateral, A to D.[222] Level A collateral was intended to label the set that had always been eligible for regular OMOs and standing facilities. It is the only set that is published on the BoE's website on an asset basis (listing ISINs).[223] Level B was to comprise other securities "trading in liquid markets" and resemble the wider collateral set eligible for extended collateral LTROs, as described above. Levels C and D were to comprise an even wider

220 For details on the FLS, cf. Churm et al. (2012).

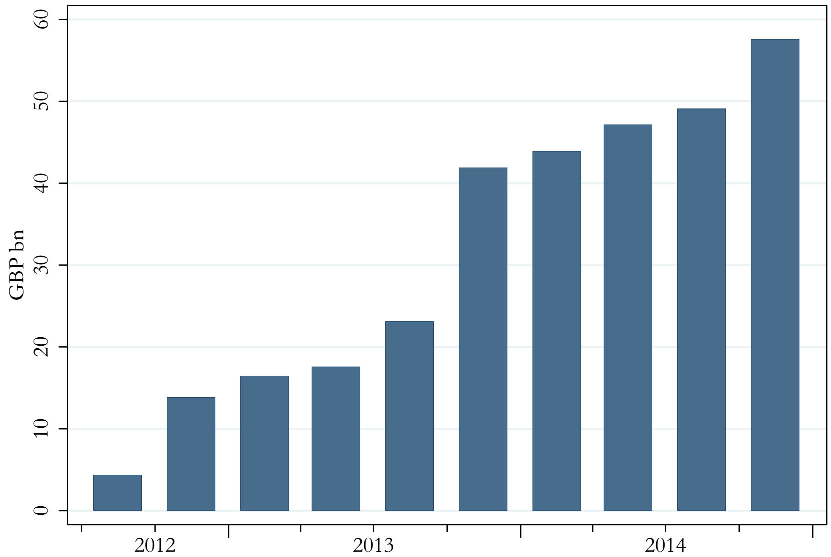
221 Moreover, the quality of collateral can be assumed to be lower at the vertical dimension, as the subsidized conditions lead to the realization of investment projects of lower productivities.

222 Cf. Bank of England, "Operational Standing Lending and Deposit Facilities; Discount Window Facility," *Market Notice*, October 20, 2008, `http://www.bankofengland.co.uk/markets/Documents/marketnotice081020.pdf`.

223 See Bank of England, *Eligible Securities*, `http://www.bankofengland.co.uk/markets/money/eligiblesecurities.xls`.

Figure 5.18: Funding for Lending Scheme Usage (Treasury Bill Drawings)

This figure shows aggregated quarterly net FLS T-Bill drawings from the introduction of the FLS until the end of 2014, i.e. the sum of the quarterly FLS extensions (drawings less repayments) at the end of each respective quarter. Demand for FLS funds remained positive in every quarter over the entire depicted period, reflecting the favorable conditions offered.



Source: author's calculation; BoE, Funding for Lending Scheme, Usage and Lending Data.

collateral set, as it was defined for the DWF. Level C was to include debt "not trading in liquid markets," and Level D to contain own-use instruments. However, the announced levels of collateral sets were used along with the definitions of "narrow", "wider" and "still wider" (or "DWF eligible") collateral for quite some time (e.g. Bank of England, 2010; Fisher, 2012; Rule, 2012). Moreover, the definitions above were subject to change, as described in the following.

From July 2011, the narrow collateral set – i.e. Level A – was tightened to only include UK government securities, BoE securities and securities issued by the governments or central banks of Canada, France, Germany, the Netherlands and the US, denominated in the respective currencies.[224] The BoE hence reacted to the European sovereign debt crisis and only declared eligible government securities from some countries rather than all EEA countries. Similarly, the list of sovereigns (and central banks) eligible in the wider (Level B) collateral set was spelled out explicitly from then onwards, with e.g. Greece missing on the list.

Since 2013, the definition of eligible collateral levels has been changed, with Levels C and D consolidated into Level C, which also contains the loan portfolios eligible under the DWF (cf. Bank of England, 2013). The structure preserved at the end of 2014 and the BoE publishes eligible asset types for each level on its website.[225] As described above, Level A contains only public securities from a narrow range of countries. It is eligible for all BoE lending facilities. Level B contains public securities from a wider range of countries, as well as such issued by international institutions and

[224] Cf. Bank of England, "Revisions to Eligibility Criteria for Sovereign, Central Bank and Supranational Debt Taken as Collateral in the Bank of England's Operations," *Market Notice*, February 11, 2011, `http://www.bankofengland.co.uk/markets/Documents/marketnotice110211.pdf`.

[225] See Bank of England, *Eligible Collateral*, `http://www.bankofengland.co.uk/markets/Pages/money/eligiblecollateral.aspx`, last accessed April 18, 2016.

Triple A-rated private securities such as ABS or RMBS and specific government-guaranteed bank debt and portfolios of commercial papers or corporate bonds rated around Single A. The collateral set of Level B can be used in ILTRs (cf. Section 5.2.1), the DWF (cf. Section 5.2.3) and the Extended Collateral Repo (cf. Section 5.2.4). Own-use securities, portfolios of (unsecuritized loans) and other private securities not eligible in Level B are eligible in Level C. The minimum rating requirement is usually around Single A. Level C collateral is eligible in the DWF, the Extended Collateral Repo and since 2014 also in the ILTRs. The differentiation of several eligible collateral sets enables the BoE to define collateral policy closer to the normative suggestion for each objective – as set out in Table 2.2 – than would be the case with a uniform collateral framework. In combination with different facilities supporting different objectives, as described above, the BoE can adopt more than one role at the same time. In particular, a narrow collateral set for its regular monetary policy conduction ensures monetary stability and reduces the trade-off to other objectives, which are analyzed in further detail in Section 6.2.

5.3 Bank of Japan

The BoJ provides most of its funds through outright purchases, which was also the case prior to the 2007/2008 financial crisis. The overwhelming majority of assets purchased are Japanese government securities. Figure 5.19 shows the breakdown of the BoJ assets. In addition to outright asset purchases, funds-supplying operations of the BoJ comprise lending against pooled collateral and repos of commercial papers as well as Japanese government securities, cf. Institute for Monetary and Economic Studies (2012). However, all lending-based facilities have a short-term focus, while outright purchases represent the long-term liquidity provision. Furthermore, the BoJ has been operating a securities lending facility since 2004, in which it lends out Japanese government securities overnight in reverse repos against cash liquidity, not swapped against other collateral. In the following, the setup of standard collateralized lending facilities of the BoJ is described, before collateral policy measures in reaction to the financial market turmoil and the Great Recession are presented.

5.3.1 Standard Lending Facilities

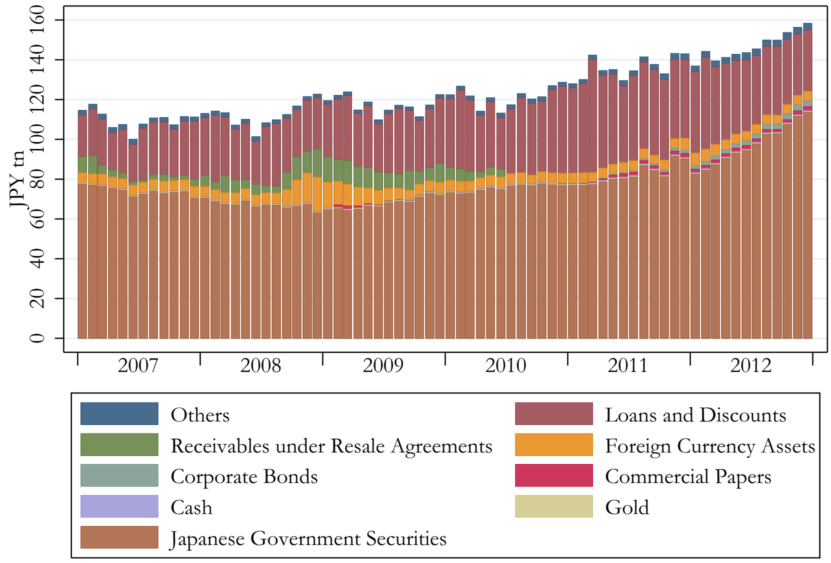
Eligible counterparties for the lending facilities are admitted once a year. They have to be banks, domestic or foreign securities companies, securities finance companies or money market brokers ("Tanshi companies") and hold a current account at the BoJ, cf. Institute for Monetary and Economic Studies (2012). Criteria evaluated in the admission process include an assessment of the creditworthiness of the applying counterparty – among others – and are publicly disclosed. While up to 150 eligible counterparties participate in outright transactions with the BoJ, the number of eligible counterparties for lending-based facilities is much smaller (between 30 and 50, depending on the facility), cf. Blenck et al. (2001) and Chailloux et al. (2008a). Moreover, the admission as an eligible counterparty is granted for each facility separately.

Funds-supplying operations against pooled collateral were established in April 2006 and constitute the main method for supplying short-term funds at the BoJ.[226] The maturity of the loans made is

[226] Cf. Bank of Japan, "Introduction of Funds-Supplying Operations against Pooled Collateral," *Release*, April 11, 2006, `https://www.boj.or.jp/en/announcements/release_2006/mok0604a.htm/`, last accessed April 12, 2016.

Figure 5.19: Bank of Japan Assets

The figure shows the distribution of assets in the BoJ's balance sheet. The BoJ mostly operates through outright purchases of Japanese government bonds. Collateral policy is relevant for the "Loans and Discount" fraction, which slightly grew in the years after the financial turmoil and peaked at 39.4% in March 2011.



Source: author's illustration; BoJ, Monetary Base and the Bank of Japan's Transactions.

not to exceed one year. Interest rates are usually determined in competitive auctions of a pre-defined volume, although the BoJ also has the opportunity to allot the funds at its uncollateralized overnight call rate target. The frequency and maturity of funds-supplying operations against pooled collateral are discretionarily decided at the BoJ's monetary policy meetings, whereby usually maturities are three, six or twelve months.

The eligible collateral set at the BoJ has been very broad ever since the introduction of the "Guidelines on Eligible Collateral" in October 2000.[227] In June 2006, the size of the eligible collateral pool of the BoJ amounted to JPY 950 trillion based on information from Bank for International Settlements (2015).[228] The categories of eligible collateral types have been essentially unchanged since that time. The following list is based on the pre-crisis framework and provides information on the minimum rating requirements in each category.[229]

1. (Japanese) government bonds, regardless of the credit rating.
2. Financing/treasury bills, which are issued by the Japanese Ministry of Finance, regardless of the credit rating.
3. Government-guaranteed bonds, as well as municipal bonds, if publicly-offered.[230]

[227] Cf. Bank of Japan, "Establishment of 'Guidelines on Eligible Collateral'," *Release*, October 13, 2000, `https://www.boj.or.jp/en/announcements/release_2000/mok0010a.htm/`, last accessed April 12, 2016.

[228] Accordingly, the eligible collateral pool was 1.9 times the Japanese GDP, which amounted to JPY 506.687 trillion in 2006 (World Bank, IBRD).

[229] Additional restrictions apply, e.g. with respect to (residual) maturities or degree of securitization, see the "Guidelines on Eligible Collateral" of the BoJ for details. Ratings are stated translated into the notation of the Eurosystem, cf. Section 4.2.4.3.

[230] Privately-placed but deemed to be as marketable as publicly-offered bonds can be eligible on decision of the BoJ.

4. Fiscal Investment and Loan Program agency bonds, if rated at least Single A by at least two eligible rating agencies (second-best rule), i.e. considered appropriate by the BoJ.[231]

5. Corporate bonds, which are publicly-offered and rated at least Single A by at least one eligible rating agency (first-best rule).

6. ABS, if rated Triple A following the first-best rule.

7. Foreign government bonds and international financial institution bonds, if rated at least Double A following the second-best rule.

8. Bills and commercial papers. For asset-backed commercial papers, a rating of at least A-1 (short-term rating) is required following the first-best rule.[232] For other commercial papers and bills, the BoJ evaluates the issuer creditworthiness itself, or demands a similar quality level.

9. Loans on deeds, when the debtor corporation maintains a rating of at least Single A following the first-best rule, or is a Japanese government.

All eligible assets additionally should be denominated in JPY, issued in Japan and governed by Japanese law. Note that this in effect prevented most foreign assets from being eligible. Furthermore, note that loans on deeds mark the only non-marketable asset type, whereby they are comparable to credit claims in the words of the Eurosystem.

The BoJ has also been operating an on-demand complementary lending facility, which counterparties can access as a last-resort liquidity source at a penalty rate (the basic loan rate, which overlies the targeted policy rate, i.e. uncollateralized overnight call rate). Loans are only granted overnight but can be rolled over infinitely without an increase in the penalty.[233] The uniform BoJ collateral pool described above is eligible for collateralization of the bilateral loans. The only limit to the loan amount is defined through the collateral value.

The BoJ has already been providing liquidity via repos against commercial papers since 1989. Within this facility, loan maturities are up to three months. The determination of interest rates is achieved through either competitive auctions or a fixed rate is set by the BoJ in line with short-term money market rates. In 2002, the BoJ established another repo facility, operating against Japanese government bonds with coupons and treasury discount bills. The maturity of these operations is no longer than one year. Counterparties submit bids on purchasing yields representing the interest rate within the repo, while a fixed-rate method is not provided for. Within both repo facilities, the eligibility criteria described above determine which commercial papers and government securities are accepted as collateral.

Summing up, the general collateral policy of the BoJ was uniform across facilities and broad regarding eligible asset types (horizontal dimension, cf. Table 2.2) until 2007. Despite being quantitatively

231 The Fiscal Investment and Loan Program supports loans to SMEs and public projects such as the construction of hospitals and welfare facilities, provision of scholarships, etc. The loans are made on a long-term basis at fixed and low interest rates, below private market conditions.

232 Cf. Bank of Japan, "Amendments to 'Guidelines on Eligible Collateral'," *Release*, January 16, 2002, `https://www.boj.or.jp/en/announcements/release_2002/mok0201a.htm/`, last accessed April 12, 2016.

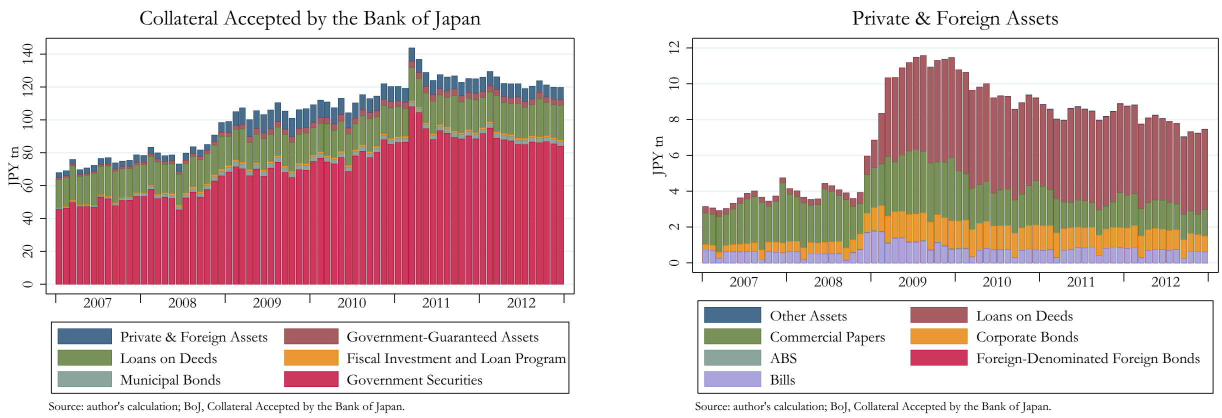
233 A respective rule increasing the penalization after a roll-over beyond five business days has been suspended since March 2003.

broad, it clearly focused on monetary stability. The quality requirements have been high, in particular for all non-public assets, which required credit qualities of at least Single A (vertical dimension, cf. Table 2.2). The on-demand complementary lending facility represents the discount window of the BoJ as a LOLR, as it fulfills all indications set out in Table 2.2, with only shortcoming of the relatively small set of eligible counterparties, see above. The funds-supplying operations against pooled collateral cannot be said to regularly represent a MMOLR action because usually funds are competitively auctioned, which should prevent subsidized refinancing conditions. The same holds for the repo facilities referring to specific collateral types, despite targeting market segments. However, for the first-named, the BoJ can decide to provide the funds at the fixed uncollateralized overnight call rate, which could represent the more favorable conditions that a MMOLR would offer.

In practice, there has been a strong focus on public collateral, which is evident from data on pledged collateral. Unfortunately, no data on the overall eligible assets pool of the BoJ is available, which would be better comparable to the data from the Eurosystem. Nonetheless, the left panel of Figure 5.20 shows the collateral actually accepted at the BoJ, i.e. collateral to secure loans incurred as a result of funds-supplying operations. This comprises all collateral registered at the BoJ for potential use by counterparties and hence does not exactly coincide with the exact amount of loans actually made. Note that the distribution will most definitely not coincide with the distribution of the eligible asset pool. In June 2006, this pledged collateral amounted to JPY 74.696 trillion and thus around 7-8% of the eligible collateral pool as estimated based on information in Bank for International Settlements (2015), see above. Furthermore, as is apparent from Figure 5.20, almost all of the pledged collateral represented debt of public Japanese institutions, mostly the government. Private and foreign assets have played an increasing role since the BoJ started its collateral policy in reaction to the financial crisis, which will be described in the next section. The right panel of Figure 5.20 zooms into this fraction of the pledged collateral, which nevertheless never exceeded 11.2% (October 2009).

Figure 5.20: Collateral Accepted by the Bank of Japan

The figure shows the collateral value of assets pledged at the BoJ to secure loans incurred as a result of funds-supplying operations. This comprises all collateral registered at the BoJ for potential use by counterparties and hence does not exactly coincide with the exact amount of loans actually made. The left panel illustrates the strong focus on public assets, while the right panel zooms into the fraction of private and foreign assets. Note that the distribution of the accepted collateral will most definitely not coincide with the distribution of the eligible asset pool.



5.3.2 Collateral Policy Measures since 2007

The BoJ conducted several – mostly temporary – collateral policy measures during the time of the financial crisis and its aftermath.[234] Immediate repercussions were also visible in the Japanese financial markets during the financial market turmoils of 2007 and 2008, although the financial system and financial institutions there had a much lower exposure to subprime housing assets (e.g. Gagnon and Hinterschweiger, 2013). Nevertheless, the BoJ took some measures of a LOLR to ensure financial stability. In September 2008, USD funds-supplying operations against pooled collateral were introduced, providing up to three-month loans in USD against the uniform collateral pool described above. This was part of a multilateral coordinated action between several important central banks around the world and represents a loosening along the dimension of the counter-asset, cf. Table 2.2. An additional haircut was applied due to the denomination of the loan in foreign currency, securing tight operation conditions requested by the normative LOLR design, cf. Table 2.2. Initially – as is common for LOLR facilities – the facility was limited until January 2009, although after several prolongations it did not expire until February 2010. Furthermore, the interest rate was initially determined through an auction, although in October 2008 the procedure was changed to full allotment at a pre-defined fixed interest rate. Eligible counterparties that could apply were as in the regular fund-supplying operations against pooled collateral, although the number of admissions to the facility was extended at the end of September 2008 (access window dimension, cf. Table 2.2). In May 2010, the facility was reintroduced with the terms of February 2010, prolonged several times and subsequently made permanent in October 2013. In addition to funds denominated in USD, from December 2011 onwards special facilities have offered funds denominated in CAD, GBP, EUR and CHF, at identical conditions. Figure 5.21 shows the loan amount provided through the USD facility during the first phase of its effectiveness between September 2008 and February 2010. Demand peaked in December 2008 at around USD 120 billion but was only temporary and in fact almost completely faded out before the facility was closed for the first time in 2010.

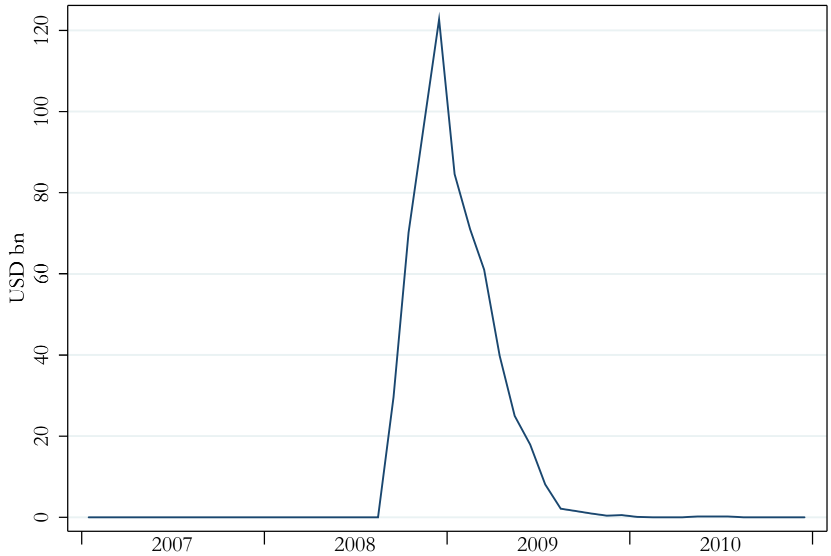
In May 2009, the eligible collateral was widened along the horizontal dimension to include government bonds of the US, the UK, Germany and France, as long as these countries retained a credit rating of as least Double A following the second-best rule. Thus, collateral denominated in foreign currencies became eligible for the first time. Japanese banks and other counterparties could hence certainly be able to liquidize these assets on their balance sheets easily if necessary, even if private markets for government securities tightened, as e.g. for European sovereigns. Nevertheless, as Figure 5.20 reveals, foreign government bonds have only represented a negligible part of the collateral pledged to the BoJ since that time.

More relevant than the financial stability in Japanese financial markets was the economic stability, i.e. fostering the credit availability in the real economy in light of a blurring world economy. Moreover, fiscal stability was to be preserved, in the sense of securing cheap refinancing conditions for the public sector, such that public investments and stimuli could be provided. The reason why the BoJ could focus on the objective of fiscal and economic stability will be discussed in

[234] Comprehensive overviews of BoJ policy measures, including collateral policy measures, are given e.g. by Kamezaki (2011), Mizuno (2009), and Vollmer and Bebenroth (2012) or on the BoJ's website, cf. Bank of Japan, *The Bank of Japan's Policy Measures during the Financial Crisis*, Outline of Monetary Policy, `https://www.boj.or.jp/en/mopo/outline/cfc.htm/`, last accessed April 13, 2016. All relevant press releases and documents defining terms and conditions of the described measures can be found there.

Figure 5.21: Amount Outstanding of USD Funds-Supplying Operations against Pooled Collateral

The figure shows the amount outstanding through the special USD facility, the BoJ as a LOLR introduced in September 2008. Demand initially sharply increased, peaking in December 2008 at around USD 120 billion, but was only temporary. The design of the facility at tight operational conditions induced an almost complete fade-out before the first closing of the facility in February 2010.



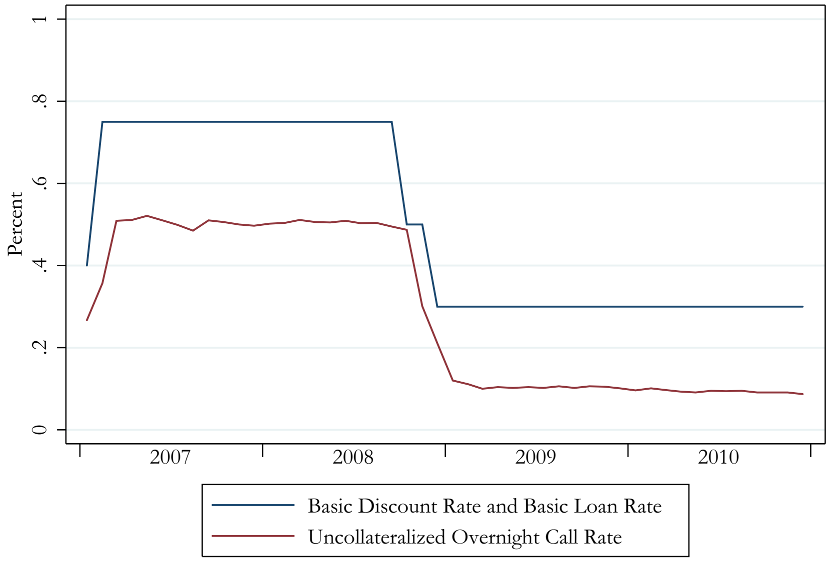
Source: author's illustration; BoJ, The Bank of Japan's Policy Measures during the Financial Crisis.

further detail in Section 6.4. As Figure 6.7 shows, Japanese GDP was already contracting in the early-2000s and then again relatively sharply in 2008 and 2009. At the same time, an erosion of the currency and hence monetary instability due to insufficient collateralization was not a threat because the price level resumed the downwards trend of the early-2000s after the outbreak of the financial crisis. By contrast, monetary stability was rather threatened by deflation, cf. Figure 6.12. The stagflationary tendencies hit the BoJ in times of already very low ammunition from traditional monetary, i.e. interest rate policy left, cf. Figure 5.22. Therefore, the BoJ made adjustments to the eligible collateral pool, focused on easing credit provision to the real economy and – at least to some extent – the Japanese government. The measures can thus be attributed to a MMOLR role, cf. Table 2.2.

In October 2008, the BoJ widened the range of Japanese government securities eligible and in particular accepted within its repo facility by floating rate government bonds, inflation-indexed government bonds and 30-year government bonds. The latter extended the maximally accepted maturity and thereby eased the long-term credit conditions for governments because counterparties now had the opportunity to pledge those debt instruments. In December 2008, the Development Bank of Japan was accepted as a counterparty. Since then, it has been able to directly refinance its (subsidized) loan-making to companies at the central bank, e.g. using the commercial papers acquired in this process. Similarly to the auxiliary constructions with public institutions described in Chapter 3, central bank funds could thus be directed to publicly-desired investments in Japan. Furthermore, the BoJ temporarily offset a provision against close links for commercial papers until April 2009. Counterparties could now pledge own-use (asset-backed) commercial papers if these met the additional criteria such as rating requirements. The eligibility was extended several times

Figure 5.22: Bank of Japan Policy Rates

The figure shows the interest rates set or targeted by the BoJ. The basic loan rate was lowered from the already low level of .75% that it had maintained since February 2007 to .5% in October 2008 and further to .3% in December 2008. The uncollateralized overnight call rate followed a course below accordingly.



Source: author's illustration; BoJ.

until the end of 2010. Furthermore, the commercial paper repo facility was conducted more frequently and in higher amounts to enhance the effect of this measure. In December 2008, the BoJ made the only reduction to asset quality requirements within its collateral framework, whereby a temporary reduction of the minimum rating requirement for corporate bonds and loans on deeds to companies from Single A to Triple B until April 2009 was made, according to the first-best rule. The measure was prolonged until the end of 2010. In January 2009, the BoJ launched an additional special facility to facilitate corporate financing. Until March 2009, an unlimited amount of liquidity was provided in weekly operations with a duration of three months at the overnight uncollateralized call rate if corporate debt was used for collateralization. All counterparties eligible for the regular funds-supplying operations were eligible here. The special facility was prolonged twice until March 2010. Furthermore, in January 2009, debt issued by real estate investment corporations (including loans) was made eligible if rated Double A or higher. Government-guaranteed commercial papers were added to the list of eligible collateral (and additionally accepted in repos) in February 2009 and thereby excluded from rating requirements. In April 2009, the range of eligible loans on deeds to the public sector was extended to include all loans on deeds to the government and municipal governments, as well as those with government guarantees. The described collateral policy measures represent selective loosening of the collateral policy stance along the horizontal dimension (additional government assets, additional real estate assets, additional government-guaranteed commercial papers, additional loans on deeds), the access window dimension (additional counterparty), the value-level dimension (close links eligibility, allotment amounts) and the vertical dimension (minimum rating requirement lowering), cf. Table 2.2, targeted at the government and companies and hence fostering fiscal and economic stability. Until June 2013, the eligible collateral pool was increased to an amount of JPY 1,164 trillion.[235] Compared to the level of JPY 950 trillion in June 2006 (see above), this is only a relatively slight increase of 22.5%; however, it is rather the selection of the broadening that matters. From Figure 5.20, it is apparent that these selective measures mirrored in the selection of collateral pledged at the BoJ. The amount of private and foreign collateral used almost quadrupled and the amount of government securities pledged also intensified.

In the wake of the Fukushima catastrophe in April 2011, the BoJ installed funds-supplying operations to support financial institutions in disaster areas. To support them, the range of eligible counterparties was extended to all applicant banks and financial institutions from the disaster area. The interest rate was fixed at the uncollateralized overnight loan rate level and up to JPY 150 billion per counterparty was provided for one year. In order to channel funds to the municipal governments and the real economy of the affected regions, eligible collateral in the operations was extended and eligibility criteria were lowered. The pledged collateral in the operation was to comprise corporate bonds, bills and loans on deeds to municipal governments or companies with business offices in disaster areas and the minimum credit rating was lowered to Triple B or – if unrated – suspended provided that the counterparty classified the debtor as a "normal borrower." The setup of this special facility clearly channeled central bank funds regionally to affected areas, representing a MMOLR measure.

Liquidity provision through the special facility to facilitate corporate financing ended after prolongations in March 2010. In order to replace it, the BoJ subsequently set up an even greater program to enhance credit provision to the real economy, namely the loan support program. It was still in effect at the end of 2014 and comprises several special rules to "stimulate bank lending" and "strengthen the foundations for economic growth." Conditions of the preceding special facility – representing a MMOLR measure – have been further eased through the loan support program, being granted for durations of loans extended to up to four years.

In addition to the described measures, operational conditions for collateralized loans were eased by the BoJ, although space was limited here due to the already very low interest rate environment established in Japan during the first half of the 2000s, following the Asian banking crisis. This cemented the MMOLR character of measures. The policy rate was lowered from 0.5% to 0.3% in October 2008 and from 0.3% to 0.1% in December 2008. The interest rate at the complementary lending facility was lowered from 0.75% to 0.5% and from 0.5% to 0.3%, respectively. Figure 5.22 illustrates the changes. Much of the liquidity provided through the measures described above was not allocated in competitive auction schemes, but rather at the fixed policy rate target (uncollateralized overnight call rate). From Figure 5.23, it becomes clear that the BoJ gradually provided an ever larger fraction of its regular funds-supplying operations at the fixed policy rate. Since October 2010, all operations have been allotted at the fixed policy rate. As described above, the character of the funds-supplying operations is thereby turned into a MMOLR measure.

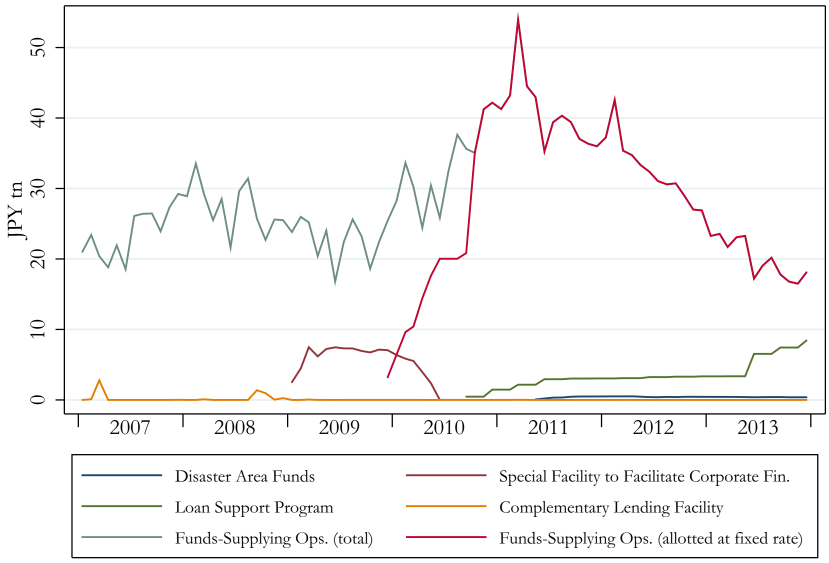
The BoJ also eased operational conditions through its haircut policy. In October 2008 and in October 2009 it lowered haircuts over the entire spectrum of asset types and maturities. This was undertaken again in October 2010, although this time it focused on private asset types rather

[235] This corresponds to 2.425 times the Japanese GDP (Bank for International Settlements, 2015), which amounted to JPY 480,128 trillion in 2013 (World Bank, IBRD).

than government bonds, where collateral value and market value had already been equal. Only in October 2011 and 2012 were the haircuts increased for some assets again. Generally, the BoJ differentiates haircuts according to asset category (see above) and residual maturity, but not credit quality. Only for the assets that were made eligible besides lower credit ratings were higher haircuts defined, although they were subsequently pooled within the whole additionally-eligible credit quality segment (cf. the description of such segmental pooling in the Eurosystem context in Section 4.5.7).

Figure 5.23: Bank of Japan Collateralized Lending Operations (Selection)

The figure shows the development of selected collateralized lending operations offered by the BoJ, which led to the increase in the amount of loans and discounts, as shown in Figure 5.19. Most funds are provided through regular funds-supplying operations, albeit at increasingly favorable conditions (fixed rate versus auction). All three special facilities targeting credit provision to the real economy are visibly used (although the funds to disaster areas make up relatively small amounts). The complementary lending facility fulfills its role as a LOLR facility, which – due to its relatively expensiveness – is only used at times of severe liquidity tensions in financial markets (as well as the respective USD facility, cf. Figure 5.21).



Source: author's illustration; BoJ, Monetary Base and the Bank of Japan's Transactions.

Figure 5.23 shows the size of the above-described collateralized lending operations of the BoJ, which drive the increase of the amount of loans and discounts within the BoJ's assets, as is visible from Figure 5.19. Most funds were lent out through the regular funds-supplying operations. However, the above-described loosening of collateral criteria, the extension of the collateral pool and in particular the loosening of operational conditions – manifesting in the sharp increase of the fraction of funds allotted at the fixed policy target (uncollateralized overnight call rate), regardless of the duration of the loans made – contributed to a temporary doubling in the amount. In addition, the special facilities to foster economic growth make an impact. During the time of operation, the special facility to facilitate corporate financing was used to the amount of around JPY 7 trillion. The loan support program – which was set up as a substitute – gradually built up to a similar level until the end of 2013. While the special facilities requiring special collateral clearly represent the MMOLR role, in pursuit of an economic strengthening, funds-supplying operations can – as described above – also be increasingly attributed thereto. The funds-supplying operations to support financial institutions in disaster areas were capped with respect to the maximum amount per counterparty but are still visibly being used after installation. As one would expect, the true LOLR facility – the complementary lending facility, which operates at a premium rate – was only used in times of severe financial tensions during 2007 and 2008. The same is true for the USD facility, which provided LOLR funds in USD, as shown by Figure 5.21.

5.4 Findings and Comparison to the Eurosystem

Finally, after having presented relevant collateral policy measures of Fed, BoE and BoJ in reaction to the recent crisis, originating in the financial turmoil of 2007 and 2008, this section wraps up outstanding observations and compares them to the Eurosystem's collateral policy, which has been extensively analyzed in Chapter 4. The conclusions are condensed into six observations.

First, collateral policy played differing roles both between the three central banks considered in this chapter and in comparison to the Eurosystem. This is illustrated by the fraction of collateralized lending operations in the balance sheets of central banks and in comparison to outright asset purchases, as illustrated in Figure 4.2 for the Eurosystem, Figure 5.1 for the Fed, Figure 5.12 for the BoE and Figure 5.19 for the BoJ. The Eurosystem conducted its policy exclusively through collateralized lending until July 2009. From then until the end of 2014, purchases have averaged approximately 20% of operations, albeit never exceeding 30%. On the other hand, the BoJ's balance sheet is dominated by outright purchased assets. In 2007, the fraction of loans and discounts averaged 22%, whereby it subsequently grew in importance to an average of 27% between 2008 and 2012, although it never exceeded its March 2011 share of 39%. At Fed and BoE, the importance of collateralized lending is limited upon first glance, although at times reliance on it was strong. The Fed's balance sheet comprised an average of 0.1% of loans in 2007 and an average of 0.01% in 2013. In the aftermath of the financial crisis, it nevertheless peaked at 46% in March 2009, thus making up almost half of the balance sheet. During the financial crisis years of 2008 and 2009, it averaged 24% of the balance sheet. The reliance of the BoE on collateralized lending is even more pronounced: the fraction of collateralized lending-based assets on the BoE's balance sheet averaged 54% in 2007 and hence collateral policy was an important policy means prior to the crisis. In 2013, the BoE almost entirely focused on asset purchases, whereby collateral policy only affected an average fraction of 0.2% over 2013 and 2014. However, in the early crisis management the BoE even intensified collateralized lending compared to the pre-crisis level, whereby the relevant fraction peaked at 78% in February 2009 and averages 62% during the year from July 2008 to June 2009. Collateral policy has thus played the most important role at the Eurosystem compared to the other three central banks, although it was of great temporary significance particularly at the BoE and to a lesser degree the Fed. The BoJ assigned growing importance to collateralized lending after the crisis outbreak, but never the primary role with respect to its balance sheet composition.

Second, the starting position of collateral frameworks implemented by the considered central banks before the crisis differed. The Eurosystem allowed a very wide range of asset types in its eligible collateral set, operated a unique collateral framework, set out quality requirements of Single A and offered its collateralized lending to a very wide set of counterparties. Similarly, the BoJ defined a unique framework comprising a wide range of assets of qualities of at least Single A. However, the importance of public sector assets in comparison to private sector assets was very pronounced and the BoJ only made loans to a smaller range of eligible counterparties, which were only admitted once a year. On the other end of the spectrum, the BoE operated a uniform but very narrow collateral framework. In particular, the collateral set was small, as it only comprised public securities of high quality (at least Double A by a second-best rule). Additionally, both counterparty access and pledgability were restricted. The Fed was the only central bank operating a differentiated collateral framework before the crisis. OMOs were only conducted against a small collateral set with few counterparties, while the discount window offered access to a wide set of counterparties against a wide range of collateral. Quality requirements were differentiated and high (Triple A) for private assets and low (Triple B) for public ones.

Third, the evaluation of the collateral policy of the central banks along the lines of the normative framework summarized in Table 2.2 results in different role-taking by the central banks through the configurations of their collateral frameworks. At the BoE, most measures can be attributed to the LOLR role. In particular, the newly-installed DWF represents a genuine LOLR facility that counterparties can tap on demand and hence the same is true for the CTRF, representing a liquidity-injecting facility activatable at the BoE's discretion. Furthermore, the measures within the special long-term repos and the SLS were targeted at last-resort liquidity provision to the financial system. Only the FLS follows the MMOLR role. The Fed role is in between a LOLR and a MMOLR, nevertheless acting with the intention of only catalyzing credit provision in private markets. The TALF, the AMLF and the MMIFF can be understood in this way, whereas the PDCF and the TSLF rather represent LOLR actions to primary dealers, although they contain elements of ELA and thus a MMOLR. The CPFF is a MMOLR measure, albeit constructed such that the Fed acted as a LOLR to a credit market segment. The TAF and measures affecting the regular discount window represent LOLR measures and stand out in terms of loan volume, cf. Figure 5.3. On the other hand, the BoJ used its collateral policy measures predominantly as a MMOLR. It selectively targeted market segments and regions and supported loan-making in the loan support program. Collateral policies affecting LOLR measures as the foreign currency facility and the complementary lending facility remain on the sideline. The funds-supplying operations against pooled collateral account for a large part of the collateralized lending of the BoJ, cf. Figure 5.23. Over time, they developed into a MMOLR facility. The reasons are similar to those discussed in Section 4.7, as the collateral policy affecting this facility resembles that conducted by the Eurosystem. However, given that a broad set of collateral is eligible for these operations and no explicit targeting is visible from the design, it remains unclear which market segments benefit most from the market-making. Therefore, the discussion on the impact and effects of collateral policy in the following Part III of this dissertation is especially important in terms of understanding the market-making of the Eurosystem and the BoJ.

Bank for International Settlements (2015) provides insights into the quantitative broadenings of the eligible collateral pools, i.e. the size of the pools relative to respective GDPs. They match the above-described roles in conjunction with the starting positions described above. The BoE – which maintained the narrowest eligible collateral pool before the crisis but then primarily took the role of a LOLR, which according to Table 2.2 should offer liquidity against a wide range of assets, freeing up large parts of banks' assets – increased its pool size (relative to GDP) the most, by a factor of approximately 2.5 between June 2006 and June 2013. In second position, the Fed's eligible collateral pool increased around 1.5-fold, because for some Fed lending facilities it had already been quite wide, such that the broadening was rather selective. The BoJ only increased its pool by the factor of 1.3,[236] as it primarily pursued MMOLR policies, selectively targeting markets. For comparison, the figure resulting from Bank for International Settlements (2015) for the Eurosystem is 1.5. However, manifold details on the broadening of the Eurosystem's collateral pool have been provided in detail in Section 4.6.

Fourth, as indicated within the previous two observations, in contrast to the Eurosystem, the Fed has always had and the BoE as well as the BoJ have developed differentiated eligible collateral sets along the horizontal, vertical and time dimensions. While admittedly the BoJ in principle remained a unique eligible collateral set for its standard lending facilities, it defined additional prerequisites on the collateral eligible in its special facilities, such as disaster area funds, the special facility to facilitate corporate financing and the loan support program. By contrast, the BoE completely differentiated its eligible collateral into several sets (levels, cf. Section 5.2.6). The different sets were subsequently assigned to different collateralized lending facilities. Moreover, the Fed introduced differentiated facilities, all of which drew upon individual collateral criteria and thus defined differing eligible collateral sets. Moreover, Fed and BoE targeted already-issued debt in their CPFF and SLS. The differentiation of collateral sets and facilities makes it possible to take different roles at the same time or to weighted degrees. It is a straightforward application of the differing normative suggestions of Table 2.2 in case of more than one central bank objective, which has already been identified in Chapter 3. Moreover, it helps to mitigate trade-offs between the monetary stability objective and the fiscal and economic stability objective as well as the financial stability objective, which will be discussed theoretically in Chapter 6.[237] On the other hand, the Eurosystem conducts almost all of its collateralized lending (which concurs with the largest chunk of its operations) within one facility – namely as LTROs of differing maturities – and against one unique eligible collateral set.

Fifth, the behavior described directly above extends to operational conditions. In particular, the Eurosystem conducts all of its OMOs at the main refinancing rate – which it lowered massively (almost) to the ZLB – and follows a full allotment policy. Additionally, haircuts were set in a favorable manner, see Section 4.5 and for a comparison to haircuts in private markets Section 7.1.2.[238] By contrast, BoE and Fed make most of their collateralized lending in auction processes or at set up premia in lending conditions. Even their MMOLR measures thus have at most a catalytic influence on credit provision. The BoJ has increasingly followed the full allotment at the fixed-rate policy of the Eurosystem over time.

Sixth, most collateral policy measures discussed in this chapter were temporary. The Fed facilities all expired, as did the special facilities of the BoE and BoJ. Furthermore, the lowering of the quality requirements on the unique collateral set at the BoJ was temporary. Accordingly, the central banks also only temporarily took the roles of LOLR and MMOLR through collateral policy. On the other hand, at the Eurosystem, several measures were repeatedly prolonged and finally made permanent, as described in Chapter 4.

236 However, the shrinking GDP in Japan makes the increase appear larger than it was in absolute terms. Correcting for this rather yields an increase of 22.5%, as stated in Section 5.3.2.

237 An additional minor observation is that that Fed and BoE conduct some of their collateralized lending as swaps to achieve an automatic sterilization with respect to monetary stability. The BoE even actively sterilized its special long-term repos.

238 Indeed, the a premium of 25 to 75 basis points has been applied at the marginal lending facility, although this lost importance due to the full allotment policy of the Eurosystem.

Part III

Impact and Effects of Collateral Policy

Chapter 6

Collateral Policy Transmission and the Decision of the Central Bank

The discussion in Part I has deduced the three central bank objectives of monetary stability, fiscal and economic stability and financial stability and classified collateral policy as well as proposing the configuration of the collateral framework along six dimensions within. Part II provided in-depth presentations of collateral policy measures in practice and assigned the central bank roles of COMPR, LOLR and MMOLR in pursuit of the objectives. This third part explains the impact of the collateral policy measures discussed in the previous part and reveals the effects of the collateral policy measures (in particular of the Eurosystem).

As a first step, this chapter *(1)* incorporates the central bank objectives deduced in Chapter 1 into a formal central bank objective function (Section 6.1). Its technical components are later illustrated with empirical observations for the four important central banks known from Part II, i.e. the Fed, the BoE, the BoJ and the ECB (Section 6.4). The presentation of collateral policy measures in practice (Part II) is thus put into the perspective of an objective function at work in the background, leading the central banks in their decision-making. The chapter also *(2)* explains the transmission process of collateral policy in comparison to classical interest rate policy (Sections 6.1 and 6.2), and *(3)* enriches the normative framework presented in Chapter 2 by concluding in Section 6.3 the optimal use of collateral policy tools from the theoretical analysis in *(2)*. To simplify the following analysis, collateral policy options are for the time being reduced to only two dimensions: the haircut definition, representing operational criteria (value-level dimension); and the quantitative dimension of the eligible collateral pool (horizontal dimension), cf. Table 2.2. The vertical dimension of collateral quality is muted and will be discussed again in Chapter 7. Chapter 8 will later base on particularly the analysis of trade-offs within the central bank decision-making conducted in this chapter when presenting distribution effects of collateral policy measures.

The following conclusions can be drawn from the analysis in this chapter. Both monetary stability and fiscal and economic stability can be affected by the central bank through the impact of interest rate policy, haircut policy and quantity policy at the level of bank lending. The central bank can influence bank lending solely with the help of interest rate policy if refinancing of banks' loan-making shall be made through the money market. However, it can use both interest rate policy and collateral policy to stimulate bank lending if it undercuts market conditions. Moreover, it can stimulate bank lending beyond the interest rate policy-restricting ZLB by using haircut policy. Financial stability can be influenced through all three policy instruments, albeit to the greatest extent through quantity policy. From the analysis of the trade-offs and interdependencies between central bank policy in pursuit of the three objectives, three conclusions are drawn with respect to the optimal use of collateral policy instruments, in the spirit of the Tinbergen principle: *(i)* A central bank in the role of a COMPR – i.e. pursuing monetary stability – should primarily use interest rate policy; *(ii)* a central bank acting as a MMOLR can reduce its trade-off between monetary stability and economic stability through the selective use of haircut policy; and *(iii)* a LOLR should primarily use quantity policy, i.e. maintain a large eligible collateral pool.

The illustration of the practical realization of weights and driving forces within the objective functions of the Fed, the BoE, the BoJ and the ECB with the help of empirical observations yields the following results. LOLR policies as described for the Fed and the BoE in Chapter 5 have been induced by a strong weight on the financial stability objective. Equally, the MMOLR policies identified at the BoJ and Fed match developments in the fiscal and economic stability gaps. For the ECB – subserving a monetary union of sovereign nation states – the case is more complicated: during the financial crisis period, its LOLR role was called upon to a greater degree by the state of financial systems in crisis countries, but to a lesser degree by the shape of financial stability in Germany and other EMU members. As the ECB mandate does not explicitly define a fiscal and economic stability objective but still leaves room for interpretation, the MMOLR role that it took according to the analysis of its collateral policy in Chapter 4 can only be explained by differences in the perception of the mandate and central banking in general within the union *in combination* with differences in the need for fiscal and economic stabilization. By the same token, the evidence presented leads to the argument that the trade-off to monetary stability was perceived in diverging ways in EMU member countries.

6.1 The Central Bank's Objective Function

Consider the central bank's quadratic loss function containing three elements representing the three possible central bank objectives:

$$\begin{aligned} L = \frac{1}{2}\left(\pi^T - \pi(r^{CB}, h^{CB}, \Psi^{CB})\right)^2 \\ + \frac{1}{2}\beta\left(Y^T - Y(r^{CB}, h^{CB}, \Psi^{CB})\right)^2 \\ + \frac{1}{2}\gamma\left(S^T - S(r^{CB}, h^{CB}, \Psi^{CB})\right)^2 . \end{aligned} \tag{6.1}$$

The first term refers to monetary stability. The functional form assumes that the monetary stability objective of the central bank has been translated into a price stability goal measured by an inflation target π^T. Any deviation from the target value leads to a loss from the central bank's perspective. Positive and negative deviations of the same magnitude are hereby of equal importance to the central bank. Fiscal and economic stability is covered by the second term. A socially desirable target level of economic output in terms of GDP, Y^T, is defined for the economy. This level may e.g. be defined by full employment. The stock of capital employed – which is consistent with sustainable investment activities – could be another defining factor. In any case, economic growth should be prevented from overheating. Government activity within aggregate demand is included in output Y.[239] Any output gap relative to the target level – either positive or negative – will cause a loss to the central bank. However, this is only the case to the extent that β the central bank pursues a fiscal and economic stability objective. The objective function of a central bank focusing only on the two other objectives would be characterized by $\beta = 0$, such that there would not be any market-making to stabilize the real economy or public finances. Finally, the financial stability objective is addressed through the third term. S^T defines the desirable level of financial stability that sustains the effectiveness of the central bank's LOLR role. Any stability level below S^T risks uncontrollable panics on financial markets, cf. Section 2.3. Any level above would represent an over-sized outside option, resulting in the classical moral hazard problematic of insurance, cf. the discussion in Section 2.3. The central bank takes its financial stability objective into account to the degree of γ. The impact channels of central bank policy – i.e. the transmission of interest rate policy (r^{CB}), haircut policy (h^{CB}) and quantity policy (Ψ^{CB}) – on the three components of inflation, output and financial stability are presented in the following.

6.1.1 Policy Influences on Monetary Stability

For the sake of this model, monetary stability is affected via the influence of central bank policy on inflation in two ways. For one, prices will increase if output Y increases.[240] The reason is that any output increase in this model is due to an increase in aggregate demand, which has been stimulated by increased credit provision of the central bank to the real economy or the government. In particular, bank lending and hence funding of investment projects will increase if the central bank offers more favorable refinancing conditions (value-level dimension, cf. Table 2.2).[241] The investment demand shock will then either induce an overall demand-driven economic activity increase or strengthen demand in specific market segments dependent on the collateral for which conditions are being eased. Aggregate supply is (at least from a short-term perspective) rigid and can only keep pace with the higher aggregate demand with the support of price increases. Moreover, the investment projects set up at the margin of the cheaper effective refinancing conditions are of a lower profitability. If they were of a high profitability, they would already have been put into practice at higher refinancing conditions. The higher costs associated with the lower productivity place additional upward pressure on prices. Also, higher demand for labor as a complementary production factor might result in higher wages. If the productivity increase – as a result of the low marginal productivity of capital (and labor) – falls short of the increase in money supply, inflation will also persist from a longer-term perspective.

For another, an increase in credit provision – as described above – can be consequent on a large eligible collateral pool, i.e. the amount of eligible collateral from a purely quantitative perspective (horizontal dimension, cf. Table 2.2). Expressed as the collateral value, this amount is a determinant for the maximum amount of liquidity that can be drawn directly from the central bank. The actual use of this pool – and thus the expansion of the monetary base, which may eventually lead

[239] If collateral criteria favor government debt accumulation, a greater part of aggregate demand can be contributed by the government, with fiscal stability being maintained at the same time.

[240] See e.g. Ball (1993), Ball et al. (1988), and Taylor (1994) on the inflation versus output trade-off.

[241] Lehmbecker (2008) confirms this negative correlation between eligible collateral quality (thus collateral policy leading to favorable refinancing conditions along the value-level dimension) and inflation.

to inflation – is usually under the direct control of the central bank, because in normal times credit is usually provided within auctioning procedures of fixed volume tenders. Admittedly, standing on-demand facilities offered at a fixed rate – such as discount windows – could in principle be used up to the collateral value of eligible collateral, although in normal times they are unattractively expensive relative to inter-bank or market refinancing options. This entirely changes in times of crisis. First, the discount window conditions now become attractive as market rates surge and market supply freezes. Second, the LOLR frequently reacts with fully-allotted liquidity provision at fixed (and in crisis below-market) rates. In fact, if there is no market supply of liquidity, any rate is a below-market rate. The quantitative size of the eligible collateral pool is subsequently a determining factor of the increase in the monetary base and hence of potentially inflationary effects. Most of the liquidity provided to counterparties by the central bank during crises is certainly kept at the central bank in excess reserve accounts, although in principle counterparties can use this liquidity to provide new loans to the real economy.[242] The recent discussion of exit strategies in the light of central banks' balance sheet expansions underlines the importance of this argument.[243]

Both of the above-described influences on monetary stability through *(i)* interest rate policy or haircut policy, affecting the refinancing conditions along the value-level dimension, and *(ii)* quantity policy, affecting the collateral pool along the horizontal dimension, are transmitted to the elements of the central bank loss function (6.1) via bank lending. The formal mechanism is thus as described in the following section.

An additional inflationary effect arises from a potential loss to the central bank's balance sheet. At any given interest rate – which is uniform for all counterparties and all types of collateral – the haircut is the only risk-mitigating instrument, as shown in Section 4.5. Lowering the haircut triggers the financing of investment projects associated with lower expected profitability, which can also mean higher pay-off uncertainty. The likelihood that the collateral has to be exploited by the central bank is thus higher, although at the same time the risk-buffering function of the haircut is smaller and the collateral might be of lower quality. Thus, the central bank faces a potential loss as an asset fails. Subsequently, it would have handed out money against an asset that has disappeared, whereby the backing for the total outstanding amount of money is hence smaller and the prices of real goods and services in the economy are inflated relative to the value of the currency. This additional inflationary effect is similar to the above-described effects on monetary stability in the sense that a loosening (tightening) of interest rate policy or haircut policy makes the potential loss and hence the inflationary effect more likely and larger (less likely and smaller). Therefore, it is not modeled explicitly to avoid redundancy. Nevertheless, the model presented in Chapter 7 will illustrate how inadequate haircut-setting in the pursuit of higher fiscal or real economic rents leads to increased risk for the central bank's balance sheet.

6.1.2 Policy Influences on Fiscal and Economic Stability

The influence on fiscal and economic stability in this model works through a bank lending channel – as outlined in the following – which affects credit provision to the real economy and eventually output. The mechanism for credit provision to the government is analogous and in fact included

[242] See also e.g. Cukierman (1994) and End (2010) for a discussion of the price stability versus financial stability trade-off.

[243] See e.g. Bernanke (2009a), Blinder et al. (2013), Gavin (2009), Meier (2009), Stella (2009), and Trichet (2010b).

here, as fiscal activity is a part of aggregate demand. The interest rate policy transmission described here works similarly to the classical interest rate channel of central bank policy transmission (e.g. Mishkin, 1995). Nonetheless, to show the peculiarities of collateral policy transmission, a simple mechanism is additionally introduced.[244] A representative bank involved in the business of loan-making to investors in the national real economy draws upon liquidity from an international money market and a central bank. In a first step, the central bank is only national as well, although later the setting is extended to two banks in two countries within a monetary union.

The Representative Bank Consider a profit-maximizing bank that chooses the level of investment that it finances through loan-making. The level that it finances is BL and it yields a return of $G(BL)$, which is non-negative, strictly increasing and concave in BL, such that $G(BL) \geq 0$, $G'(BL) > 0$, $G''(BL) < 0$, $\lim_{BL \to 0} G'(BL) = \infty$ and $\lim_{BL \to \infty} G'(BL) = 0$. Higher levels of BL can hence be associated with the financing of less profitable investment projects in an economy. The investment projects are uncertain – depending on the investment climate in the country in which the bank operates – and only pay off with probability p, where $0 \leq p \leq 1$.

The representative bank has two options to refinance its loans, namely the central bank and the money market. The refinancing costs are summarized in the following cost function:

$$C(BL) = \begin{cases} pr^{MM}BL + (1-p)m^{MM}BL & \text{if refinancing in money market,} \\ pr^{CB}BL + (1-p)m^{CB}BL & \text{if refinancing at central bank.} \end{cases} \tag{6.2}$$

In case the investment project does not pay off (probability $(1-p)$), the bank defaults on its refinancing loan and the ownership of the collateral is transferred to the money market or the central bank, respectively. The market value of the collateral has to be at least as high as the loan value from the money market or the central bank, which is equal to the value of the bank lending to an investment project, i.e. BL plus an initial margin $m = \frac{1}{1-h}$, which is implicitly determined by the haircut definition of the central bank or the money market, respectively, as further discussed below.[245] If the investment project pays off (probability p), the bank earns $G(BL)$ and repays its refinancing loan at the central bank's or the money market's interest rate $r \geq 1$. The optimization problem of the representative bank is summarized by

$$\max_{BL} \left[pG(BL) - \min[pr^{MM}BL + (1-p)m^{MM}BL, pr^{CB}BL + (1-p)m^{CB}BL] \right]. \tag{6.3}$$

244 The transmission channel modeled to explain the impact of central bank policy and especially collateral policy on bank lending and thus on output builds upon work of Cassola and Koulischer (2014), see also Cassola and Koulischer (2016), Koulischer (2015), and Koulischer and Struyven (2014). However, the model in this dissertation abstracts from moral hazard à la Holmström and Tirole (2011), shifting the focus to the utility of collateral policy as a policy tool within the different central bank objectives. Banks can *only* obtain refinancing liquidity using collateral. In addition, the more realistic assumption of counterparty-unspecific interest rate is not only made for the central bank, but also for money market financing. Standardized liquidity-providing facilities not only exist at central banks but also in the inter-bank market, e.g. at CCPs, see Section 7.2. Moreover, these facilities differentiate haircuts between different collateralizing assets, in contrast to the assumption of Cassola and Koulischer (2014) the type of asset *does* matter. This is captured through the introduction of individualized default probabilities for collateral.

245 The transformation of the initial margin into the haircut is as explained in Section 4.5.2. Note that $\frac{\partial m}{\partial h} = \frac{1}{(1-h)^2} > 0$ – i.e. changes of the haircut h – influence the margin m in the same direction.

Both refinaning options require collateralization. Consequently, the bank's given stock of eligible collateral results in the following collateral restriction:

$$BL \leq \begin{cases} PCV = (1-h^{MM})MV(A_e^{MM}) = \frac{MV(A_e^{MM})}{m^{MM}} & \text{if refinancing in money market,} \\ ECV = (1-h^{CB})MV(A_e^{CB}) = \frac{MV(A_e^{CB})}{m^{CB}} & \text{if refinancing at central bank.} \end{cases} \tag{6.4}$$

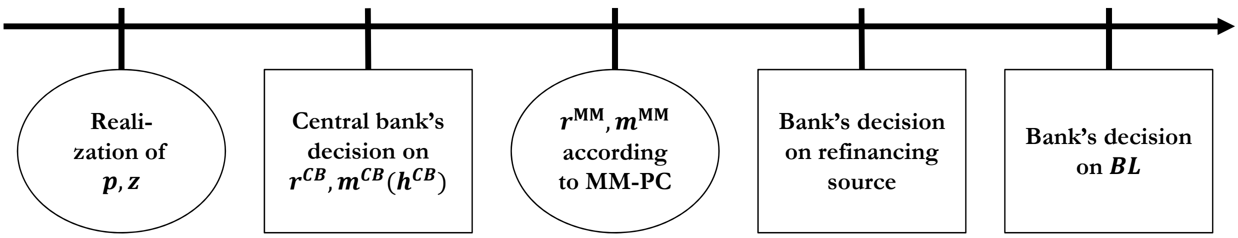
Hence, the amount of bank lending has to be smaller than or equal to the collateral value CV, cf. (4.1), which is defined as the haircut-adjusted market value of the assets on the bank's balance sheet that have been deemed eligible by either the central bank or the money market. ECV denotes the collateral value at the central bank and PCV in the money market, respectively. The bank owns an exogenously given stock of assets, the eligible part of which is assumed to suffice to collateralize any amount of BL.[246] The impact of a binding collateral constraint is discussed below.

The Money Market An international money market comprises risk-neutral liquidity-providing institutions – which could be other banks, corporations or funds, etc. – with excess cash. The market is perfectly competitive. There are two options for the private liquidity on the money market to be invested into: *(i)* the central bank offers an unlimited deposit facility at a constant interest rate, which is identical to the refinancing rate for the representative bank, i.e. r^{CB}, representing the money market's safe outside option; and *(ii)* the excess cash can be provided as a refinancing loan to the bank, whereby the expected return is then $BL[pr^{MM} + (1-p)zm^{MM}]$, where $(1-z)$ is the probability of collateral default, with $0 \leq z \leq 1$.[247] z is specific to the collateral pledged, but for now there is only one type of collateral that the representative bank owns. Evolving from the two options for the money market, its participation constraint in the refinancing loan (MM-PC) is

$$pr^{MM}BL + (1-p)zm^{MM}BL \geq r^{CB}BL. \tag{6.5}$$

The money market observes r^{CB} and subsequently offers conditions for refinancing loans – i.e. r^{MM} and m^{MM} – such that (6.5) is binding owing to the competitive market structure. After this, the bank decides on the refinancing source and level of bank lending according to (6.3). The course of action is illustrated in Figure 6.1. Following the order of backwards induction, the next section derives the bank's decision.

Figure 6.1: Course of Action



Source: author's illustration.

[246] See Section 6.1.3, for details on the eligible fraction of banks' assets.

[247] z can also be interpreted as the fraction of the market value of the collateral that can actually be realized by the creditor in case of the bank's default.

Bank's decision The bank maximizes (6.3). Comparing the costs of funding, it chooses its refinancing source:

$$pr^{MM} + (1-p)m^{MM} \lesseqgtr pr^{CB} + (1-p)m^{CB}. \tag{6.6}$$

The decision is now divided into two parts: *(i)* refinancing (borrowing) in the money market, if the RHS of (6.6) is greater or equal;[248] or *(ii)* refinancing (borrowing) at the central bank, if the left hand side (LHS) of (6.6) is greater.

(i) Refinancing in Money Market
If the bank borrows from the money market, the first-order condition (FOC) yields

$$pG'(BL) - (pr^{MM} + (1-p)m^{MM}) \stackrel{!}{=} 0. \tag{6.7}$$

The marginal expected return from one unit of bank lending into investment projects has to equal the marginal cost of funding in the optimum. Plugging in from (6.5) and solving for the optimal bank lending level yields

$$BL^{MM} = G'^{-1}\left(\frac{pr^{MM} + (1-p)m^{MM}}{p}\right) = G'^{-1}\left(\frac{r^{CB}}{zp} - \frac{(1-z)}{z}r^{MM}\right). \tag{6.8}$$

The optimal bank lending level is determined by the inverse of $G(\cdot)$, which is strictly decreasing in the argument and convex, hence the investment level negatively depends on both the interest rate r^{MM} and the margin m^{MM} (and thus also the haircut h^{MM}) but positively on the investment climate p. (6.8) now offers two scenarios: *(a)* the case of completely safe collateral, $z = 1$; and *(b)* risky collateral, $0 < z < 1$.

Ad *(a)*, where $z = 1$:

$$BL^{MM}_{z=1} = G'^{-1}\left(\frac{r^{CB}}{p}\right) = G'^{-1}(\Omega_I) \tag{6.9}$$

$$\frac{\partial\Omega_I}{\partial r^{CB}} = \frac{1}{p} > 0 \tag{6.10}$$

The bank lending level – and thus the investment level in the real economy – is higher the better the investment climate in a country, i.e. the higher p, cf. (6.9). As expected, the level of bank lending also negatively depends on the central bank interest rate r^{CB}. The maximum level of bank lending achievable for the central bank is $BL^{MM}_{z=1,\max} = G'^{-1}(\frac{1}{p})$, where $r^{CB} = 1$, i.e. at the ZLB. $BL^{MM}_{z=1,\max}$ is the highest for $p = 1$, as then Ω_I is the lowest. Any marginal increase of the central bank policy rate increases the argument Ω_I (decreases $BL^{MM}_{z=1}$), and the effect is the stronger the smaller p, cf. (6.10). For the central bank, this means that it is easily possible to transmit its policy to the real economy through interest rate policy if investment projects in the economy are not too uncertain. Subsequently, the central bank does not have to lend itself, but can trigger increased

[248] Hereby, the simplifying assumption is made that the bank chooses refinancing at the money market whenever both refinancing options offer equal conditions. Thus, it is abstracted from any equilibrium in mixed strategies in case of equal conditions.

money market refinancing at eased conditions until the ZLB is reached. In the following, this case shall be called Scenario I.

Ad *(b)*, where $0 < z < 1$:

$$\begin{aligned} BL^{MM}_{0<z<1} &= G'^{-1}\left(\frac{r^{CB}}{zp} - \frac{(1-z)}{z} r^{MM}\right) \\ &= G'^{-1}\left(\frac{r^{CB}}{p} + \frac{(1-z)(1-p)m^{MM}}{p}\right) \qquad (6.11) \\ &= G'^{-1}\left(\Omega_{II}\right) < G'^{-1}\left(\Omega_{I}\right) = G'^{-1}\left(\frac{r^{CB}}{p}\right) = BL^{MM}_{z=1} \qquad (6.12) \end{aligned}$$

$$\frac{\partial \Omega_{II}}{\partial r^{CB}} = \frac{1}{p} = \frac{\partial \Omega_{I}}{\partial r^{CB}} > 0 \qquad (6.13)$$

If the collateral is not completely safe – whereby it remains uncertain whether the collateral can be utilized in case of a bank default at all (or to what extent) – the level of bank lending is below the level in Scenario I, cf. (6.11) versus (6.9). This is true for any given value of r^{CB} conditional on $z < 1$ (as assumed in this case) and $p < 1$, i.e. imperfect investment certainty.[249] The reason is that the money market chooses a combination of r^{MM} and m^{MM} making itself indifferent between the deposit facility at the central bank and the refinancing loan to the bank. (6.5) has to hold. In the argument in $G'^{-1}(\Omega_{II})$, the latter part represents the value of what is additionally at stake for each unit of the loan. This increases the argument and thus lowers BL. As a result, it is more difficult for the central bank to steer the level of investment via the interest rate channel and through the money market. Indeed, the marginal effect of a change in the policy rate is equal to Scenario I, cf. (6.13). However, because the money market wants to be compensated for the additional risk, refinancing from the money market is more expensive compared to Scenario I for any given central bank policy rate, cf. (6.12). Moreover, the perception of z in the money market can change or be distorted – e.g. in the case of rating distortions – as theoretically analyzed in Chapter 7. This directly affects the investment level that is refinanced through the money market. In any case, the ZLB for the central bank thus becomes binding in the sense that additional investment cannot be triggered more quickly. At this ZLB, the maximum investment level that can be reached is $BL^{MM}_{0<z<1,\max} = G'^{-1}\left(\frac{1}{p} + \frac{(1-z)(1-p)m^{MM}}{p}\right)$, and hence lowered compared to Scenario I to the extent of the second term in the argument. In the following, the result discussed will be called Scenario II.

(ii) Refinancing at Central Bank

If the bank's evaluation of (6.6) leads to the decision to borrow from the central bank, the FOC yields

$$pG'(BL) - (pr^{CB} + (1-p)m^{CB}) \stackrel{!}{=} 0. \qquad (6.14)$$

Again, in the optimum, the marginal expected return from one unit of bank lending into investment projects has to equal the marginal cost of refinancing this very unit of bank lending. From this,

[249] Also, $z(1-p)m^{MM} > 0$ has to hold, which applies for any positive margin defined by the money market.

the optimally-chosen level of bank lending can be deduced:

$$BL^{CB} = G'^{-1}\left(\frac{pr^{CB} + (1-p)m^{CB}}{p}\right) = G'^{-1}\left(r^{CB} + m^{CB}\frac{(1-p)}{p}\right) = G'^{-1}\left(\Omega_{III}\right) \tag{6.15}$$

$$\frac{\partial\Omega_{III}}{\partial r^{CB}} = 1 \tag{6.16}$$

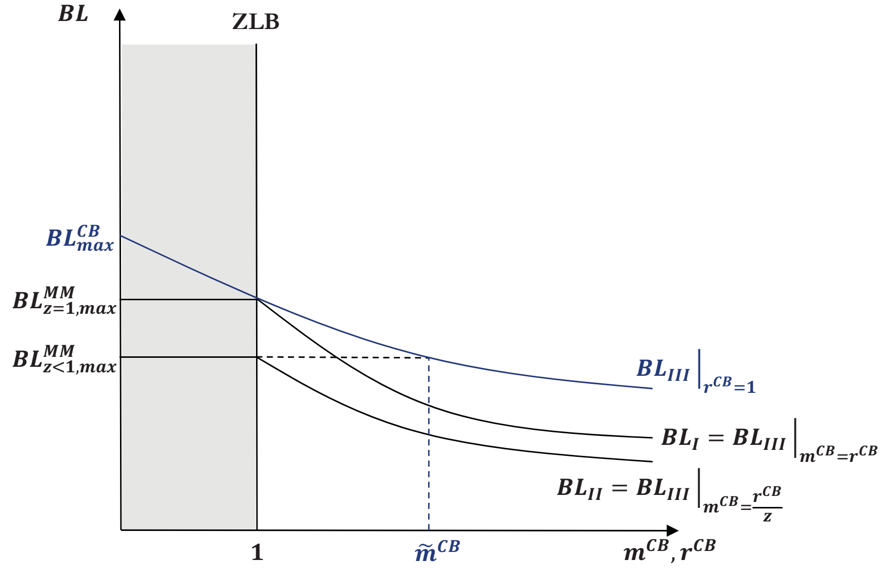
$$\frac{\partial\Omega_{III}}{\partial m^{CB}} = \frac{1-p}{p} > 0. \tag{6.17}$$

In this Scenario III, the level of bank lending and thus investment does not depend on the collateral risk z, cf. (6.15). The central bank can choose discretionally the extent to which it wants to be compensated for this risk. However, the level of bank lending depends on the investment safety p, as the margin m^{CB} set by the central bank is due more frequently the riskier the investment climate. This is the case because consecutively the bank expects the loss of its collateral more frequently. Any choice of r^{CB} and m^{CB} leading to refinancing at the central bank – cf. (6.6) – undercuts the money market conditions and hence represents a subsidy relative to private refinancing conditions. On the other hand, if the central bank decides to set its conditions such that the money market is circumvented and banks turn to the central bank for refinancing directly, the investment level is perfectly steerable for the central bank. As (6.16) reveals, the tractability through the interest rate channel is most direct and not weighted by p, as it is in the previous scenarios. However, the investment level is always diminished by the second term in Ω_{III}, unless the investment climate is perfectly good, i.e. $p = 1$. In addition to the interest rate channel, for any $p < 1$ the central bank can support investment in the real economy by lowering the haircuts that it imposes on the market value of the collateral. This can be especially relevant as it extends the policy means beyond the ZLB. If there is uncertainty $p < 1$, this collateral policy channel is more powerful the higher the uncertainty, i.e. p is lower because the marginal impact – cf. (6.17) – is then especially large relative to the marginal impact of interest rate policy, cf. (6.16). Collateral policy is subsequently relatively more powerful compared to interest rate policy. In principle, the central bank can achieve a maximum investment level of $BL^{CB}_{\max} = G'^{-1}(1)$, independent of both the investment climate and collateral risk. However, this would also mean that all risk would be borne by the central bank.

Figure 6.2 summarizes the policy options for the central bank to influence bank lending discussed above. On the abscissa, the values of r^{CB} and m^{CB} are running. The depiction takes account of the fact that the interest rate cannot fall below the ZLB. The level of bank lending is given on the ordinate. p and z are assumed to be constant in this picture. Furthermore, it is assumed that m^{MM} is chosen such that it exactly covers the risk of collateral loss – i.e. $m^{MM} = \frac{r^{MM}}{z}$ – and due to the competitive money market $r^{MM} = r^{CB}$, and hence $m^{MM} = \frac{r^{CB}}{z}$. In Scenario I, the level of bank lending for any central bank policy rate r^{CB} runs above the level in Scenario II, owing to the uncertainty within the collateral in Scenario II. However, the difference becomes smaller for larger interest rates and is largest at the ZLB. Any haircut policy by the central bank in these two scenarios is worthless because all bank refinancing goes through the money market. Both bank lending curves hit their maximum as $r^{CB} = 1$, i.e. at the ZLB.

Whenever the central bank sets refinancing conditions below market conditions, it circumvents the money market and provides refinancing to banks directly. However, note that in the assumed case of $r^{MM} = r^{CB}$ this is only possible through a haircut policy that does not completely cover the

Figure 6.2: Bank Lending



Source: author's illustration.

collateral risk, because it must be the case that $m^{CB} < m^{MM} = \frac{r^{CB}}{z}$. Starting from the curve for Scenario II, the central bank can reach all levels of bank lending represented by the area above this curve and below the curve for Scenario I by setting $r^{CB} \leq m^{CB} < \frac{r^{CB}}{z}$, namely by not completely taking the collateral risk into account. Haircut policy and interest policy are substitutable within the boundaries set by the ZLB and the condition to remain below market refinancing conditions. At $m^{CB} = r^{CB}$, the central bank would act as if the collateral would be completely safe. Note that in any case the expected repayment per unit of refinancing loan from the bank to the central bank is below r^{CB}.

The blue line illustrates possibilities for haircut policy if the ZLB is already reached by the interest rate policy, such that $r^{CB} = 1$. It also marks the upper bound for levels of bank lending, which is now only dependent on the value of m^{CB}, as $r^{CB} = 1$. On this upper bound, $\tilde{m}^{CB} = \frac{1}{z}$ marks a critical border. Any haircut lowering from there – such that $m^{CB} < \tilde{m}^{CB}$ – implies two things. First, the level of bank lending increases beyond the maximally possible level of bank lending refinanced through the money market, i.e. $BL^{MM}_{0<z<1,\max}$. This level could also have been implemented through money market refinancing and interest rates set to unity. Second, the repayment that the central bank can expect per unit of BL if $m^{CB} < \tilde{m}^{CB}$ is smaller than one, which means that the nominal value of the expected repayment is smaller than the nominal value of the loan. Another border is crossed when $m^{CB} < 1$, whereby the refinancing loan is then de facto partially uncollateralized. In this case, the value of the refinancing loan even exceeds the market value of the collateral. Incidentally, the effect of an insufficient $m^{CB} < 1$ is the same as an over-valuation of the collateral (perhaps within a theoretical valuation process). Therefore, one can think of this area as either an over-valuation of a theoretically valued asset or a loan against insufficient collateral (as e.g. ELA). However, the haircut policy also offers an opportunity to cross the ZLB here and further increase the level of bank lending. At $m^{CB} = 0$, all policy tools included in this model are exhausted, the refinancing is de facto completely uncollateralized and $BL^{CB}_{\max} = G'^{-1}(1)$

is reached. The possibilities for a central bank to affect bank lending levels described above are summarized in Lemma 6.1.

Lemma 6.1 (**Transmission of Central Bank Interest Rate Policy and Haircut Policy to Bank Lending Levels**).

i) *In Scenario I, where bank lending to investment projects is refinanced in the money market and the collateral is completely safe, the central bank can influence the investment level through interest rate policy. The maximum level of bank lending that can be reached at the ZLB is* $BL^{MM}_{z=1,max} = G'^{-1}(\frac{1}{p})$.

ii) *In Scenario II, where bank lending to investment projects is refinanced in the money market and the collateral is risky, the central bank can influence the investment level through interest rate policy. The maximum level of bank lending that can be reached at the ZLB is* $BL^{MM}_{0<z<1,max} = G'^{-1}\left(\frac{1}{p} + \frac{(1-z)(1-p)m^{MM}}{p}\right)$, *which is below the levels reached in Scenario I.*

iii) *In Scenario III, the central bank undercuts market conditions such that bank lending to investment projects is refinanced at the central bank directly. The central bank can subsequently influence the investment level through interest rate policy and haircut policy, which are substitutable within boundaries. The maximum level of bank lending that can be reached at the ZLB is equal to the maximum level reachable in Scenario I. However, the ZLB can be crossed through haircut policy such that a higher maximum level of bank lending of* $BL^{CB}_{max} = G'^{-1}(1)$ *can be reached.*

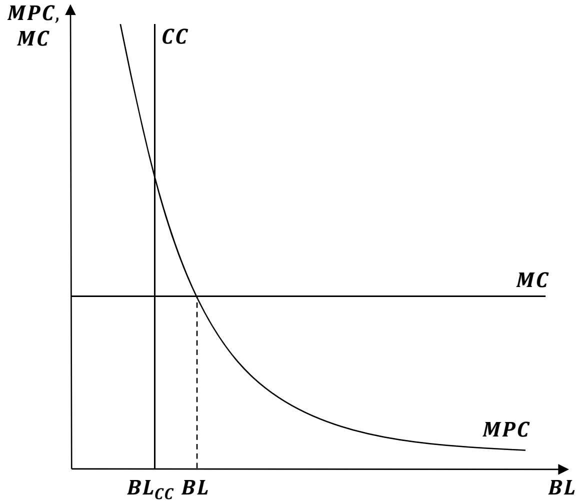
Binding Collateral Constraints Finally, the impact on bank lending of a central bank policy concerning the quantity of eligible collateral (6.4) has to be discussed. Independent of the financing source, a binding collateral constraint leads to a level of bank lending below the optimally-chosen level for the respective scenario. This means that the respective FOC is not fulfilled ((6.7) and (6.14)) because the marginal expected return – which shall also be called the marginal productivity of capital (MPC) – remains higher than the marginal cost of funding, or marginal cost of capital (MC). Figure 6.3 illustrates the situation in a stylized way, where $BL_{CC} < BL$.[250] Assume that the fraction of eligible assets A_e of the bank's balance sheet total assets A is given by

$$\Psi = \frac{A_e}{A}. \tag{6.18}$$

In the case of Scenarios I or II, where refinancing goes through the money market, a marginal increase of Ψ^{CB}, the fraction of assets deemed eligible by the central bank would only affect BL_I if $\Psi^{CB} = \Psi^{MM}$ (before the increase) and $MC^{CB} < MPC$. In this specific situation, the bank would refinance additional bank lending at the central bank until $MC^{CB} = MPC$. In Scenario III, bank lending is refinanced at the central bank. Any loosening of a binding collateral constraint increases bank lending directly until the FOC (6.14) holds with equality. If $\Psi^{CB} < \Psi^{MM}$ (before the increase) and $MC^{MM} < MPC$, bank lending is not increased but refinancing is shifted away from the money market to the central bank.

250 The example is independent of refinancing source and scenario and hence no indexes are drawn.

Figure 6.3: Bank Lending and Binding Collateral Constraint



Source: author's illustration.

6.1.3 Policy Influences on Financial Stability

It has already been discussed in Section 2.3 that financial crises take a more severe course if banks lose the trust of depositors in terms of their ability to pay out (overnight) deposits whenever reclaimed. The same is true for inter-bank claims or any other creditor loosing trust. This trust is strengthened if the banks are able to liquidize large parts of their assets in a timely manner. However, they usually lack this ability due to the banking business-immanent maturity mismatch between assets and liabilities. Liabilities (deposits and other claims) are overwhelmingly due within short terms – often daily – while assets (loans and other investments) frequently have a much longer maturity. Banks regularly cannot sell non-marketable assets as loans (credit claims), can only slowly sell other large assets of long maturities and cannot sell at all any asset in times of crises and illiquid asset markets.

The option of borrowing liquidity to meet demands of depositors running on banks as well as other creditors hence holds utmost importance to preserve financial stability. As the money market is unlikely to support troubled banks with large amounts of liquidity in times of distress, the LOLR role of the central bank is crucial for the degree of financial stability, which is modeled here as being dependent on the collateral value of a bank's assets at the central bank (ECV), such that

$$\frac{\partial S(\cdot)}{\partial ECV} > 0. \tag{6.19}$$

In the following, it is discussed how central bank policy has an influence on

$$\begin{aligned} ECV &= (1 - h^{CB}) MV(A_e^{CB}) \\ &= (1 - h^{CB}) \frac{A_e^{CB}}{r^{CB}} \\ &= (1 - h^{CB}) \frac{\Psi^{CB} A}{r^{CB}}. \end{aligned} \tag{6.20}$$

Three components determine the maximum amount of liquidity that can be drawn from the central bank, i.e. ECV: *(i)* the haircut h^{CB} set by the central bank; *(ii)* the fraction of the balance sheet $\Psi^{CB}A$ declared as eligible collateral by the central bank; and *(iii)* the market value MV of this fraction, which has to be smaller than the face value because the assets are (as discussed above) of longer-term maturity. The market value thus implies a discounting of the face value to the present value, as incorporated in (6.20).[251]

Comparative statics show that the effects of central bank policy on ECV substantially differ depending on the policy tool used. The effect of a marginal change of the interest rate is given by

$$\frac{\partial ECV}{\partial r^{CB}} = -\frac{(1-h^{CB})\Psi^{CB}}{r^{CB^2}} < 0 \Rightarrow \frac{\partial S(\cdot)}{\partial r^{CB}} < 0. \tag{6.21}$$

Hence, financial stability negatively depends on interest rate increases, because the market value of any longer-term asset is smaller in a high interest rate environment than in a low interest rate environment. Consequently, if a central bank hikes interest rates, it weakens banks' balance sheets not only in the sense of the classical balance sheet channel (cf. Bernanke and Gertler, 1995), but also in terms of the collateral value that the bank can use in collateralized lending transactions. The effect is stronger the lower the haircut and the larger the fraction of eligible assets on the bank's balance sheet. A marginal increase of the haircut yields

$$\frac{\partial ECV}{\partial h^{CB}} = -\frac{\Psi^{CB}A}{r^{CB}} < 0 \Rightarrow \frac{\partial S(\cdot)}{\partial h^{CB}} < 0. \tag{6.22}$$

A haircut increase also negatively affects financial stability because the pledgable amount of collateral is reduced. This effect is stronger the larger the fraction of eligible assets and the smaller the interest rate. The intuition is straightforward: a larger haircut deducts a larger part of each asset's market value and hence directly lowers the collateral value of the bank's balance sheet.

As discussed in the previous Section 6.1.2, both haircut reductions and interest rate lowerings can also stimulate new investment projects and hence originate new assets in the bank's balance sheet. However, there is no effect from this additional asset availability on financial stability because all of these new assets are backed by lower-quality investment projects (those that previously did not pay off). Hence, they are excluded from eligibility and thus the effect on financial stability is zero.

Finally, the effect of an increase in the fraction of eligible assets on the bank's balance sheet – i.e. a quantitative broadening of the eligible assets pool – is

$$\frac{\partial ECV}{\partial \Psi^{CB}} = \frac{(1-h^{CB})A}{r^{CB}} > 0 \Rightarrow \frac{\partial S(\cdot)}{\partial \Psi^{CB}} > 0. \tag{6.23}$$

Obviously, the financial stability in the sense discussed here is greatest if the central bank accepts all assets of the bank's balance sheet, i.e. if $\Psi^{CB} = 1$. The marginal effect of an increase of this

[251] Of course, the discounting modeled here makes the simplifying assumption that all creditor claims on the bank are due today and all assets mature in the next period ("tomorrow"). In reality, much differentiated maturity structures preserve on both the asset and liability side. However, the general maturity mismatch is captured by (6.20). Furthermore, the market value does not only depend on maturity in practice, although this is not a relevant shortcoming in (6.20) as this entire section abstracts from asset quality in the sense that the collateral is homogenous from a quality perspective.

fraction is thus positive. It is stronger the lower the haircut – which is subsequently deducted from additionally-eligible assets – and the lower the interest rate. Note that the quantitative broadening could e.g. be represented by the additional eligibility of a credit claim behind which stands a loan that is absolutely similar to a loan backing an already-eligible covered bank bond. Thus, the haircut and discounting applied are similar in either case.

In order to evaluate the policy instruments affecting financial stability with respect to the strength of their impact and consequently find a preference order, it is necessary to determine the relative size of the marginal effects deduced above. If one sub-divides collateral policy into quantity policy and haircut policy, the magnitude of the impact of haircut policy is relatively smaller whenever $\Psi^{CB} = \frac{A_e^{CB}}{A} < (1 - h^{CB})$. This is likely to be true in reality, because otherwise the bank would have relatively many eligible assets (as then $\frac{A_e^{CB}}{A}$ would be large) of relatively low quality (as then $(1 - h^{CB})$ would be small because h^{CB} would be large). A comparison of the magnitude of the effects of haircut policy and interest rate policy yields the notion that haircut policy works relatively stronger whenever $(1 + r^{CB}) > (1 - h^{CB})$, which is true because the LHS is greater than one and the RHS is smaller than one, unless the central bank operates at the ZLB and with a zero haircut. Finally, quantity policy has a relatively stronger impact compared with interest rate policy whenever $\Psi^{CB} < 1 + r^{CB}$. This holds because the LHS is smaller than one and the RHS is greater than one, unless the central bank declares all assets of the bank eligible collateral and operates at the ZLB. (6.24) sums up the preference order regarding the relative strength of the impact of the haircut policy, interest rate policy and quantity policy:

$$\left|\frac{\partial ECV}{\partial \Psi^{CB}}\right| > \left|\frac{\partial ECV}{\partial h^{CB}}\right| \geq \left|\frac{\partial ECV}{\partial r^{CB}}\right|. \tag{6.24}$$

Hence, regarding the collateral value ECV and thus financial stability, the impact of quantity policy is strongest, followed by haircut policy.[252] The traditional policy tool of a central bank – interest rate policy – is the least preferable according to the analysis conducted here.

6.2 Trade-offs in Central Bank Decision

Having described the influences of central bank policy on the three components of the central bank objective function, cf. (6.1), individually, it shall now be discussed how the three central bank policy tools (interest rate policy, haircut policy and quantity policy) affect the central bank objective function (6.1) in total and interact. As a result, the evolving trade-offs are carved out and the strengths and weaknesses of the policy tools are evaluated with respect to the central bank roles presented in Chapter 2.

6.2.1 Interest Rate Policy

The marginal effect of an interest rate increase on (6.1) is as follows:

[252] The first inequality in (6.24) is true if $\Psi^{CB} = \frac{A_e^{CB}}{A} < (1 - h^{CB})$, as discussed above, the second relation always holds.

$$\frac{\partial L}{\partial r^{CB}} = \left(\pi^T - \pi(\cdot)\right) \underbrace{\underbrace{\frac{\partial \pi}{\partial Y}}_{>0} \underbrace{\frac{\partial Y}{\partial BL}}_{>0} \underbrace{\frac{\partial BL}{\partial r^{CB}}}_{<0}}_{<0} + \beta \left(Y^T - Y(\cdot)\right) \underbrace{\underbrace{\frac{\partial Y}{\partial BL}}_{>0} \underbrace{\frac{\partial BL}{\partial r^{CB}}}_{<0}}_{<0}$$
$$+ \gamma \left(S^T - S(\cdot)\right) \underbrace{\underbrace{\frac{\partial S}{\partial ECV}}_{>0} \underbrace{\frac{\partial ECV}{\partial r^{CB}}}_{<0}}_{<0}. \tag{6.25}$$

If – as assumed for the following analysis – the inflation gap is negative because of an inflation above target level ($\pi^T - \pi(\cdot) < 0$), although the output and stability gaps are positive as both output and financial stability are below target levels ($Y^T - Y(\cdot), S^T - S(\cdot) > 0$), the interest rate increase has three effects on the central bank loss: *(i)* a positive (loss-decreasing) effect on the monetary stability objective (first term in (6.25)) because inflation is lowered; *(ii)* a negative (loss-increasing) effect on the fiscal and economic stability objective because output is lowered (second term in (6.25)); and *(iii)* a negative (loss-increasing) effect on the financial stability objective because the pledgable collateral value is lowered (third term in (6.25)).

For a central bank purely focused on monetary stability in the role of a COMPR, i.e. $\beta, \gamma = 0$, no trade-offs appear. The interest rate r^{CB} can be set such that $\left(\pi^T - \pi(\cdot)\right) = 0$ and the loss L is minimized.[253]

A central bank with a fiscal and economic stability goal in addition to the monetary stability goal – a MMOLR – *does* face a trade-off. This case is represented by $\beta > 0$, $\gamma = 0$. Assume a positive output gap, i.e. $Y(\cdot) < Y^T$. The central bank will subsequently accept a negative inflation gap – i.e. inflation above target – because

$$\left(\pi^T - \pi(\cdot)\right) = -\beta \frac{\left(Y^T - Y(\cdot)\right)}{\underbrace{\partial \pi / \partial Y}_{>0}} < 0, \tag{6.26}$$

as long as $\left(Y^T - Y(\cdot)\right) > 0$. Note that the partial marginal effects of the interest rate on bank lending and the transitory partial marginal effect of bank lending on output canceled out in the denominator and the numerator of (6.26), as the transmission to both monetary and financial stability goes through the effect of the interest rate policy on bank lending. The accepted inflation above target is higher the greater the (positive) output gap, the greater the focus of the central bank on fiscal and economic stability and the smaller the marginal effect of output on inflation (the smaller the denominator of (6.26)). The latter applies because the size of the marginal effect of output on inflation determines the relative size of the impact of interest rate policy on the monetary stability objective versus the fiscal and economic stability objective.[254] If the first-named is relatively small, the central bank implicitly places more weight on the reduction of the output gap, where it obtains a stronger impact and accepts higher inflation in the course of this.

[253] Set (6.25) to zero to find the loss-minimizing interest rate.
[254] The last-named is equal to one because output is the targeted variable referring to fiscal and economic stability.

A monetary stability-focused central bank that also holds responsibility as a LOLR such that $\beta = 0$, $\gamma > 0$ faces a similar trade-off. Here, the negative inflation gap accepted in optimum amounts to

$$\left(\pi^T - \pi(\cdot)\right) = -\gamma \frac{\left(S^T - S(\cdot)\right) \overbrace{\frac{\partial S}{\partial ECV} \frac{\partial ECV}{\partial r^{CB}}}^{<0}}{\underbrace{\frac{\partial \pi}{\partial Y} \frac{\partial Y}{\partial BL} \frac{\partial BL}{\partial r^{CB}}}_{<0}} < 0. \tag{6.27}$$

Accepted inflation is higher the stronger the focus on financial stability, the greater the financial stability gap and the higher the ratio of interest rate policy transmission to financial stability (in numerator of (6.27)) versus monetary stability (denominator of (6.27)).

For a central bank that combines all three stability objectives – i.e. $\beta > 0$, $\gamma > 0$ – the trade-off that it faces while determining its interest rate policy becomes even greater. If both the financial and the fiscal and economic stability gaps are positive, the FOC for the interest rate minimizing its loss implies the following inflation gap:

$$\left(\pi^T - \pi(\cdot)\right) = -\beta \frac{\left(Y^T - Y(\cdot)\right)}{\underbrace{\partial \pi / \partial Y}_{>0}} - \gamma \frac{\left(S^T - S(\cdot)\right) \overbrace{\frac{\partial S}{\partial ECV} \frac{\partial ECV}{\partial r^{CB}}}^{<0}}{\underbrace{\frac{\partial \pi}{\partial Y} \frac{\partial Y}{\partial BL} \frac{\partial BL}{\partial r^{CB}}}_{<0}} << 0. \tag{6.28}$$

It becomes clear from (6.28) that a central bank with three monetary policy objectives trades off monetary stability against two effects. As a result, the inflation gap is ceteris paribus greater than in (6.26) and in (6.27): more precisely, it is the sum of both of these gaps.

6.2.2 Haircut Policy

A central bank using haircut policy to minimize its loss function faces the following trade-offs conditional upon its orientation towards monetary stability, fiscal and economic stability and financial stability. The marginal effect of a haircut increase comprises the following parts:[255]

$$\begin{aligned} \frac{\partial L}{\partial h^{CB}} = \left(\pi^T - \pi(\cdot)\right) \underbrace{\underbrace{\frac{\partial \pi}{\partial Y}}_{>0} \underbrace{\frac{\partial Y}{\partial BL}}_{>0} \underbrace{\frac{\partial BL}{\partial h^{CB}}}_{\leq 0}}_{\leq 0} + \beta \left(Y^T - Y(\cdot)\right) \underbrace{\underbrace{\frac{\partial Y}{\partial BL}}_{>0} \underbrace{\frac{\partial BL}{\partial h^{CB}}}_{\leq 0}}_{\leq 0} \\ + \gamma \left(S^T - S(\cdot)\right) \underbrace{\underbrace{\frac{\partial S}{\partial ECV}}_{>0} \underbrace{\frac{\partial ECV}{\partial h^{CB}}}_{<0}}_{<0}. \end{aligned} \tag{6.29}$$

[255] The above-described effect of haircut changes on possible losses to the central bank balance sheet (cf. Section 6.1.1) is not explicitly factored in, as in principle it proceeds in the same direction as the influence of haircut changes on bank lending. E.g. a haircut increase would both mitigate bank lending *and* the possible loss on the balance sheet. For both reasons, there would be less inflation.

The interpretation is similar to that of interest rate policy. Again, depending on the sign of the gaps, the three elements of the marginal effect have positive or negative impacts on the central bank loss. However, a fundamental difference is that the first two elements become zero whenever the central bank refinancing conditions are equal or above market conditions, such that Scenarios I or II (cf. Section 6.1.2) apply. This has two implications: first, haircut policy is worthless for pursuing a monetary or fiscal and economic stability objective unless the conditions are set below market such that market refinancing is circumvented; and second, the central bank can use haircut policy to achieve its financial stability target without facing any trade-offs as the FOC subsequently implies $\left(S^T - S(\cdot)\right) = 0$, as long as it does not slide into Scenario III because it undercuts market conditions. For the following discussion of trade-offs, it is assumed that the central bank faces Scenario III (cf. Section 6.1.2).

For a central bank solely focused on monetary stability such that $\beta, \gamma = 0$, no trade-offs apply, as in the case of interest rate policy. The haircut can be set such that the inflation gap equals zero. The relative size of the loss-minimizing effect of a haircut increase compared to the size of the loss-minimizing effect of an interest rate increase is greater the higher the probability of a failure of investment projects, which means the worse the investment climate in the economy, cf. (6.16) and (6.17). If the failure of investment projects is more likely than their success, haircut policy dominates interest rate policy in this respect. The reason is that banks subsequently expect the loss of collateral with a higher probability than the payment of the interest rate and as a result reduce their bank lending more if the haircut is increased than if the interest rate rises.

An additional focus on fiscal and economic stability ($\beta > 0$, $\gamma = 0$) – as a MMOLR possesses – carries a trade-off with it as long as the output gap is of the opposite sign to the inflation gap. Assume a positive output gap, i.e. $Y(\cdot) < Y^T$. The central bank subsequently trades off a reduction of this output gap against higher inflation such that the inflation gap is

$$\left(\pi^T - \pi(\cdot)\right) = -\beta \frac{\left(Y^T - Y(\cdot)\right)}{\underbrace{\partial\pi/\partial Y}_{>0}} < 0. \tag{6.30}$$

Note that this gap is identical to the inflation gap resulting from the use of interest rate policy, cf. (6.26). There is no difference regarding the trade-off of monetary versus fiscal and economic stability between the use of interest rate and haircut policy.

Adding a focus on financial stability rather than fiscal and economic stability to the monetary stability objective such that $\beta = 0$, $\gamma > 0$ (LOLR) yields the following inflation gap:

$$\left(\pi^T - \pi(\cdot)\right) = -\gamma \frac{\left(S^T - S(\cdot)\right) \overbrace{\frac{\partial S}{\partial ECV} \frac{\partial ECV}{\partial h^{CB}}}^{<0}}{\underbrace{\frac{\partial \pi}{\partial Y} \frac{\partial Y}{\partial BL} \frac{\partial BL}{\partial h^{CB}}}_{<0}} < 0. \tag{6.31}$$

In this case, inflation is traded off against financial stability. The resulting inflation gap is negative as long as the financial stability gap is positive. It is greater the stronger the focus on financial stability and the larger the inflation gap. Furthermore, if the reaction of inflation to the haircut change is relatively strong (the denominator of (6.31) is large) compared to the reaction of financial stability to the haircut change (the numerator of (6.31) is small) – such that the central bank faces a strong trade-off – it will only accept a relatively small inflation gap. On the other hand, this means it can only reduce the financial stability gap to a lesser degree.

Considering the strengths of the two effects in comparison to the inflation gap resulting from the use of interest rate policy (cf. (6.27)) yields two implications. *(i)* The numerator in (6.31) is ceteris paribus larger due to the relation given in (6.24). A smaller change in the haircut than in the interest rate is needed to create financial stability to the same extent. The trade-off against inflation is thus weaker here than in the case of interest rate policy. *(ii)* The denominator in (6.31) is larger if the investment climate is relatively bad ($p < (1-p)$), resulting in an opposing effect to *(i)*. The trade-off that the central bank faces strengthens, i.e. relatively high inflation would have to be accepted to reach financial stability. Alternatively, the denominator in (6.31) is smaller if the investment climate is relatively good ($p > (1-p)$), representing the more realistic case. Subsequently, the effect amplifies *(i)* and the trade-off further weakens. In this case, haircut policy dominates interest rate policy for a central bank trading off an inflation gap versus a financial stability gap of an opposite sign. It has to use a smaller haircut change to achieve the same financial stability level as through a larger interest rate change, which means that the resulting inflation gap can be kept smaller. Additionally, the reaction of inflation to this (smaller) haircut change is weaker than in the case of interest rate policy, further helping to keep the inflation gap small.

Finally, it has to be remarked that it is evident from (6.31) that a central bank confronted with a very large financial stability gap (of opposite sign to the inflation gap) and only equipped with the haircut policy tool will reduce its loss through a rather strong use of haircut policy, resulting in a rather large inflation gap, traded off against as much financial stability gap reduction as possible. This is the case because e.g. the positive (loss-reducing) marginal effect of a haircut reduction on financial stability is relatively strong compared to the negative (loss-increasing) marginal effect of a haircut reduction on inflation, which creates incentives for the central bank to act accordingly. A natural example of such a situation where a central bank can no longer use interest rate policy is the ZLB.

As in the previous section, the triple objective case with $\beta > 0$ and $\gamma > 0$ brings the strongest trade-off against monetary stability:

$$\left(\pi^T - \pi(\cdot)\right) = -\beta \frac{\left(Y^T - Y(\cdot)\right)}{\underbrace{\partial\pi/\partial Y}_{>0}} - \gamma \frac{\left(S^T - S(\cdot)\right)\overbrace{\frac{\partial S}{\partial ECV}\frac{\partial ECV}{\partial h^{CB}}}^{<0}}{\underbrace{\frac{\partial \pi}{\partial Y}\frac{\partial Y}{\partial BL}\frac{\partial BL}{\partial h^{CB}}}_{<0}} << 0. \tag{6.32}$$

Both the output gap and the financial stability gap lead to trade-offs against the inflation gap. As discussed above (cf. (6.30)), the MMOLR's trade-off within the triple objective case is as with interest rate policy (cf. (6.28)). However, the additional LOLR's trade-off (cf. (6.31)) is weaker than in the case of interest rate policy.

6.2.3 Quantity Policy

The marginal effect of a quantitative broadening of the eligible asset pool is:[256]

$$\frac{\partial L}{\partial \Psi^{CB}} = \left(\pi^T - \pi(\cdot)\right) \underbrace{\underbrace{\frac{\partial \pi}{\partial Y}}_{>0} \underbrace{\frac{\partial Y}{\partial BL}}_{>0} \underbrace{\frac{\partial BL}{\partial \Psi^{CB}}}_{\geq 0}}_{\geq 0} + \beta \left(Y^T - Y(\cdot)\right) \underbrace{\underbrace{\frac{\partial Y}{\partial BL}}_{>0} \underbrace{\frac{\partial BL}{\partial \Psi^{CB}}}_{\geq 0}}_{\geq 0}$$
$$+ \gamma \left(S^T - S(\cdot)\right) \underbrace{\underbrace{\frac{\partial S}{\partial ECV}}_{>0} \underbrace{\frac{\partial ECV}{\partial \Psi^{CB}}}_{>0}}_{>0}. \tag{6.33}$$

As in the previous section, the first two elements of (6.33) become zero if the central bank operates in Scenarios I or II (cf. Section 6.1.2), where all refinancing lending goes through the money market. The remaining third element in (6.33) reveals that there would subsequently be no trade-off against any other objective and the quantity policy could be used to steer the financial stability gap to zero. Moreover, quantity policy cannot be used for policy measures concerning the two other objectives. The following discussion of existing trade-offs is hence performed in the Scenario III environment (cf. Section 6.1.2).

If the central bank is a COMPR focused solely on monetary stability and its refinancing conditions are below market, it can perfectly react to an inflation gap and does not face trade-offs, analogously to the previous two sections. However, note that the maximum bank lending that can be reached through the use of quantitative broadening is given by BL in Figure 6.3, because the refinancing costs of the central bank (MC in the figure) remain unchanged by the measure. Until this intersection point of MC and MPC is reached, the impact of the policy measure is comparably strong because any additionally-eligible asset is immediately pledged to the central bank for another unit of refinancing credit, which is subsequently used for additional bank lending.

Facing a fiscal and economic stability objective in addition to its monetary stability objective, the MMOLR optimizes such that

$$\left(\pi^T - \pi(\cdot)\right) = -\beta \frac{\left(Y^T - Y(\cdot)\right)}{\underbrace{\partial \pi / \partial Y}_{>0}} < 0, \tag{6.34}$$

which is again identical to (6.26) and (6.30).

The optimality condition for the LOLR yields

$$\left(\pi^T - \pi(\cdot)\right) = -\gamma \frac{\left(S^T - S(\cdot)\right) \overbrace{\frac{\partial S}{\partial ECV} \frac{\partial ECV}{\partial \Psi^{CB}}}^{>0}}{\underbrace{\frac{\partial \pi}{\partial Y} \frac{\partial Y}{\partial BL} \frac{\partial BL}{\partial \Psi^{CB}}}_{>0}} < 0. \tag{6.35}$$

[256] Naturally, all effects proceed in the opposite direction than with interest rate policy or haircut policy, as an increase of Ψ^{CB} represents an *easing* rather than a *tightening* monetary policy.

The effect of the quantitative broadening in the numerator is stronger than in the case of interest rate policy or haircut policy, cf. (6.24), i.e. the effect that the central bank can achieve against a financial stability gap is rather strong: in other words, the broadening that it has to achieve to close the gap is small. This means that only a relatively small policy change triggers the counter-acting effect on inflation, that the central bank trades off against. However, the effect of the quantitative broadening on bank lending is also strong because the central bank operates in Scenario III, see the explanation above. In principle, this would point towards a strong trade-off and leave the issue of whether quantity policy is attractive for a LOLR relative to haircut policy or interest rate policy uncertain.

However, the natural setting for a LOLR to take action is a crisis. Consider Figure 6.4. Refinancing at the central bank was possibly initially more expensive than refinancing in the money market, i.e. $MC^{CB} > MC^{MM}$, as depicted in the figure. A sudden crisis subsequently dries up the money market, effectively making refinancing in the money market more expensive or impossible.[257] In this situation, a quantitative broadening (shifting CC out to CC') would not increase bank lending. The level of bank lending in point B_1 is smaller than before the crisis, depicted by point A. Moreover, it is likely that in a crisis p also falls, such that MPC shifts inwards and the intersection point of MC^{CB} and MPC' is reached at an even lower level of BL (point B_2). Both arguments indicate that the trade-off vanishes. In the natural LOLR setting of a crisis, the counter-acting effect of a quantitative broadening on inflation is hence negligible as demand for refinancing credit will be much lower.

As in the previous two sections, a triple objective implies the sum of both the trade-off of the MMOLR and the LOLR. The marginal effect of a quantitative broadening is as follows:

$$\left(\pi^T - \pi(\cdot)\right) = -\beta \frac{\left(Y^T - Y(\cdot)\right)}{\underbrace{\partial\pi/\partial Y}_{>0}} - \gamma \frac{\left(S^T - S(\cdot)\right) \overbrace{\frac{\partial S}{\partial ECV} \frac{\partial ECV}{\partial \Psi^{CB}}}^{>0}}{\underbrace{\frac{\partial \pi}{\partial Y} \frac{\partial Y}{\partial BL} \frac{\partial BL}{\partial \Psi^{CB}}}_{>0}} << 0. \tag{6.36}$$

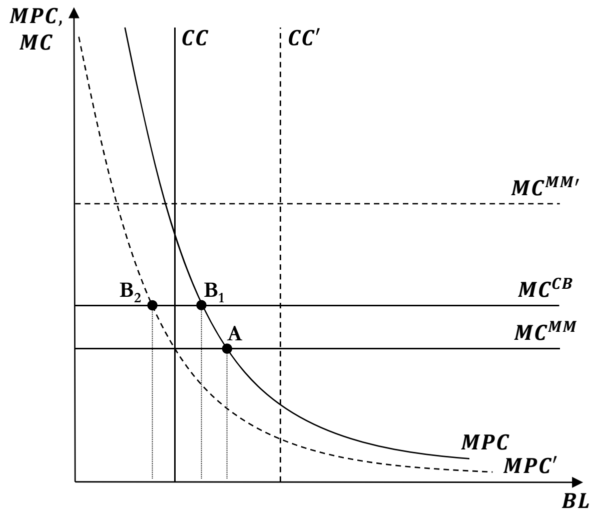
6.3 Optimal Policy Instrument by Central Bank Objective

The analysis above has shown that the problem addressed by Tinbergen (1952) also appears here. Every policy objective in principle calls for a separate policy instrument.[258] Moreover, he demands these policy instruments to be linearly independent to avoid trade-offs. This linear independence is not fulfilled by the three policy instruments discussed and it has been shown that this results in trade-offs whenever the central bank has more than one objective, whereby the trade-offs add up in case of triple objectives for the usage of all three policy instruments.

[257] E.g. Arslanalp and Tsuda (2012), Bank for International Settlements (2011), and Engler and Große Steffen (2016).

[258] See also Weidmann (2015) for a reformulation of the statement in a more recent context.

Figure 6.4: Effect of Quantity Policy on Bank Lending in Crisis



Source: author's illustration.

Nevertheless, as extensively discussed above, there are differences in the countervailing effects. In the spirit of the Tinbergen principle, this section will thus argue how the three policy instruments are optimally used depending on the central bank objectives.

Proposition 6.1 (**Optimal policy instrument for monetary stability**)**.** *A central bank in the role of a COMPR should primarily use interest rate policy.*

The reason is that in all scenarios (I-III) interest rate policy yields the greatest impact on bank lending. In Scenarios I and II, it is the only policy instrument that has impact at all, being stronger the better the investment climate. In Scenario III, haircut policy can have a greater impact on bank lending than interest rate policy if it is more likely that investment projects fail than being successful, which is not realistic. In Scenario III, quantity policy can also have a strong impact on bank lending, albeit only in case of a binding collateral constraint that restricts bank lending to a level below the market equilibrium, where marginal refinancing costs equal the marginal product of capital. Even if this would be the case, the strength of the effect of quantity policy would only equal that of interest rate policy. Moreover, quantity policy is only effectual until the above-described market equilibrium. Finally, as will be described below (cf. Proposition 6.3), a binding collateral constraint is not in the interest of a central bank anyway.

As shown by (6.26), there is no trade-off to be expected for a central bank with a single mandate, i.e. a first-best solution can be reached through interest rate policy. Another supporting argument for the use of interest rate policy is that the policy is transmitted through the money market (in Scenarios I and II), thus sparing the central bank from too much risk as a consequence of refinancing loan-making and leaving the decision on investment financing to market forces.

The ZLB restricts the effectiveness of the interest rate as a policy tool and it has been shown that haircut policy can be an alternative here (see Lemma 6.1). However, for a monetary stability-oriented central bank, two things speak against its use: for one, market conditions have to be undercut to have an influence through haircut policy; and for another, at the ZLB, the central bank has to apply a haircut below the threshold value of $\tilde{m}$ (cf. Figure 6.2) to achieve an effect. This means that it can only expect a repayment below the nominal value of the loan: in other words, it has to expect losses to its balance sheet. In turn, these could lead to a weakening of the currency and possibly inflation.

Proposition 6.2 (Optimal policy instrument for fiscal and economic stability). *A central bank acting as a MMOLR can reduce its trade-off between monetary stability and fiscal and economic stability through the selective use of haircut policy.*

It has been shown above that from a marginal loss versus marginal benefit perspective all three policy instruments are identical to the central bank as a MMOLR (in Scenario III), as long as it does not hit its constraints, cf. the identity of (6.26), (6.30) and (6.34).[259] The trade-off that it faces is the same for each policy instrument, although this changes if the economy is modeled more realistically in a heterogeneous fashion, such that there is more than one market segment.

In the case of two market segments ($i \in \{1, 2\}$), there are also two bank asset types resulting from investment projects in these two market segments, both of which are assumed to be eligible collateral. Interest rate policy now yields the following marginal effect on (6.1):

$$\begin{aligned}\frac{\partial L}{\partial r^{CB}} = {} & \left[\pi^T - \pi\left(Y_1(\cdot) + Y_2(\cdot)\right)\right]\left(\underbrace{\underbrace{\frac{\partial \pi}{\partial Y_1}}_{>0}\underbrace{\frac{\partial Y_1}{\partial BL_1}}_{>0}\underbrace{\frac{\partial BL_1}{\partial r^{CB}}}_{<0}}_{<0} + \underbrace{\underbrace{\frac{\partial \pi}{\partial Y_2}}_{>0}\underbrace{\frac{\partial Y_2}{\partial BL_2}}_{>0}\underbrace{\frac{\partial BL_2}{\partial r^{CB}}}_{<0}}_{<0}\right) \\ & + \beta\left[\left(Y^T - Y_1(\cdot)\right)\underbrace{\underbrace{\frac{\partial Y_1}{\partial BL_1}}_{>0}\underbrace{\frac{\partial BL_1}{\partial r^{CB}}}_{<0}}_{<0} + \left(Y^T - Y_2(\cdot)\right)\underbrace{\underbrace{\frac{\partial Y_2}{\partial BL_2}}_{>0}\underbrace{\frac{\partial BL_2}{\partial r^{CB}}}_{<0}}_{<0}\right] \\ & + \gamma\left(S^T - S(\cdot)\right)\underbrace{\underbrace{\frac{\partial S}{\partial ECV}}_{>0}\underbrace{\frac{\partial ECV}{\partial r^{CB}}}_{<0}}_{<0}. \end{aligned} \tag{6.37}$$

As the central bank policy rate r^{CB} cannot be discriminated between the two market segments, bank lending in both segments reacts equally to a change in the interest rate. Suppose that the inflation gap is negative and the output gap in one segment is positive while it is negative in the other, because the potential has already been reached in this segment. As a result of an interest rate lowering, there would subsequently be two negative (loss-increasing) effects leading to higher inflation (first line of (6.37)): one positive (loss-decreasing) effect owing to a closing output gap in the targeted market segment, as well as another negative effect due to a widening output gap in the other market segment (second line of (6.37)).[260] Interest rate policy is hence blurry and yields a strong trade-off in this situation.

[259] These constraints are the ZLB for interest rate policy, the uncollateralized (or at least insufficiently collateralized) loan constraint for haircut policy and the market equilibrium (where $MC = MPC$) for quantity policy.

[260] The effect on financial stability is neglected here, as a MMOLR primarily tackles the trade-off between monetary stability and fiscal and economic stability.

On the other hand, through the use of haircut policy the central bank can decide to selectively undercut the market conditions for refinancing conditional upon the use of one type of collateral, in this example to support market segment 1. The marginal effect then yields:

$$\frac{\partial L}{\partial h_1^{CB}} = \left[\pi^T - \pi\left(Y_1(\cdot) + Y_2(\cdot)\right)\right] \underbrace{\underbrace{\frac{\partial \pi}{\partial Y_1}}_{>0} \underbrace{\frac{\partial Y_1}{\partial BL_1}}_{>0} \underbrace{\frac{\partial BL_1}{\partial h_1^{CB}}}_{\leq 0}}_{\leq 0} + \beta\left(Y^T - Y_1(\cdot)\right) \underbrace{\underbrace{\frac{\partial Y_1}{\partial BL_1}}_{>0} \underbrace{\frac{\partial BL_1}{\partial h_1^{CB}}}_{\leq 0}}_{\leq 0}$$
$$+ \gamma\left(S^T - S(\cdot)\right) \underbrace{\underbrace{\frac{\partial S}{\partial ECV}}_{>0} \underbrace{\frac{\partial ECV}{\partial h_1^{CB}}}_{<0}}_{<0}. \qquad (6.38)$$

Obviously, now there is only one negative effect, while the positive effect remains the same as in (6.37).[261] The reason is that the central bank operates in Scenario III in market segment 1, offering refinancing conditions below the money market conditions there and thus incentivizing more bank lending to more investment projects. The bank lending in market segment 2 does not react to this policy measure and the central bank can possibly still operate in Scenario II, where all refinancing goes through the money market. Additionally, the negative effect of higher inflation is smaller than in the case of interest rate policy. The trade-off that the central bank faces is thus much less strong and it can fulfill its market-making role to a greater degree, in turn having to trade in less of its monetary stability objective.[262]

Proposition 6.3 (**Optimal policy instrument for financial stability**)**.** *A central bank acting as a LOLR should primarily use quantity policy in pursuit of the financial stability objective.*

As described above, in the environment of Scenarios I and II – where refinancing credit is provided by the money market – the central bank does not face any trade-off in pursuit of its financial stability objective if it uses quantity policy, cf. (6.33), where the first two elements become zero in these cases. The central bank can define a broad eligible collateral pool and secure financial stability without any inflationary risks. It would also not make sense to use interest rate policy or haircut policy in pursuit of the financial stability objective, because both instruments have weaker impacts on financial stability, cf. (6.24). Moreover, the use of interest rate policy to strengthen financial stability yields a trade-off against monetary and possibly also fiscal and economic stability, cf. (6.28). Finally, it is wise for the central bank to follow the Tinbergen principle and use interest rate policy in pursuit of monetary stability and haircut policy in pursuit of fiscal and economic stability – as summarized by Propositions 6.1 and 6.2 – and not shoot valuable interest rate or haircut bolts in pursuit of financial stability.

Of course, this policy implication is less clear-cut in Scenario III. The trade-offs subsequently appear in (6.33), although as argued above the countervailing elements in the marginal effect are likely to be small or negligible in a crisis, see Section 6.2.3.

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261 Again abstracting from the financial stability part in the marginal effect.

262 The use of collateral policy to achieve an asymmetric monetary policy within a heterogeneous monetary union has been suggested by Brunnermeier (2010). For similar reasons as laid out in the argumentation above, he advocates utilizing collateral policy in the manner described in the EMU. Cassola and Koulischer (2014) also arrive at a similar conclusion.

To summarize, if the central bank tries to stay in Scenarios I or II in general and only allows Scenario III to realize in targeted market segments or in a crisis, it can manage the challenge of a triple objective using its policy tools wisely.

6.4 Determining Weights on Central Banks' Objectives in Practice

While the previous analysis explored the marginal effects of a policy measure and presented the resulting trade-offs that a central bank faces depending on its objectives, thus far it has been left open what might be explanatory for the size of the weights that it places on the three objectives (if any). In other words, parameters β and γ, their relative sizes and their impact in combination with the size of the three gaps regarding the objective targets shall be made more precise in the following. This discussion is necessary as a legal central bank mandate can determine whether the three objectives are applicable for the respective central bank – i.e. whether the parameters β and γ are zero or positive – although it has difficulties with the definition of the exact weight that a central bank shall apply in its policy-making. After all, central bank statutes do not state a mathematical objective function, like (6.1). Instead, the weights placed on the objectives – that were legally assigned by mandate – endogenously follow the characteristics of the economic and political landscape in which a central bank operates. Over time, they can be subject to change. The following section offers a description of some of these characteristics in the EMU, in comparison with the economic areas of the jurisdictions of the three central banks discussed in Chapters 4 and 5 over the period from 2000 to 2014. As the weight on monetary stability in the model above is assumed as 1, in the first place the weights on the other two objectives are discussed in relation to it: first financial stability (Section 6.4.1), followed by fiscal and economic stability (Section 6.4.2). Subsequently, the state of monetary stability itself is presented (Section 6.4.3).

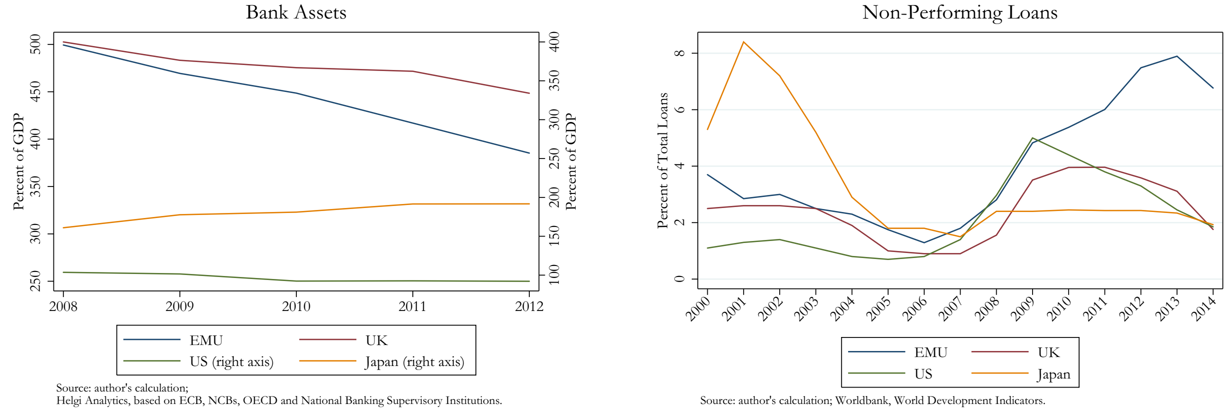
6.4.1 Size and Vulnerability of the Financial System

As far as the focus on financial stability is concerned, the relative size of the financial sector in the total economy is both an indicator of the severity that would be imposed on the economy through financial instability as well as the public and political attention and interest in the issue. If the financial sector is relatively large, the central bank is likely to place a high weight on safeguarding its stability. Moreover, in terms of the above model, financial stability enhancing measures are assumed as being transmitted through the asset side of banks' balance sheets. Therefore, the left panel of Figure 6.5 shows bank assets as a percentage of GDP for the EMU in comparison to the jurisdictions of the Fed, the BoE and the BoJ. The banking sector is relatively large in the EMU and the UK and much smaller in Japan and the US in comparison. While bank assets have been decreasing relative to GDP in all depicted central bank jurisdictions aside from Japan, this downward trend has been most pronounced for the EMU, were the ratio has declined by 23% since the first crisis year of 2008 until the latest available data in 2012.[263] This militates for an initially relatively strong focus on the financial stability objective for the ECB, which subsequently abated towards other objectives throughout the crisis years.

[263] The data illustrates the "Helgi-Indicator", which was only publicly available for the depicted years at the time of writing.

Figure 6.5: Importance and Stability of Financial System in International Comparison

The figure aims to measure the importance of the financial stability objective within the central banks' objective function (6.1) **over the crisis years. The left panel indicates the importance of the banking system within the economy, showing the ratio of total bank assets to GDP. The size of the parameter** β **– i.e. the strength of the focus on financial stability – can be concluded. The banking sector is relatively large in the EMU and the UK and much smaller in Japan and the US in comparison. While bank assets have been decreasing relative to GDP in all depicted central bank jurisdictions aside from Japan, this downward trend has been most pronounced for the EMU. The right panel gives a measure of financial instability by showing the share of non-performing loans in total bank loans and thus pointing to the size of the financial stability gap. All central banks faced a decrease of financial stability as measured by the share of non-performing loans in the aftermath of the financial turmoils in 2007 and 2008, although the surge was particularly pronounced in the US, the UK and the EMU, as well as being especially long-lasting in the latter.**



However, while the size of the financial sector can serve as an indication for γ – i.e. the *weight* on financial stability – the *state* of financial stability itself is illustrated by the fraction of non-performing loans among total loans (see right panel of Figure 6.5). In terms of the above model, a higher fraction of non-performing loans would lead to an aggravated illiquidity problem for a bank because the debt is not being served (thus in arrears), thus destabilizing the financial system. Non-performing loans are also often included in financial stability reports prepared by central banks around the world, especially as a reaction to the recent financial crisis.[264] Taking the non-performing loan development additionally into account leads to a revision of the above-stated shifting away from the financial stability objective at the ECB. While in the early history non-performing loans were not particularly pronounced in the EMU compared to the other jurisdictions and Japan led the field, the outbreak of the financial crisis changed the picture. All central banks faced declining financial stability as measured by the share of non-performing loans in the aftermath, although the surge was particularly pronounced in the US, the UK and the EMU, as well as being especially long-lasting in the latter. When the Fed and the BoE observed a turnaround in 2009/2010 and a recovery of the financial stability measure to approximately its respective pre-crisis levels (just as in Japan), the EMU figure kept increasing to more than fourfold and only broke this trend during the last year depicted. In contrast to the reduced size of the banking sector discussed above, this strongly increased share of non-performing loans should have rather increased the Eurosystem's focus on financial stability enhancement. These observations sustain the policy analyses in Chapters 4 and 5. The comparably large financial sector of the Eurozone led the Eurosystem to already having

[264] See Gadanecz and Jayaram (2008), who also provide a recent overview of financial stability measures and related literature.

rather broad eligibility criteria before the financial crisis. On the other hand, the minor importance of the discount window in the US matches the relative importance of the financial sector there. However, during the crisis the increase in financial instability as measured by non-performing loans was strongest in the EMU and second strongest in the US, to a comparable extent as in the UK. Both the BoE and the Fed thus conducted considerable LOLR policies. The horizontal dimension of the eligible collateral pool of the Eurosystem was already very wide before the financial crisis, before being further increased at the onset of the crisis, as induced by the measure of financial instability discussed above.

Figure 6.6 offers a more detailed view of the developments of financial stability measures in the Eurozone, showing both bank assets to GDP and the non-performing loans share for selected EMU member countries. The figure also shows that the EMU is not a homogeneous entity from a financial stability perspective. The fall in the bank assets to GDP ratio for the EMU as a whole as seen in Figure 6.5 is apparently exclusively due to the development in Ireland and not separately depicted EMU members ("Other EMU members"), see left panel of Figure 6.6. The German figures remain relatively constant, but all crisis countries and in particular France experienced an increased importance of the financial system relative to the overall national economies. The right panel shows that before the crisis all non-performing loan fractions in the EMU were below 7%. The graphs subsequently spread out across a wide range during the crisis years, increasing for all countries except for Germany. Taken together, it is likely that from the German perspective alone – as well as from the perspectives of not separately depicted EMU members ("Other EMU members") – the financial stability focus of the ECB should have remained constant throughout the crisis years, while from the perspectives of crisis countries it should have increased. The Eurosystem's collateral policy analysis from Chapter 4 showed that there was a large quantitative broadening of eligibility criteria, thus reflecting a LOLR policy. Moreover, it was concluded that the ECB conducted collateral policy measures focused on the banking sector. Insofar it seems that the latter perspective has dominated in ECB decision-making. Furthermore, as Chapter 9.3 will reveal, financial systems in crisis countries especially benefited from the broadening of the eligible asset pool.

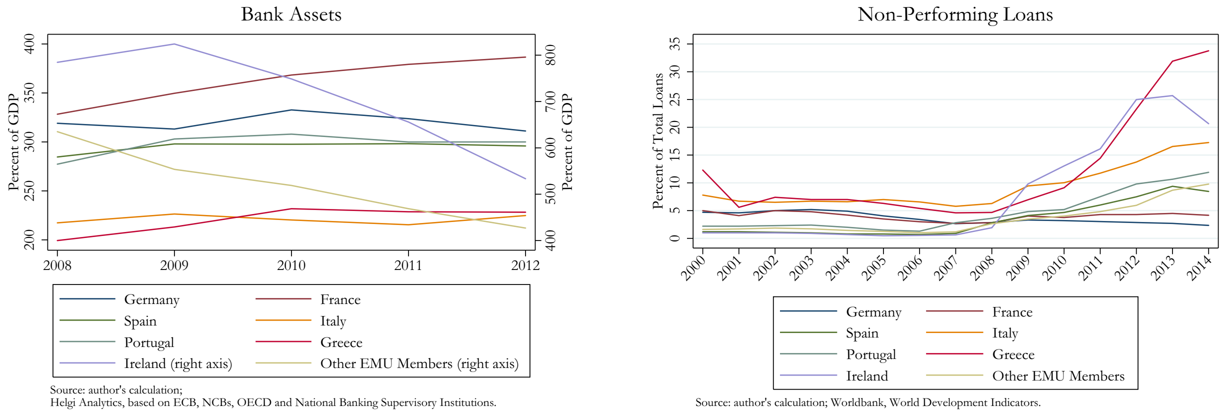
6.4.2 Need and Responsibility for Economic Policy Conduction

The trigger for economic policy conduction – if mandated to the central bank and thus represented in its objective function at all – is naturally a fluctuation of the economic performance above or below the target value. Such fluctuations are measured by the output gap, the development of which is shown for the EMU in an international comparison in Figure 6.7. In other words, the output gaps presented in the following represent the need for economic policy conduction. Whether there is a responsibility for the respective central bank at all is incorporated in the parameter β, which will be debated a little further below.

The EMU output ran around potential output until 2005 and sharply increased before the breakdown due to the financial crisis. However, it did not become as negative as the output gaps that central banks in the other jurisdictions depicted faced. The pronounced market-making focus of the Fed and the targeted actions as a MMOLR conducted by the BoJ (see Chapter 5) that already took place in the earlier aftermath of the crisis can be explained by these large negative output gaps.

Figure 6.6: Importance and Stability of Financial System within the European Monetary Union

The figure aims to measure the importance of the financial stability objective within the ECB's objective function (6.1) **over the crisis years by showing the measures described in Figure 6.5 for selected Eurosystem countries. The figure also shows that the EMU is not a homogeneous entity from a financial stability perspective. Apart from Ireland and "Other EMU Members", the banking sectors remained relatively constant size-wise, albeit on different levels. Non-performing loans were below 7% in all EMU countries before the crisis but spread out afterwards, especially in crisis countries.**



On the other hand, the values for EMU and UK only fell to around -2% in 2009. While the output also quickly recovered to less negative values in the US and Japan, the negative developments in the UK and the EMU continued throughout the second crisis phase. Thus, the need for MMOLR activities increased relative to the other jurisdictions in the EMU. The first position in terms of the output gap turned into the last throughout the crisis.

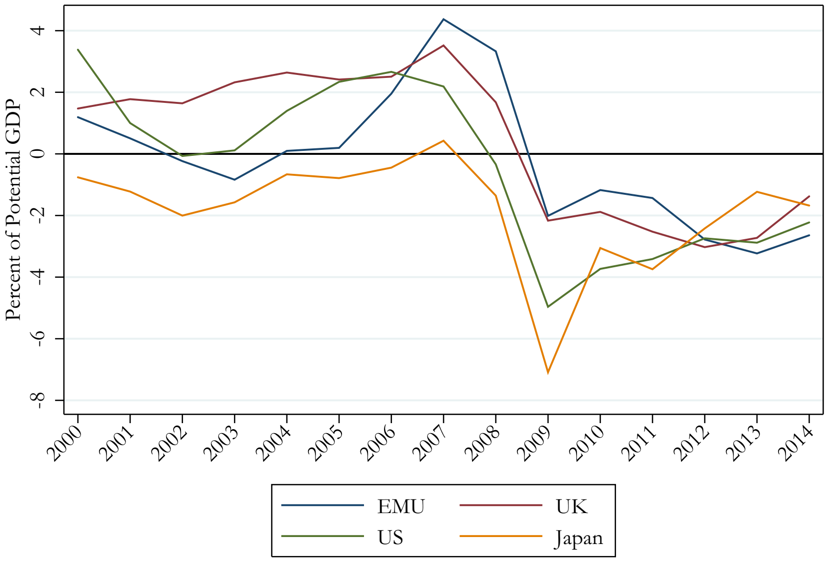
Complexity for the ECB increased – as Figure 6.8 discloses – owing to the asymmetric developments across EMU member countries. Greece is the most extreme in both directions, followed by Ireland. The rest of the EMU members displayed rather homogeneous output gaps before the crisis and in the first crisis year. However, developments spread out from 2009 onwards, with Germany recovering to around potential, although all crisis-afflicted countries including France followed a rather downward-oriented trend. Only Ireland is truly on a recovery path and the "Other EMU Members" stabilized at a slightly negative level. The result of these developments initially after the crisis is a small but homogenous need for economic stabilization, but later very heterogeneous preferences among the member countries, ranging from no need for market-making activity in Germany to very strong and growing needs in crisis countries.[265]

Thus far, the fiscal stability part of the fiscal and economic stability objective has been somewhat neglected. As commonly known but not underpinned by a graph here, fiscal stability was not under very much pressure in the immediate aftermath of the financial crisis breakout (except in Ireland), although it subsequently became an issue in crisis countries from 2010 onwards, when the European

265 The issues of a single monetary policy given heterogeneous needs in the EMU are also discussed by e.g. Bordo and James (2008), Drometer et al. (2013), Flaig and Wollmershäuser (2007), and Sturm and Wollmershäuser (2008). Hristov et al. (2014b) point to the role of differences in characteristics of financial markets within the EMU. Hristov et al. (2014c) devote particular attention to the development of the transmission of interest rate policy of the Eurosystem throughout the financial crisis and show that heterogeneity in transmission worsened. For an in-depth presentation of the difficulties in designing the ECB and its process regarding different perceptions of monetary policy, see James (2012, Ch. 8). Another explicit discussion of this "battle of ideas" is given in Brunnermeier et al. (2016).

Figure 6.7: Output Gaps in International Comparison

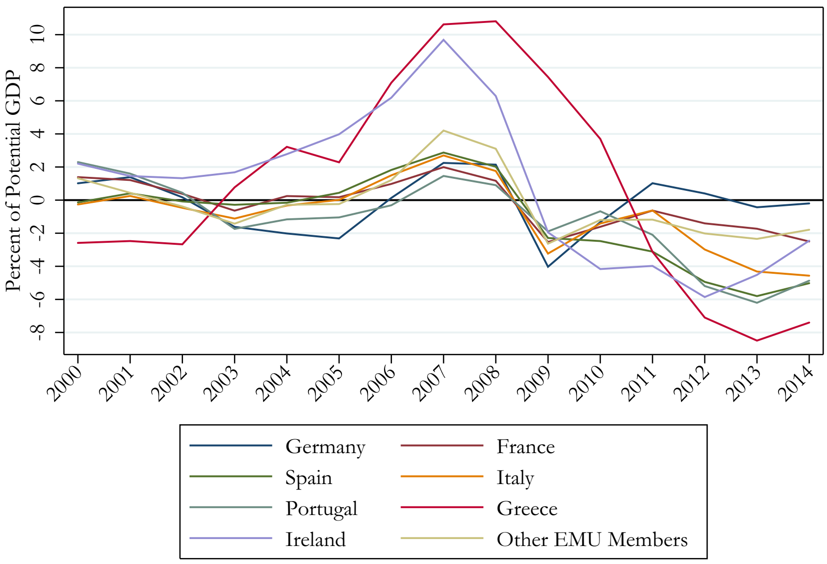
The figure shows the difference between potential or target output and actual economic performance (output gap) over time. It thus assesses the (fiscal and) economic stability gap in central banks' objective function (6.1)**. All depicted economic areas went from production levels close to or above potential to negative output gaps (below target) after the financial crisis (Great Recession). Central banks thus had reason to conduct credit stimulating policies, if within their mandate (see discussion below).**



Source: author's illustration; IMF, World Economic Outlook Database.

Figure 6.8: Output Gaps within the European Monetary Union

The figure decomposes the development shown in Figure 6.7 for selected EMU countries. While following a homogeneous course before the crisis (apart from Ireland and Greece), countries' performances developed quite heterogeneously during the crisis years, especially during the European debt crisis period. While the German economy was around potential, crisis countries experienced negative output gaps. If the ECB felt called to pursue a fiscal and economic stability objective, it faced differing needs from member countries.



Source: author's illustration; IMF, World Economic Outlook Database.

sovereign debt crisis gathered pace. Accordingly, it does not affect the described need for economic policy in the first phase of the crisis but strongly boosts the heterogeneity developing later on.

The second relevant element to evaluate the strength of the fiscal and economic stability weights at the central banks during the crisis is the parameter β, i.e. the relative focus on fiscal economic stability. Above all, it depends on the mandate attributed to the respective central bank by its legal statutes. In case of the Fed, its triple mandate clearly contains an objective on fiscal and economic stability as it calls for "maximum employment". The BoE has orders to defend price stability and subject to this assisting the government in pursuit of growth and employment. No such mandate is given to the BoJ, which only has price stability and financial stability in its statutory objectives. Nonetheless, as already remarked in Section 5.3 and visible in Figure 6.12, price developments in Japan were rather deflationary. Obviously, the BoJ could thus develop an objective for fiscal and economic stability (and support targeted market segments), which was motivated by the price stability aspiration.

The ECB is oriented to first and foremost deliver price stability. In the early years of the Eurosystem, this apparently was consensus, as the discussion in Issing et al. (2001) exemplifies. However, e.g. Folkerts-Landau and Garber (1992) highlighted very early that the ECB will have to develop towards its missing dual mandate. Recently, the call for a contribution to the achievements of the objectives of the EMU – including inter alia "full employment" and "balanced growth", albeit only "without prejudice to the objective of price stability" – has been remarkably often pronounced, e.g. on the ECB's website.[266] In any case, for the reasons discussed above, price stability is never without prejudice to fiscal and economic stability (see Section 1.2 for a verbal discussion and Section 6.2 for a more formal discussion), which is also acknowledged in Issing et al. (2001). The analysis in this dissertation arrives at the conclusion that the collateral policy conducted by the Eurosystem strongly resembled the role of a MMOLR and affect markets, cf. Section 4.7. This is also recognized by e.g. Sinn (2014a) and Wolff (2014) and has already been discussed before the recent crisis by Buiter and Sibert (2005) versus Bindseil and Papadia (2006). The view of the support of employment and growth as a "secondary mandate" (see below) hence must have led the Eurosystem to pursue the objective of fiscal and economic stability.

If the parameter β is thus assumed to have been positive for the ECB as well as for all other central banks named above – even for the BoJ – the crucial question is: how positive? After all, this determines the weight of the fiscal and economic stability focus relative to the two other objectives, in particular relative to the monetary stability objective, where the trade-off discussed in Section 6.2 applies. As a starting point, the preference for economic policy – i.e. the pursuit of fiscal and economic stability – within society can be consulted. The presumption is that a politically left-wing orientation favors a stronger focus on growth-fostering and of course unemployment-reducing policies – including by the central bank – and in turn is willing to give up more monetary stability (e.g. Persson and Tabellini, 2000, Ch. 16). On the other hand, monetary stability and low inflation represent the stronger preference of the rather conservative and right-wing-oriented voters and politicians.[267] The left panel of Figure 6.9 thus shows the political orientation of Eurozone

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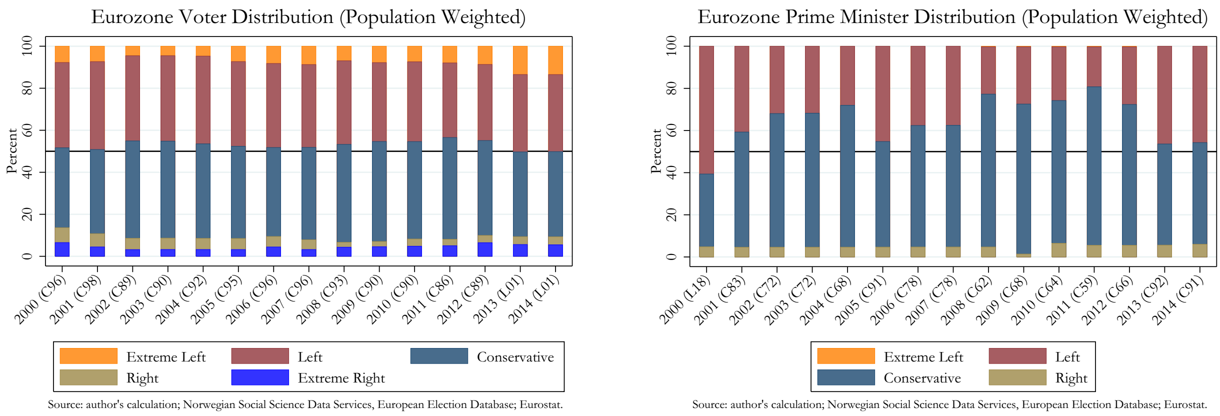
[266] ECB, Monetary Policy, Introduction, *Objective of Monetary Policy*, `https://www.ecb.europa.eu/mopo/intro/objective/html/index.en.html`, last accessed 23 February 2016.

[267] This argumentation follows the partisan approach of literature on the political economy of central banks, cf. Eijffinger and Haan (1996), Havrilesky (1994) or Way (2000); for a literature review Alesina et al. (1997).

voters.[268] The solid black line marks the median voter. It is also stated in brackets behind the year on the abscissa, e.g. in 2000, the conservatives needed 96% of the votes of their group and all votes right from that to assemble a majority. At times, the median voter moved further to the right, e.g. in 2002, when only 89% of the conservative group was needed for a majority. The picture shows how the conservatives expanded their majority in the early years of the EMU, whereas in 2007 and 2008 the lefts gained consent. Furthermore, conservatives dominated the political landscape of the Eurozone in the early crisis years, although throughout the European sovereign debt crisis they lost votes and ultimately the majority due to the increasing fraction of the extreme lefts. In 2013 and 2014, the median voter sat within the left wing of the political spectrum, albeit only in the first percentile of the left group: in other words, on the very right of the lefts. The message from the Eurozone voter distribution panel is that the majority of conservatives and rights have always been at most narrow, such that the preference in society for the fiscal and economic stability objective of the central bank was never too small. Throughout the crisis years, the preference is likely to have increased as voters moved to the left in the EMU.

Figure 6.9: Political Orientations in the European Monetary Union

The figure shows political sentiments among Eurozone voters and prime ministers. The presumption is that a politically left-wing orientation favors a stronger focus on growth-fostering and of course unemployment-reducing policies – including by the central bank – and in turn is willing to give up more monetary stability. For the left panel, data from all general elections in the respective EMU member countries during the depicted time was analyzed and the vote shares of the respective national parties aggregated across nations into five groups of political orientation. The median voter is depicted by the black horizontal line and given in brackets behind each year on the abscissa, e.g. in 2000, the conservatives needed 96% of the votes of their group and all votes right from that to assemble a majority. At times, the median voter moved further to the right, e.g. in 2002, when only 89% of the conservative group was needed for a majority. It becomes apparent from the picture that the majority of right-wings has at most been narrow, such that the preference for fiscal and economic stabilization by the central bank was never too small and increased throughout the crisis years.



The right panel of Figure 6.9 shows the population weighted distribution of Eurozone prime ministers, i.e. the political leaders of the governments of the EMU member countries. While the left panel hence shows the society's preferences, the right reveals more of the actual decision-makers' orientation. The median prime minister started to sit on the right wing, within the 18th percentile

[268] The calculation was made following the approach of Alesina and Grilli (1991). Data from all general elections in the respective EMU member countries during the depicted time was analyzed and the vote shares of the respective national parties aggregated across nations into five groups of political orientation: extreme left, left, conservative, right and extreme right. The aggregation was made in the style of the aggregation of parties into groups of the European Parliament, whenever possible, taking population sizes into account.

of the left group (seen from the right). From then onwards, it moved into the conservative group, although only barely in 2005, 2013 and 2014. Almost all conservative prime ministers were needed to make majority decisions in these years.

In practice, of course many central banks enjoy independence from governments.[269] According to the theory of the conservative central banker, going back to Rogoff (1985) (see also Herrendorf and Lockwood, 1997), independence in combination with the assignment of rather conservative central bankers shall spare society from accumulating excessive inflation rates.[270] In terms of the above model, a conservative central banker would possess a lower β than society and politicians. The Fed has been independent since 1951, albeit only "within government" and it is accountable to the US Congress. This means that it can act independently from government members and is not under direct presidential control but still has to take voters' preferences into account. Moreover, the triple mandate (see above) obliges it to have a fiscal and economic stability objective. Similarly, the BoE enjoys operational independence, which was only been granted in 1997. However, its mandate is defined by the government. The BoJ received its independence in 1998. As a result, for all three of these central banks, the parameter β should be smaller than in society. In the UK and Japan, independence is still very young and under constant public debate. Especially in crisis, the operational independencies of central banks like the BoE or the Fed tend to collapse to some extent under political pressure (cf. Stark, 2014). By contrast, genuinely independent central banks such as the pre-EMU Bundesbank assert themselves against political resistance (e.g. Berger and Haan, 1999) and hence have much lower values of β in their objective functions.

While the ECB is a genuinely independent central bank, it comprises central bankers of all EMU member countries, which makes the assessment of its β difficult. The reason is that different views on central banking and central bank independence have existed from the foundation of the ECB in societies and among central bankers of the different member countries (e.g. Dornbusch, 1996; Monnet, 2012). The "Thomas Becket Effect" – according to which new members of an institution swap their political conviction for the goals of the institution – predicts that these different views would vanish with the installment of the ECB.[271] However, explanatory for this behavior is the notion that central bankers (usually) lacking the option to increase their income through performance are motivated by the accumulation of social reputation.[272] However, if a monetary stability consensus in society is missing or – as in the EMU – different national consensuses exist, the effect of aligning interests of central bankers towards the institutionally goals is absent (cf. Frey and Schneider, 1981); rather, central bankers from the member countries are likely to act according to their respective national consensus.[273] This might particularly be the case in times of economic and financial crisis, when the desire for monetary stability vanishes from the focus, cf. James (2010).

269 Literature on central bank independence and its importance is vast. In particular, studies evaluating the degree of independence of central banks around the world are numerous. A selection includes Berger et al. (2001), Bernhard (1998), Bibow (2009), Cukierman (1992, 1994), Debelle and Fischer (1994), Eijffinger and Schaling (1993), Elgie (1998), Grilli et al. (1991), Haan and Van't Hag (1995), Quaglia (2005), and Tullio and Ronci (1997).

270 Belke and Potrafke (2012) confirm that in particular left-wing governments make use of having the central bank conducting a more conservative policy.

271 See e.g. Eijffinger and Haan (1996), Goodman (1992), and Issing (2008) for details on the "Thomas Becket Effect" applied to central banking, an idea that goes back to Otmar Issing.

272 See Galahn (1996), Kaltenthaler (1998), and Vaubel (1993), for this argument.

273 E.g. Badinger and Nitsch (2011), Fatum (2006), and Hayo and Méon (2013) confirm this behavior.

Good examples of the differing views on the ECB mandate are speeches by two members of the initial ECB council – in fact even of the executive board – given in 1999. On the one hand, Solans (1999), a Spaniard, posed the question: "Should the ECB have broader objectives beyond price stability?" Indeed, he answered himself very clearly: "Yes, the ECB should have and, as a matter of fact, it does," referring to the above-named contribution to broader EMU goals. On the other hand, Issing (1999) from Germany underlined the importance of "the single objective of price stability." A statement of the French President Mitterand from 1992 exemplifies the different convictions about central bank independence. He argues that the (then-future) ECB would not have the right to make decisions, but that the "technocrats" at the ECB would have to apply the decisions made by the elected political leaders of the EMU countries in the European Council.[274]

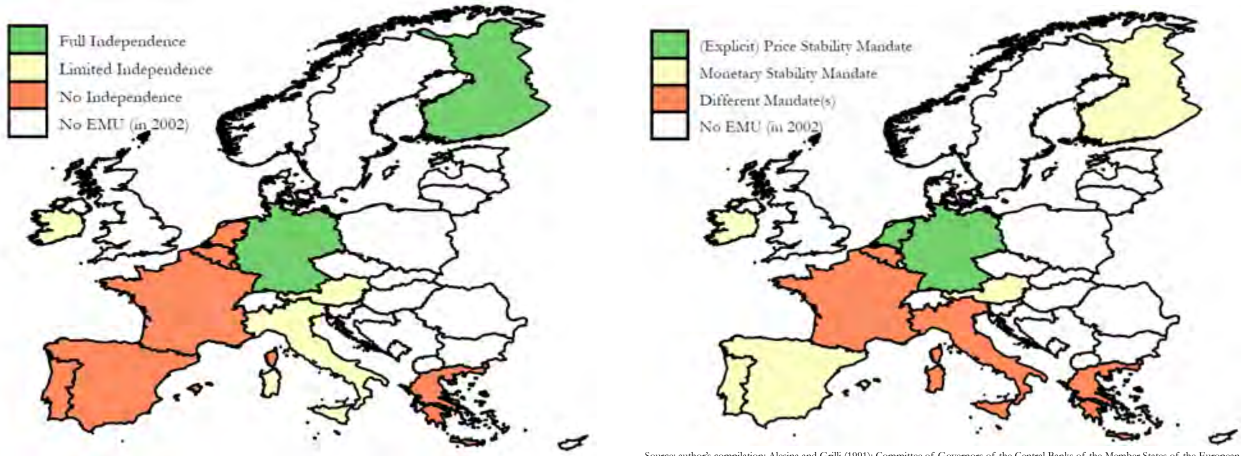
As an illustration of the differences in national perceptions on the independence and mandates across EMU member states, Figure 6.10 summarizes the situation in the countries that physically introduced the euro in 2002 around the time of the decision on the EMU and its designing in 1991/1992. In the left panel, the state of central bank independence is shown. The respective years (in brackets) of central bank independence are Austria (1955), Belgium (1993), Finland (1886), France (1994), Germany (1957, at foundation), Greece (1994), Ireland (1942), Italy (1981), Luxembourg (1998, at foundation), Netherlands (1993), Portugal (1995) and Spain (1994). Most NCBs of the Eurosystem were thus only granted independence in the process of forming the EMU and – as a matter of fact – they were forced by the requirements to join. Before that, in France or Greece, monetary policy decisions had essentially been made by the governments. Many other countries had government representatives included in their executive boards or needed to consult government entities with suggested policy measures. Even in some countries with formally independent central banks – namely Austria, Ireland and Italy – the government had been responsible for a part of the monetary policy decisions (setting the discount rates in Italy) or could interfere as a member of the decision-making body (Austria, Ireland). This represents limited independence in the picture. As the analysis in Chapter 3 has already shown, the predominant conviction that e.g. governmental steering of central bank credit to foster economic growth in France or Spain led to central banks that were dependent agents – sometimes instruments – of their governments. On the other hand, the German (and Finnish) approach was perceived as sacrificing too much output for price stability (Debelle and Fischer, 1994).

The right panel of Figure 6.10 classifies central bank mandates of pioneering EMU central banks (those that jointly introduced the euro physically in 2002). At the time before the EMU had been decided upon (around 1990), the Bundesbank and the Nederlandsche Bank were the only of these central banks that had price stability – the later ECB mandate – explicitly in their mandates (Alesina and Grilli, 1991). Several of the countries had assigned their central banks a monetary stability mandate (exclusively) of some sort (including currency stability). By contrast, Belgium, Greece, Italy and France had provided their central banks with different mandates (as the case may be in addition to the monetary stability mandates). These included control of the credit system, growth enhancement or unemployment reduction or no explicit mandate at all. Three of these countries struggled massively following the outbreak of the European debt crisis and in the settings

[274] Cf. an interview with the French telestation TF 1 on September 3, 1992, see Deutsche Bundesbank, *Auszüge aus Presseartikeln* 61, September 9, 1992, Frankfurt am Main, Germany.

Figure 6.10: Independence and Mandates of National Central Banks before the Formation of the European Monetary Union

The figure illustrates differences in national perceptions and practices on the independence (left panel) and mandates (right panel) of central banks across Euro-pioneers before the alignment of central banks to common standards had set in, i.e. at the time of the decision of the EMU and its designing in 1991/1992. Most NCBs of the Eurosystem were only granted independence in the process of forming the EMU. Moreover, Germany and the Netherlands were the only countries that had already anchored price stability explicitly and exclusively in the mandates of their NCBs.



Source: author's compilation; Capie et al. (1994); Committee of Governors of the Central Banks of the Member States of the European Economic Community (1993); European Monetary Institute (1995); Eijffinger and Schaling (1993); NCBs.

Source: author's compilation; Alesina and Grilli (1991); Committee of Governors of the Central Banks of the Member States of the European Economic Community (1993); European Monetary Institute (1995); Eijffinger and van Keulen (1995); Eijffinger and Schaling (1993); NCBs.

of their pre-EMU central bank arrangements they would most likely place a strong focus on the fiscal and economic stability objectives that they would have attributed to their NCB.

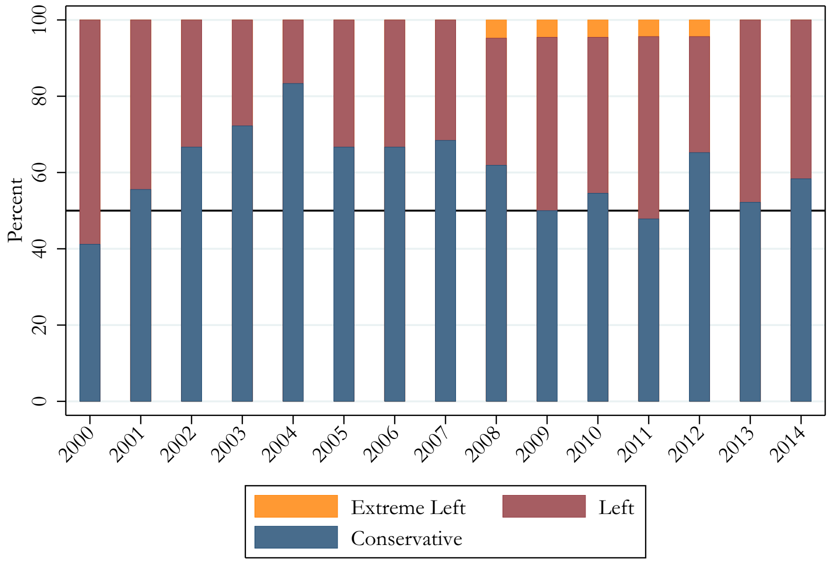
If for the above reasons – namely *(i)* the fragile conviction of central bank independence, *(ii)* the fragile agreement on price stability as the single ECB objective and *(iii)* the absence of the "Thomas Becket Effect" owing to heterogeneous views on central banking across EMU societies – central bankers within the ECB council pursue monetary policy in their national interests, following the political orientation of their societies, the stylized political orientation of the ECB council would be as pictured in 6.11.[275] The difference to the right panel of Figure 6.9 is due to two factors: first, the one-country-one-vote doctrine in the ECB council;[277] and second, the fact that some countries have two votes in the ECB council due to the voting right of the central bankers in the executive board. It becomes clear that after a relatively comfortable majority of conservative central bankers in the years before the crisis, the left-oriented wing gained shares and at times even decision-making power. While conservatives still only needed 85% of their group's votes to make a decision in 2008, they needed all of them in 2009. Indeed, this is only true if the French ECB President Trichet at that time called the decision to be conservative with his second vote, which the President receives in case of a deadlock. In 2010, no deviant from the conservative group was affordable, while in 2011 the left-oriented central bankers could make the decision. A conservative majority was restored in 2012, although this melted down again in 2013. Therefore, particularly during the early years of the

275 The political orientation of ECB council members is assumed to follow that of the prime minister of their respective home country, an approach established by Alesina and Grilli (1991) and supported by the above-named results of Hayo and Méon (2013).[276] For the technocrat governments in Italy and Greece in 2011 and 2012, the orientation is assumed to be left, following the general sentiments in these crisis-stricken countries at the time. The political situation at the end of the respective year is decisive.

277 See Sinn (2012a, 2014a) for a critical assessment of the one-country-one-vote doctrine. Further discussions of voting rights in the ECB council, possible reforms and effects of Eurozone enlargements include Bénassy-Quéré and Turkisch (2009), Berger and Moutos (2004), Hayo and Méon (2013), and Stella and Vandenbussche (2010).

Figure 6.11: Stylized Political Orientations in the Governing Council of the European Central Bank

The figure stylizes the political orientations in the ECB Governing Council analogously to Figure 6.9. The assumption is that members of the council follow the national interests of their prime ministers. An indication of the size of the parameter γ – i.e. the strength of the focus on the fiscal and economic stability focus of the ECB – can be drawn from the picture. The further left the median is shifted, the greater γ.



Source: author's calculation; Norwegian Social Science Data Services, European Election Database; ECB.

crisis, when most collateral policy decisions were made and even more so during the heyday of the European sovereign debt crisis, the left orientation in the ECB council was very strong. Put into the frame of this discussion concerning the focus on a fiscal and economic stability objective, these results point towards a rather large value for β. Additionally, through the voting arrangement (one-country-one-vote), neither the majority situation in the EMU population nor the majority situation among the EMU prime ministers is mirrored by the ECB council (cf. Figure 6.9).[278] Moreover, the described disparities within the EMU are likely to be at the roots of disagreements within the ECB (as described extensively in Sinn, 2015a), hampering unified conviction regarding the ECB's objective(s).

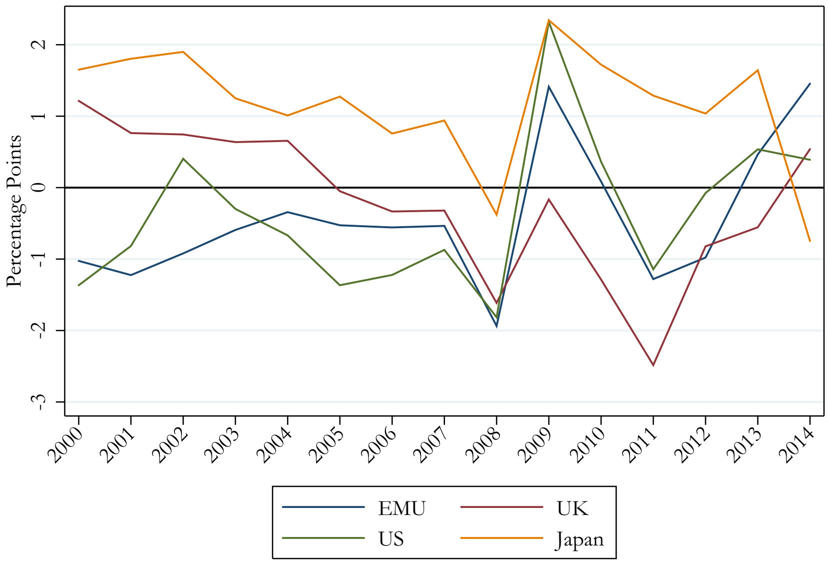
6.4.3 The State of Monetary Stability

While the weights that central banks place on financial stability and fiscal and economic stability in the above-presented model depend on two elements each – namely the distance of the stability from the target value and the focus that the central bank places on the respective objective at all – the monetary stability objective has been assumed as always being present and to be traded off against. The weight that it has in the objective function thus only depends on the gap from the target. As all central banks discussed here have an explicit or implicit inflation target, it is straightforward to measure this gap using the inflation gaps depicted in Figure 6.12.

[278] The voting arrangement in the ECB council has been criticized as undemocratic, as e.g. in Sinn (2014b), Sinn et al. (2004), and Sinn and Wollmershäuser (2012).

Figure 6.12: Inflation Gaps in International Comparison

The figure shows the divergence of inflation rates from target values defined by the central banks (inflation gaps), which are set to 2% at the Fed, 2% at the BoE, 1.8% at the ECB and 1% at the BoJ until 2012 and 2% thereafter. Positive gaps mark inflation rates below target and negative gaps mark inflation rates above target. Years with positive gaps thus represent settings where no trade-off between monetary stability and the other two objectives applies, while the trade-off becomes stronger the more negative the inflation gap. Immediately after the financial crisis set in, no central bank faced much of a trade-off. However, this changed (except for the BoJ) during 2010–2012.



Source: author's calculation; IMF, World Economic Outlook Database; Eurostat.

The annual price level increase targeted by the Fed has been 2% for quite some time, a policy that the Fed made official in January 2012.[279] The target of the BoJ had been 1% until 2012, before being changed to 2% in January 2013.[280] The BoE has been targeting 2% inflation since 1992.[281] At the ECB, price stability has been interpreted as "below, but close to 2%" ever since.[282] In the figure, positive values represent inflation rates below target, i.e. do not imply trade-off against increasing inflation for loosening policies. By contrast, those policies would subsequently support the closing of all objective gaps simultaneously. Negative values imply inflation rates above target, i.e. any loosening central bank measures comprise a trade-off.

Before the financial crisis started, Japan and the UK experienced slightly lower than targeted inflation rates and the US and the EMU slightly higher than targeted. In 2008, all depicted jurisdictions experienced rather high inflation, although in 2009 the depressing and deflationary impacts of the financial crisis kicked in. According to the picture, the Fed and the BoJ – and to a lesser degree also the ECB – faced the lowest trade-offs in the immediate aftermaths of the financial crisis event in 2009 and 2010. Inflation was highest in the UK. None of the central banks thus had

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279 See e.g. "Why the Fed Targets 2% Inflation," *The Economist*, 13 September 2015, `http://www.economist.com/blogs/economist-explains/2015/09/economist-explains-7`.

280 L. Kihara and S. White, "Bank of Japan to Mull 2 Percent Inflation Target as Abe Turns Up Heat," Reuters, 18 December 2012, `http://www.reuters.com/article/us-japan-economy-boj-idUSBRE8BG14V20121218`; BoJ, *Joint Statement of the Government and the Bank of Japan on Overcoming Deflation and Achieving Sustainable Economic Growth*, 22 January 2013, `http://www.boj.or.jp/en/announcements/release_2013/k130122c.pdf`.

281 See BoE website.

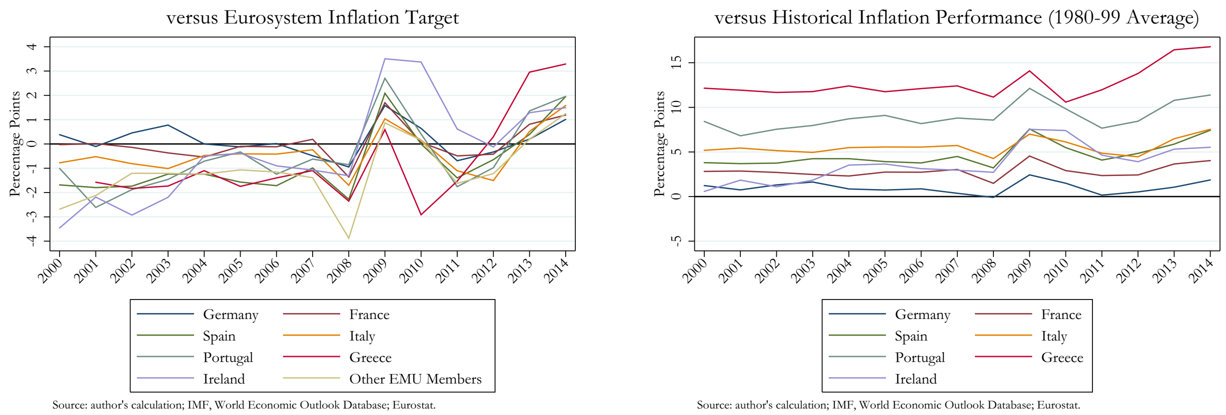
282 See ECB website. For an explanation of the choice, see Issing et al. (2001).

to worry about a trade-off to their LOLR actions and at most the BoE had to worry about one to its LOLR actions later on. However, the fact that it restricted most of its measures with respect to time helped to regain inflation rates closer to target from 2012 onwards again.

During the European sovereign debt crisis, the ECB faced (in 2012 more than any other central bank) negative inflation gaps and thus potential trade-offs to its MMOLR actions. A more detailed look at the monetary union (left panel of Figure 6.13) reveals that measured against the Eurosystem's price stability target, the crisis countries should have been especially worried as their individual consumer price indices (CPIs) were further away from the target than those of Germany or France, for instance. On the other hand, as discussed in the previous section and illustrated by the right panel of Figure 6.10, a price stability target had been close to unknown in most member states before they joined the EMU. The right panel of Figure 6.13 thus offers a guess of the "perceived" inflation gap within selected EMU member countries. In order to reach this, the national price developments (CPIs) have not been related to the Eurosystem's inflation target but rather to the national average annual inflation rates prior to the introduction of the common currency. The figure suggests that none of the EMU members have ever perceived inflation rates as too high. By contrast, while Germany experienced price stability as according to customs, the crisis-afflicted countries might all feel relatively weakly inflated. Taking up the point from above (central bankers in the ECB council tending to act according to the national customs and perceptions of central banking) leads to the conclusion that the monetary stability weight in the ECB's objective function during the crisis management was either small (from Germany's perspective) or large – although due to a stability gap perceived as positive rather than negative (crisis countries' perspective) – such that the optimization of the objective function did not reveal any trade-off to the loosening central bank collateral policy measures.

Figure 6.13: Official and "Perceived" Inflation Gaps within the European Monetary Union

The left panel of the figure details the information provided in Figure 6.12 for selected EMU member countries. Inflation developments were rather synchronous throughout the crisis years. The crisis countries should have been especially worried about the trade-off with monetary stability as their individual CPIs were further above target than those of Germany or France, for instance. Therefore, the right panel of the figure estimates the "perceived" inflation gap for the selection of EMU countries by taking the difference between actual CPI and the historical average of the CPI growth rates before the euro was introduced, whereby the picture changes. While according to the estimate Germany would perceive inflation as at target, all other countries – and in particular crisis countries – would perceive price increases as being too low. Consequently, a perception for a trade-off against monetary stability would have also been missing.



Chapter 7

Quality Effects of Collateral Policy[283]

The previous chapter muted the vertical dimension of the eligible collateral pool, i.e. the differing quality of eligible assets. By contrast, in this chapter collateral is modeled as explicitly differing along the quality dimension and the influence of central bank collateral policy is analyzed. It was explained in Section 4.5.6 that the Eurosystem applies a clustering approach in its haircut definition with respect to liquidity, residual maturity and most prominently along the credit quality dimension, such that haircut values are pooled within only two credit quality segments. Similar clustering approaches were identified at other central banks in Part II of this dissertation. This practice of segmentally pooling public refinancing conditions (cf. Section 4.5.7) is explicitly modeled in the extended model in Section 7.2.2. In addition to the haircut definition, the segmental pooling specification incorporates the application of supplementary haircuts irrespective of credit quality and the theoretical valuation of assets. In the following, a model of the repo market is set up, where private lenders offer refinancing through repos and the public offer for refinancing by the central bank is modeled as an outside option (Section 7.2.1). Before the theoretical analysis is conducted in Section 7.2, an institutional background of the European repo market is provided, which represents the money market in this chapter (Section 7.1).

Concluded from the analysis of segmentally-pooled refinancing policy is an adverse selection of collateral represented by the attraction of relatively low-quality collateral by the central bank within each credit quality segment. This phenomenon is referred to as Gresham's Law of Collateral (GLOC). Concomitant is a subsidization by the central bank of this low-quality collateral. Hence, it acts as a MMOLR for investment projects of lower quality (lower productivity). The subsidization leads to risk within the central bank's balance sheet and thus a threat to monetary stability.

As in reality, determining the quality of an asset that is backed by some kind of financing for an investment project is difficult, whereby the definition of quality requirements often refers to credit ratings by rating agencies. Therefore, asymmetric information between borrowers and lenders is additionally introduced into the model, as well as signals, representing ratings. Consecutively, the effects of the definition of collateral requirements in terms of credit ratings are carved out. Possible misevaluation of asset qualities plays a central role in this context. The case of positively

[283] This chapter bases on joint work with Jakob Eberl (Eberl and Weber, 2013; 2015), which has also been used in his dissertation (Eberl, 2016).

distorted ratings yields an expansion of the eligible asset pool beyond the control of the central bank. Moreover, the above-stated attraction of relatively low-quality collateral and its consequences are intensified. On the other hand, the case of negatively distorted ratings turns the market-making of the central bank into a LOLR activity, where the attraction of low-quality collateral, subsidization and risk-taking are alleviated.

7.1 Institutional Background: The Repo Market

This section sets up the institutional background of the model presented in the next section. As discussed in Section 4.1, the Eurosystem provides liquidity predominately as collateralized loans while the private provision of short-term liquidity in the money market usually takes the form of repos.[284] Although legal attributes and operational processing differ between collateralized loans and repos, they are equivalent from an economic perspective and considered as close substitutes for borrowers in need of refinancing credit.[285] The following section addresses general aspects of repos and provides a brief overview of collateral criteria and haircut definition in the European interbank repo market. Furthermore, similarities and differences between private repos and collateralized loans by the Eurosystem are carved out.

7.1.1 General Aspects of Repurchase Agreements

A repo is an agreement between two parties in which one sells assets to the other and simultaneously agrees to buy back the assets at a later date.[286][287] The repurchase price usually exceeds the purchase price such that the difference can be regarded as equivalent to interest paid in a collateralized loan. In the following, the discussion will mainly refer to two banks interacting in a repo on the repo market, although of course the counterparties can also be financial institutions other than banks.

The importance of repos manifests in two reasons. First, they are the main instrument for short-term bank funding (cf. European Central Bank, 2012; 2014b). In December 2014, the total value of contracts outstanding in the European repo market was estimated at EUR 5.5 trillion, having slightly declined from EUR 5.8 trillion in June 2014, cf. International Capital Market Association (2014). These figures do not include the value of repos transacted with the Eurosystem or central banks outside the Eurosystem. Accordingly, the majority of these repos were performed in the interbank market.[288] Second, the Eurosystem carries out a fraction of its liquidity-providing operations via repos as one of two possible types of reverse transactions (cf. Section 4.1). Therefore, repo markets occupy first-order relevance for the Eurosystem's refinancing operations.[289]

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284 The terms repo market and money market are thus used somewhat interchangeably.

285 See Ruchin (2011) for a comparison of repos and collateralized loans from a legal perspective and Adrian et al. (2013) for a discussion from an economic perspective.

286 Therefore, one party is usually called the seller/borrower/collateral provider and the other is referred to as the buyer/lender/cash provider.

287 For more detailed information on repos, see Choudhry (2006, 2010), Duffie (1996), and Garbade (2006). For the importance of repos from a central bank perspective, see e.g. Bank for International Settlements (1999), Bindseil et al. (2009b), and D'Amico et al. (2014).

288 Cf. Bakk-Simon et al. 2012. For a detailed investigation of the European repo market, see European Central Bank (2014c) as well as Mancini et al. (2015).

289 See Bank for International Settlements (1999) for an early description of the repo market from the perspective of central banks.

There are different reasons for both the lender and the borrower to enter a repo.[290] In general, the interbank repo market allows liquidity-seeking banks to receive funding from banks with excess liquidity. Borrowers can use idle assets to finance long positions while lenders are able to cover short positions. Interest costs are usually low as repo markets feature high market liquidity. For banks with excess liquidity, repos thus reflect an additional investment option that implies relatively small risk owing to short duration and collateralization ("cash-driven" motive). Moreover, the motive for entering a repo can also be to borrow certain collateral assets ("security-driven"). Consequently, collateralizing assets are usually specified in security-driven repos, while cash-driven repos are often conducted as general collateral (GC) repos. In GC repos, lenders accept as collateral a basket/range of assets (i.e. a specific asset type or a specified list of ISIN codes) provided that they meet requirements on e.g. credit quality. Security-driven repos are usually referred to as "specials" and no prior restrictions on collateralizing assets are made.

The following two processes within repo transactions hold interest for the analysis at hand as they are decisive for the specification of collateral quality criteria and haircuts within the definition of operational conditions, i.e. *(i)* the management of collateral and *(ii)* the clearing of delivery and payment obligations.[291]

Collateral Management At the level of collateral management, securities are valued, selected and delivered as collateral from the borrower to the lender. This is undertaken either bilaterally – i.e. by counterparties themselves ("bilateral") – or under the involvement of a third party, usually a custodian bank ("tri-party"). Throughout the repo transaction, functions related to collateral management also involve maintaining collateral value and quality. Irrespective of whether collateral management is bilateral or tri-party, collateral risk remains with the lender as the third party does not assume any risk. Repos in which a third party manages collateral are usually cash-driven as the lender and the borrower only negotiate repo conditions but not the delivery of specific collateral assets.

Clearing At the clearing level, delivery and payment obligations are netted among lenders and borrowers.[292] Clearing is performed either bilaterally or multilaterally: in the former, each lender/borrower nets obligations separately with each borrower/lender, while in the latter a CCP interacts between the lender and the borrower and nets obligations. The CCP also becomes the buyer and seller, respectively, of collateral once the transaction has been agreed between the lender and the borrower. Therefore, the CCP becomes the counterparty to both parties of the repo, i.e. the borrower to the lender and the lender to the borrower, respectively. Repo contracts not cleared by a CCP are less standardized with respect to both collateral requirements and contract terms. However, CCP-cleared repos are usually advantageous to both the lender and the borrower

[290] For an extensive description of these reasons, see e.g. Choudhry (2006).

[291] Trading and settlement are two further processes in repo transactions. See e.g. European Central Bank (2013a) for further details.

[292] Clearing refers to several activities in between trading and settlement, namely trade capture, trade verification, trade matching or affirmation, legal confirmation, reporting to a trade repository, position and payment netting, portfolio compression, novation (a central clearing mechanism) and risk management, cf. European Central Bank (2013a).

as the CCP is usually a Triple A-rated agency and protects both from counterparty default.[293] Furthermore, risk exposure is reduced as the CCP nets transactions between counterparties on a multilateral basis, which implies a smaller net exposure between counterparties relative to non-CCP clearing. The motivation for lenders entering CCP-cleared repos is usually cash-driven, while it is often security-driven in non-CCP-cleared repos as the smaller degree of standardization allows collateral to be more specific. Table 7.1 illustrates the possible combinations of clearing and collateral management, indicating who specifies collateral criteria and imposes the haircut.

Table 7.1: Combinations of Clearing and Collateral Management in Private Repos

The table details the possible combinations of clearing and collateral management. Combinations are vital for who is exposed to collateral risk, hence specifying collateral criteria and the haircut.

		Collateral Management	
		Bilateral	Tri-Party
Clearing	CCP	collateral criteria and haircut imposed by *CCP*	collateral criteria and haircut imposed by *CCP*
	Non-CCP	collateral criteria and haircut imposed by *lender*	collateral criteria and haircut imposed by *lender*

Source: author's compilation.

Risk Mitigation through Collateralization and Haircuts Lenders in the repo market – just as well as central banks in reverse transactions – hedge risk in two steps (see discussion in Section 4.5.3): first, collateral is taken to hedge risk of borrower default (counterparty risk); and second, haircuts are applied to mitigate risk associated with collateral (collateral risk).[294] The eligibility of collateral in the repo market is usually restricted to bonds and other fixed-income instruments and haircuts are applied to the market value of the collateral to mitigate the risk associated with liquidation in case of counterparty default. Table 7.1 reveals that lenders determine eligibility requirements and haircuts applied to collateral in non-CCP-cleared repos irrespective of whether a third party is involved in collateral management. The third party only manages collateral but does not assume any responsibility for it. Thus, risk mitigation is crucial for the lender as he would be left with any loss in case of borrower default. By contrast, in CCP-cleared repos, the CCP buys the collateral and also imposes requirements and haircuts to the collateral. Hence, haircuts are exogenous to lenders in CCP-cleared repos.

7.1.2 Collateral and Haircuts in the European Repo Market

The Eurosystem competes for collateral with private lenders that participate in the European repo market.[295] The total value of repo contracts outstanding in this market amounted to EUR 5.5 trillion in December 2014, compared to EUR 0.63 trillion of outstanding refinancing credit from the

[293] CCPs are Triple A-rated as exposure is strictly collateralized, backed by reserves and further safeguards like default funds.

[294] Gorton and Metrick (2010) empirically analyze evolutions in the US repo market throughout the financial crisis, finding that haircuts significantly increased from essentially zero in the process of deleveraging, which is referred to as a "run on repo". Further studies on the development of repo markets and haircuts during and after the financial crisis include Brunnermeier (2009) and Krishnamurthy et al. (2014).

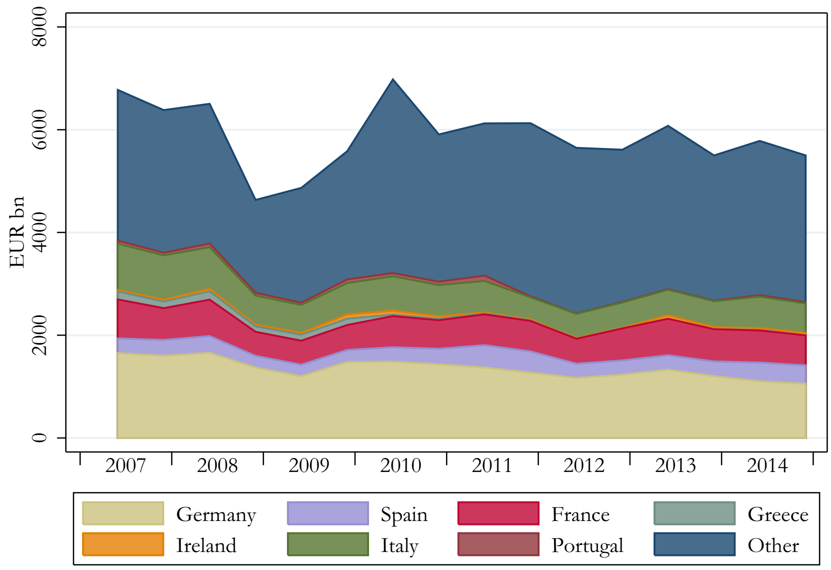
[295] As well as other central banks in the respective repo markets of their jurisdiction accordingly.

Eurosystem, cf. International Capital Market Association (2014) and Figure 8.9.[296] The following collects the scarce information available on the European repo market in terms of collateral and haircuts.

Collateral The geographical distribution of collateral sold in the European repo market is illustrated in Figure 7.1.[297] It indicates the development of the value of outstanding repos and shows that the fraction of assets used for repos in Germany, Spain, France, Greece, Ireland, Italy and Portugal (where the vast majority of collateral in the Eurosystem's eligible collateral pool comes from, as shown in Figure 4.15) slightly declined over time, i.e. from 56.7% in June 2007 to 48.1% in December 2014. Most of this collateral was sold in Germany, France, Italy and Spain, while only negligible amounts were pledged in Greece, Ireland and Portugal.

Figure 7.1: Collateral Pledged in the European Repo Market by Country

The figure elaborates on the geographical distribution of collateral pledged in the European repo market, showing that the fraction of collateral from Germany, Spain, France, Greece, Ireland, Italy and Portugal slightly declined over time. Collateral from these countries constitutes the majority of the eligible collateral pool of the Eurosystem, cf. Figure 4.15.



Source: author's compilation; ICMA (2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014).

In order to gain further insights, the European repo market is divided along the lines of Table 7.1, i.e. with respect to clearing (CCP-cleared versus non-CCP-cleared) and collateral management (bilateral versus tri-party), as additional information is available for CCP-cleared and tri-party repos. The terms of non-CCP-cleared and bilateral repos are usually negotiated directly between counterparties with no information being available.

[296] For the following analysis of the European repo market, the series of the ICMA repo market survey is consulted, see International Capital Market Association (2007, 2008, 2009, 2010, 2011, 2012a, 2013, 2014).

[297] The geographical distribution is considered in terms of the country where collateral was issued. This is consistent with the other geographical analyses in this dissertation.

According to International Capital Market Association (2014), 27.4% of repo contracts were cleared with CCP involvement in 2014.[298] Clearing services in the European repo market were mainly provided by five CCPs by the end of 2014, i.e. CC&G in Italy, BME Clearing in Spain, LCH-Clearnet SA in France, LCH-Clearnet Ltd in the UK and Eurex Clearing in Germany. Owing to this geographical differentiation and potential differences in risk preference, CCPs deemed eligible different types of collateral. CC&G accepted government bonds from Germany, France and Italy, while BME Clearing deemed eligible a variety of securities and government bonds from Austria, Belgium, France, Germany, the Netherlands, Spain, the UK and the US. For LCH-Clearnet SA, government bonds from inter alia Belgium, France, Germany, Italy, the Netherlands, Portugal, Spain, the UK and the US were eligible, as well as government-guaranteed bonds. Likewise, LCH-Clearnet Ltd embraced a variety of government bonds, from e.g. Austria, Belgium, Finland, Germany, Ireland, the Netherlands, Portugal, Slovakia, Slovenia, Spain and the UK. In addition, it deemed eligible corporate bonds that were rated above Single A. Finally, Eurex approved a broad variety of fixed-income securities such as government bonds denominated in EUR, CHF as well as other currencies. Moreover, it accepted equities denominated in EUR and CHF.

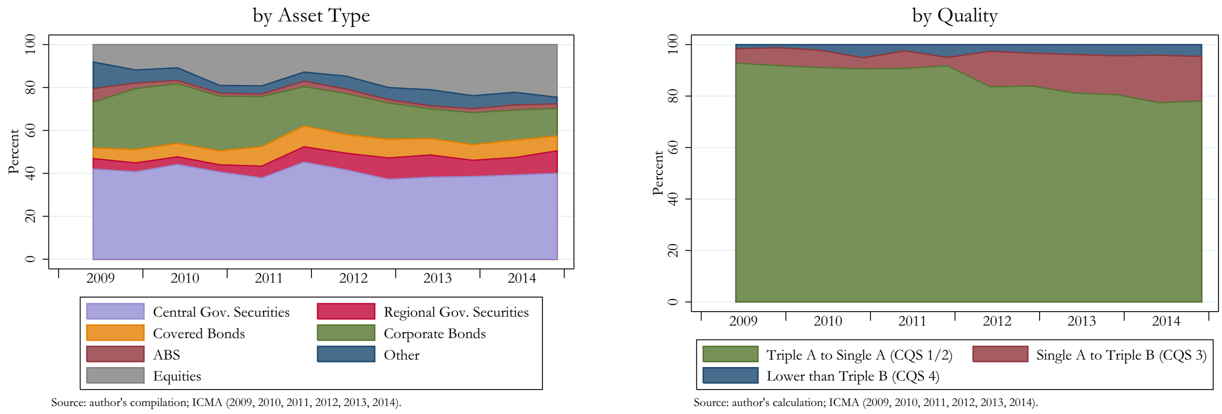
For the tri-party sector of the European repo market, information is available on the type and credit quality of traded collateral. Tri-party repos are contracted directly between the two parties as the third party involved undertakes collateral management but does not assume any risk. International Capital Market Association (2014) reports that 10.5% of contracts in the European repo market in 2014 were tri-party, having slightly increased over recent years. The development of the type and credit quality of collateral in tri-party repos is depicted in Figure 7.2 from June 2009 to December 2014. The left panel reveals that government bonds, corporate bonds and equities are predominantly sold in tri-party repos. Growing fractions of regional government bonds and equities have replaced a declining fraction of corporate bonds over time. While equities have been deemed ineligible as collateral by the Eurosystem as of May 2005 (cf. Section 4.3.1), non-marketable assets are not eligible in tri-party repos. A comparison with the published data on pledged collateral (cf. Figure 4.21) highlights that the reliance on ABS and bank bonds is stronger at the Eurosystem, while a larger share of tri-party repos are based on government bonds and corporate bonds. The right panel indicates the credit quality of pledged assets (aligned to the Eurosystem's understanding of credit quality) and shows that it remained relatively high, with about 80% to 90% of all assets rated within CQS 1/2.

Comparing the development of collateral quality in tri-party repos to the quality of collateral eligible at the Eurosystem (cf. Figure 4.16) reveals differing developments. In June 2009, 92.8% of collateral pledged in tri-party repos was rated within CQS 1/2, while 96.4% of collateral eligible at the Eurosystem was of such high quality. Credit quality deteriorated in both the repo market and with the Eurosystem's eligible collateral pool over time, although the decline was stronger for tri-party repos. At the end of 2013, 90.8% of collateral eligible at the Eurosystem was still rated within CQS 1/2 compared to 80.5% in the repo market. However, this observation suffers from lacking information in two respects.

[298] Therefore, the vast majority of repos – 72.6% worth EUR 4 trillion in 2014, cf. International Capital Market Association (2014) – was contracted without CCP involvement. In these repos, contractual details are negotiated bilaterally and no a priori restrictions on collateral are made.

Figure 7.2: Collateral Pledged in Tri-Party Repos by Asset Type and Quality

The figure illustrates the development of the composition of collateral pledged in tri-party repos from 2009 to 2014 by asset type (left panel) and quality (right panel). The left panel reveals that government bonds, corporate bonds and equities were predominantly pledged in tri-party repos. The right panel indicates that the quality of pledged assets deteriorated from June 2009 to December 2014.



First, the comparison is between collateral quality actually *pledged* in the private repo market and the entire *eligible* asset pool at the central bank. As this lack of information is not solved by the Eurosystem, the quality of collateral used is inferred in Section 8.7. Comparing the quality distribution of collateral pledged in the repo market to the inferred quality distribution of pledged collateral (see right panel of Figure 8.10) yields that both might rather deteriorate to similar levels. In fact, according to Figure 8.10, at the end of 2013 only 78.9% of collateral pledged with the Eurosystem was still rated within CQS 1/2. In terms of the model presented in Chapter 6, the explanation for this observation is that the refinancing conditions for assets of qualities within CQS 1/2 were more favorable in the money market (repo market), while assets of qualities within CQS 3 were more attractive for refinancing with the Eurosystem.

Second, the comparison above does not shed any light on the distribution of collateral quality within the credit quality segments (CQS 1/2, CQS 3 and CQS 4) defined by the Eurosystem. One central contribution of the model presented in the following (cf. Section 7.2) is to analyze the effect of the collateral policy of the Eurosystem on the likely distribution of pledged collateral within credit quality segments. The policy of segmentally-pooled refinancing conditions (cf. Section 4.5.7) plays a key role within the analysis.

Haircuts According to Table 7.1, haircuts are imposed by CCPs in CCP-cleared repos but bilaterally negotiated otherwise. In accordance with the European Market Infrastructure Regulation, CCPs are required to apply haircuts that are regularly tested (and revised if necessary) and take market conditions into account.[299] Haircuts have to be determined individually for each collateral asset, considering relevant properties such as type and credit quality.[300] Available information

299 Cf. European Parliament, "Regulation (EU) of the European Parliament and of the Council of 4th July 2012 on OTC Derivatives, Central Counterparties and Trade Responsibilities."

300 Other properties are legal risk, operational risk, duration, historical and hypothetical future price volatility (manifested in liquidity risk), wrong-way risk and exchange-rate risk. See Section 4.5 and e.g. European Central Bank (2013a).

on haircuts applied in private repos is scarce, with the little indicative evidence suggesting that haircuts depend on the type of repo, i.e. whether it is GC or special (see above). In certain GC repos (e.g. Eurex Repo Euro GC Pooling, LCH.Clearnet Ltd's RepoClear €GC), haircuts (and collateral criteria in general) are assumed from the Eurosystem, such that there is no difference with respect to refinancing conditions. In less standardized CCP-cleared repos, CCPs impose their own haircuts. For instance, BME Clearing states that it applies a "minimum haircut, equal to that of the ECB [...]", which is increased if deemed necessary.[301] Table 7.2 compares average haircuts applied to selected government bonds from January 2011 to December 2013 by two CCPs and the Eurosystem.[302] The table reveals that the average haircut of the Eurosystem was always lower than that applied by CCPs.[303] Haircut determination by CCPs may also be more differentiated and not segmentally pooled. For instance, CC&G differentiated haircuts according to eleven clusters of residual maturity for Italian government bonds but only for four clusters in the case of French or German government bonds. LCH-Clearnet SA used nine clusters of residual maturity for determining haircuts on the variety of government bonds that it accepted.

Table 7.2: Haircuts Applied to Selected Government Bonds by Central Clearing Counterparties and the Eurosystem

The table compares the average haircut applied to selected government bonds of different residual maturity between January 2011 and December 2013 by two CCPs and the Eurosystem, revealing that average haircuts of the Eurosystem fell short of those of CCP for all considered government bonds.

(Percent)	Duration	BME	CC&G	Eurosystem
Germany	Short[a]	2	3.86	0.5
	Middle[b]	3.56	7.72	2.42
	Long[c]	7.65	20	5.46
France	Short[a]	2	3.86	0.5
	Middle[b]	3.56	3.86	2.42
	Long[c]	7.65	7.72	5.46
Italy	Short[a]	n/a[d]	5.95	0.5
	Middle[b]	n/a[d]	13.45	2.42
	Long[c]	n/a[d]	22.51	5.46
Spain	Short[a]	2	n/a[d]	0.5
	Middle[b]	3.56	n/a[d]	2.42
	Long[c]	7.65	n/a[d]	5.46

[a] Defined as a government bond with residual maturity of less than six months.
[b] Defined as a government bond with residual maturity of four years.
[c] Defined as a government bond with residual maturity of eleven years.
[d] Not available as deemed ineligible.
Source: author's compilation; CCPs; ECB.

This indicative evidence suggests that while a broad range of collateral is deemed eligible in both the (different sectors of the) repo market and by the Eurosystem, contract conditions such as haircuts may differ. While this has been discussed for CCP-cleared repos, it is intuitive that conditions

301 Cf. BME Clearing, "Collateral Valuation," `http://www.bmeclearing.es/ing/Collateral/CollateralProcessing.aspx`.

302 See also European Central Bank (2014a) for a further comparison of haircuts applied by CCPs and the Eurosystem.

303 This is in line with Whelan (2014), who also finds lower haircuts for sovereign bonds compared to the market.

differ even more between non-CCP-cleared repos and collateralized loans from the Eurosystem. In these repos, haircuts are subject to negotiation between the lender and the borrower and contracted over the counter, i.e. conditions are much less standardized. Almost three-quarters – i.e. the vast majority – of the repo transactions are non-CCP-cleared (International Capital Market Association, 2014), which makes available data and information very scarce.

As with the model presented in Chapter 6, the following model places the different refinancing conditions in private repo conditions (the money market) and the collateralized refinancing loans from the central bank – in particular the Eurosystem – at the heart of the analysis. While the model in Chapter 6 only referred to one or at most two different collateralizing assets of similar quality, the quality dimension is explicitly introduced by the following model. Here, collateral of only one type but different qualities is assumed, in particular to elaborate on the impact of credit ratings and the practice of segmentally pooling refinancing conditions (cf. Section 4.5.7) on the allocation of refinancing drawn from the money market versus the central bank. All borrowers are assumed to have discretion to pledge collateral in the market or with the Eurosystem. Hence, applicability may be limited if a borrower does not have this discretion owing to e.g. counterparty ineligibility (e.g. the borrower is not deemed eligible by the Eurosystem) or collateral ineligibility (e.g. the collateral is deemed ineligible by the Eurosystem). However, this limitation is de facto small since the Eurosystem lends to a broad range of counterparties against an ever-broader range of collateral (see Chapter 4).

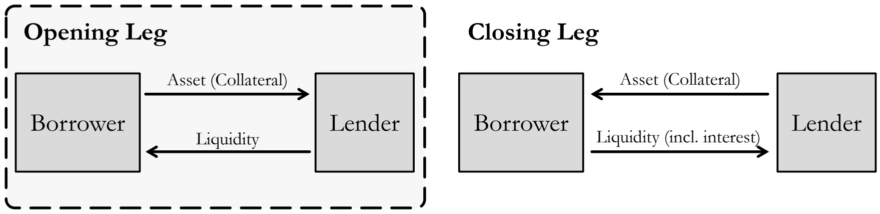
7.2 Gresham's Law of Collateral: A Model of Adverse Selection of Collateral

This section presents a model that elaborates on the behavior of liquidity-seeking banks. Banks can draw this liquidity by borrowing either in the market (private liquidity) or from the Eurosystem (public liquidity). It was discussed above that repos and collateralized loans are equivalent from an economic perspective. Therefore, no distinction is made between the specifics of liquidity provision in the market and by the Eurosystem, which is modeled as repos. The model builds upon the course of action of a repo stylized in Figure 7.3, which depicts the decomposition of a repo into two transactions taking place at distinct points in time, i.e. the opening and closing legs. Within the opening leg, the lender and the borrower agree upon the repo as well as its conditions and transfer liquidity in exchange for collateral. Within the closing leg, the borrower repurchases the collateral from the lender, who receives back the liquidity provided together with interest implied in a potentially higher repurchase price.

The model focuses upon the opening leg and the borrower's decision to enter a repo with either another bank (or other financial institution) on the money market (private lender) or the Eurosystem (public lender). Repo terms (refinancing conditions) are assumed to be identical at both the private and the public lenders except for the haircut applied. In other words, the borrower is in search for refinancing for one specific loan to an investment project, such that all determinants of the refinancing conditions *except* the haircut value applied to deduct the collateral value are identical. These determinants emerge from the layers of dimensions of collateral policy given in Table 2.1. In particular, the identical *(i)* asset type, *(ii)* asset quality and *(iii)* asset age – i.e. the same

Figure 7.3: Stylized Course of Action for a Repo

The figure stylizes the course of action for a repo and depicts its decomposition into two transactions taking place at distinct points in time, i.e. the opening and closing legs. The following analysis focuses upon the opening leg.



Source: author's illustration.

collateralizing asset – is used by *(iv)* the identical counterparty against *(v)* the same counter-asset at *(vi)* operational conditions that only differ regarding the layer of the haircut specification. As a result, the borrower only has to compare the haircut values demanded by the private lender (the money market) to those demanded by the public lender (the central bank).

Lenders impose a haircut to mitigate collateral risk such that the haircut size reflects expectations about the collateral liquidation value. In a world of certainty, the lender would not bear a loss from borrower default as it would be fully anticipated. The repo would be fully collateralized and the lender would not be worse off from liquidating collateral. However, in reality, borrower default could imply a loss to the lender as expectations about the liquidation value may be incorrect, leading to an under-collateralized repo. Risk mitigation is carried out in the opening leg based on expectations about the collateral liquidation value. The actual outcome of the repo in the closing leg – i.e. whether or not the asset is repurchased – is of second order as expectations of this outcome are reflected in repo terms realized in the opening leg. Hence, the analysis is narrowed to the opening leg without loss of generality.

The model elaborates on the adverse selection of collateral, which is often referred to as "Gresham's Law of Collateral" (GLOC) in the literature. GLOC is adapted from "Gresham's law", which describes the tendency of bad money driving out good money. Accordingly, if coins contained metal of different value yet had the same value as legal tender, those comprising the cheaper metal ("bad money") would be used for payments while the those made of the more expensive metal ("good money") would be hoarded (see e.g. Macleod, 1856; von Hayek, 1976). Historical exemplifications include the developments in the Latin Monetary Union of 1865, comprising France, Belgium, Switzerland and Italy (Greece also joined three years later). A lack of regulation of the relation of gold to silver led monetary union members to extensively use the cheaper of the precious metals when minting the coins, which changed over time as new discoveries of the metals affected supply while demand also fluctuated. The analogy to the EMU is very strong because the unilateral erosion of the currency backing could be used to enrich oneself at the cost of other members by issuing "cheaper" currency and buying goods from other union members.[304] The analogy between Gresham's law for specie and for collateral was established narratively by Chailloux et al. (2008a,b) and addressed as the risk of adverse selection of collateral in Singh (2013b). The adverse selection of collateral was first technically analyzed by Ewerhart et al. (2006), who suggest borrowers'

[304] This example is e.g. provided in Krämer (1970) and Sinn (2012b, Ch. 9).

preference to pledge illiquid collateral with the central bank owing to different pricing of liquidity risk by the private market and the central bank. Drehmann and Nikolaou (2013) and Ewerhart and Tapking (2008) support the notion that the least liquid and most risky assets are deposited with the central bank, while higher-quality assets are pledged in private (bilateral) repos as this alleviates two-way credit risk. Bindseil (2014) seizes on the phenomenon of GLOC and discusses four measures that central banks could in principle consider to counteract the concentration of bad collateral owing to adverse selection, see also Bindseil (2013). Most recently, Fecht et al. (2015) document adverse selection (referred to as "systemic arbitrage") for German banks' borrowing from the Eurosystem over the 2006–2010 period. In this context, systemic arbitrage is also addressed in Nyborg (2015). The following model differs from previous analyses as it addresses GLOC specifically for the Eurosystem based on the peculiarities of the Eurosystem's collateral policy, especially the clustering approach of segmentally pooling public refinancing conditions, as described in Section 4.5.7. Moreover, it emphasizes the role of rating agencies for the degree of adverse selection.

The elaboration of the model is structured as follows. First, the basic model with symmetric information is set up as the benchmark. Subsequently, asymmetric information, a signal of collateral quality and an outside option to borrowers are introduced. The outside option is then further specified and modeled as a stylization of repo conditions offered by the Eurosystem in terms of segmentally pooling refinancing conditions.

7.2.1 Model with Private and Public Liquidity Provision

In the basic model, only the repo market is considered and counterparties can interact in the following simple way: liquidity-seeking banks can use bonds in repos with banks that have excess liquidity. In this environment, four steps of analysis will be taken in which the information structure and the involved players differ. First, borrowers and lenders are symmetrically informed about the quality of bonds that can be used as collateral. Second, the case is considered in which the borrower has more information than the lender about collateral quality (asymmetric information). Third, the impact of credit ratings as a signal on collateral quality is evaluated. Fourth, an outside option for borrowers is introduced, i.e. the possibility to use collateral outside the repo market, e.g. with the central bank as public lender.

7.2.1.1 Model Setup[305]

There are J profit-maximizing borrowers who own one collateral asset each, e.g. a bond. The initial cost of bond creation is assumed to be zero. Bonds differ in the level of quality θ such that bond j is of (unique) quality θ_j, which can be perceived as e.g. higher credit quality, legal certainty, transparency or liquidity of bond j, cf. Table 2.1.[306] Quality is uniformly distributed in the range between the lowest $\underline{\theta}$ and the highest quality level $\bar{\theta}$, i.e. $\theta_j \in [\underline{\theta}, \bar{\theta}] \subset \mathbb{R}$. Different quality levels emerge as risk-to-return ratios of assets underlying the bonds differ such that $0 < \underline{\theta} < \bar{\theta} < \infty$.[307] Selling the bonds gives borrowers liquidity that can be used e.g. to make new loans resulting in a positive return.

305 The model setup is inspired by Mas-Colell et al. (1995, Ch. 13).

306 Hence, θ is directly linked to the default/applicability probability of the collateral in terms of the model presented in Chapter 6.

307 Assets underlying the bonds are the loans to investment projects financed by the bank, which borrows refinancing liquidity in this model.

Risk-neutral lenders purchase bonds under perfect competition at price $\rho(\theta_j)$. The purchase price is equal to the haircut-adjusted market value of the bond, i.e. $(1-h^L(\theta_j))MV(\theta_j)$, with $0 \leq h^L(\theta_j) \leq 1$ being the haircut that a lender applies to the market value $MV(\theta_j)$ of bond j with quality θ_j.[308] Lenders seek to maximize profit and use an identical production function yielding constant returns to scale with bonds being the only input. For simplicity, each bond generates output equal to θ_j, which can be regarded as return on investment (depending on the quality of the bond), assuming the absence of production costs. The price that lenders take on their output is equal to unity, such that their earnings also equate to θ_j.

7.2.1.2 Symmetric Information

If lenders and borrowers both have complete information about the quality of each bond, lenders will offer to pay distinct prices equal to quality $\rho(\theta_j) = \theta_j$. This is what lenders earn from owning the bond and owing to the competitive structure on the demand side it also gives the equilibrium price. As borrowers miss alternative utilization of the bonds, the set of marketing borrowers is given by $\Theta(\rho) = \{\theta_j : 0 \leq \rho(\theta_j)\}$. As $\rho(\theta_j)$ is equal to θ_j and $\underline{\theta}$ is strictly positive, the set comprises all J borrowers. All bonds are traded and aggregate surplus in the repo market (defined as the sum of rents of borrowers and lenders) is maximized. Figure 7.4 provides a graphical illustration of the equilibrium with symmetric information. Bond quality θ runs on the horizontal axis, with the relevant quality range indicated by $\underline{\theta}$ and $\bar{\theta}$. The 45°-line maps bond quality onto the vertical axis as quality θ_j equals output net of cost and hence earnings from the bond to a lender who is willing to pay a price of the same amount. Consequently, the price is given on the vertical axis. As each bond is traded at a price equal to its quality level, lenders are left with zero rent. Payments to borrowers are reflected by the area underneath the price curve in the range between $\underline{\theta}$ and $\bar{\theta}$. The area gives aggregate surplus in this market and corresponds to the rent of the supply side, i.e. borrowers.

Technically, rent distribution can be formulated as follows. Lenders are left with zero rent, i.e. $R^L = 0$, while each borrower receives $\rho(\theta_j)$ in exchange for collateral, has zero cost and all bonds are traded such that[309]

$$R^B = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2} \tag{7.1}$$

is the rent of borrowers. Aggregate surplus R in the market is equal to the rent of borrowers as R^L is equal to zero, i.e. $R = R^B = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2}$.

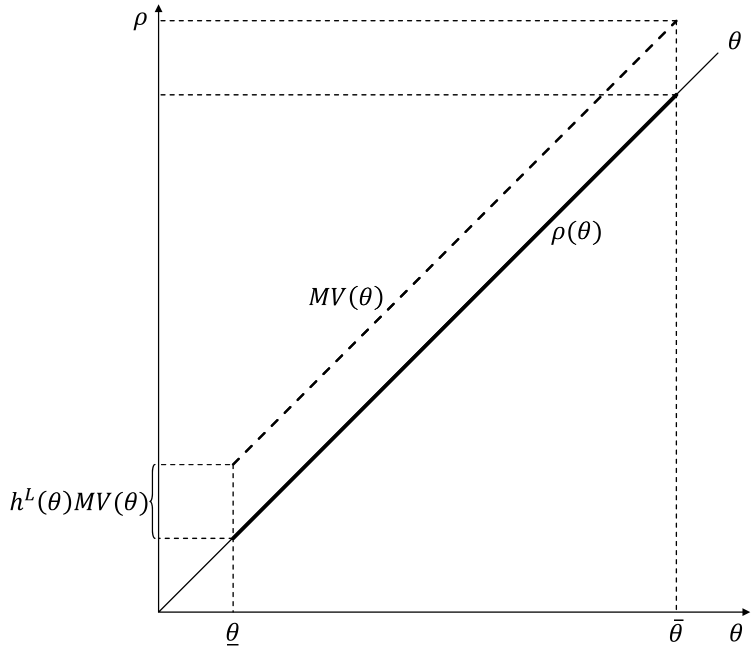
7.2.1.3 Asymmetric Information

In the next step, lenders cannot observe the quality of the bond that they purchase (asymmetric information). Rather than distinct prices equal to bond quality, lenders now offer the uniform price $\rho(\theta_j) = \rho \; \forall \; \theta_j$. As borrowers still lack an alternative to selling bonds in the market, they accept any non-negative price. Accordingly, the set of marketing borrowers is given by $\Theta(\rho) = \{\theta_j : 0 \leq \rho\}$.

[308] This haircut-adjusted market value will later be referred to as private collateral value (PCV), i.e. the value that private lenders assign to collateral, in differentiation to the public collateral value (ECV).

[309] See the appendix for the derivation of (7.1).

Figure 7.4: Equilibrium with Symmetric Information



Source: author's illustration.

Lenders' demand for bonds ζ is a function of ρ and can be expressed as

$$\zeta(\rho) = \begin{cases} 0 & \text{if } \mu < \rho; \\ [0, \infty) & \text{if } \mu = \rho; \\ \infty & \text{if } \mu > \rho, \end{cases} \tag{7.2}$$

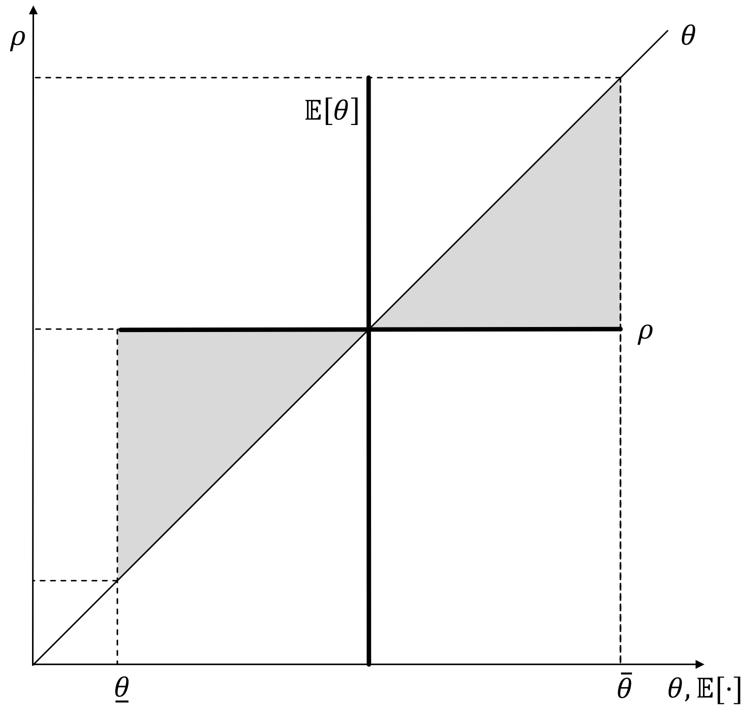
with μ representing the lenders' uniform belief concerning the average quality of traded bonds. Figure 7.5 illustrates the market with asymmetric information. Lenders anticipate that at any non-negative price, $\Theta(\rho)$ comprises all J borrowers and all bonds in the range from $\underline{\theta}$ to $\bar{\theta}$ are marketed. Lenders' belief concerning the average bond quality in the market – i.e. the expected bond quality – is given by $\mu = \mathbb{E}[\theta|\theta \in \Theta(\rho)] = \frac{\bar{\theta}+\underline{\theta}}{2}$ as θ is uniformly distributed within $[\underline{\theta}, \bar{\theta}]$. Lenders are in perfect competition for bonds and offer a price that simply reprieves them from an expected loss such that $\rho = \frac{\bar{\theta}+\underline{\theta}}{2}$. While some lenders realize profits and others lose, lenders overall are still left with zero rent, i.e. $R^L = 0$. Therefore, the rent of borrowers is again equal to aggregate surplus in the market, amounting to[310]

$$R^B = R = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2}. \tag{7.3}$$

Figure 7.5 shows the expenditure of lenders by the rectangle under the horizontal price line (between $\underline{\theta}$ and $\bar{\theta}$), which is also what borrowers receive as payment for their bonds, i.e. their rent R^B. The earnings of borrowers correspond to the area below the 45°-line (between $\underline{\theta}$ and $\bar{\theta}$). The rents of borrowers and lenders are equal to the benchmark case of symmetric information, as is the aggregate surplus R. However, there are important differences with respect to the distribution of rents within the groups of lenders and borrowers. On the one hand, lenders purchasing (without

[310] See the appendix for the derivation of (7.3).

Figure 7.5: Equilibrium with Asymmetric Information



Source: author's illustration.

knowing) bonds of relatively low quality of up to $\frac{\bar{\theta}+\underline{\theta}}{2}$ take losses, as illustrated by the left shaded triangle. This is because they pay the uniform price $\rho = \frac{\bar{\theta}+\underline{\theta}}{2}$ but receive bonds of quality $\theta_j < \frac{\bar{\theta}+\underline{\theta}}{2}$. On the other hand, lenders purchasing higher-quality bonds, $\theta_j > \frac{\bar{\theta}+\underline{\theta}}{2}$, receive profits that correspond to the right shaded triangle. Only the lender who receives the bond of quality $\theta_j = \frac{\bar{\theta}+\underline{\theta}}{2}$ for paying $\rho = \frac{\bar{\theta}+\underline{\theta}}{2}$ makes zero profit, like all lenders did with symmetric information. As the shaded triangles offset in aggregate, R^L remains unaffected. Likewise, borrowers are affected by asymmetric information. Those borrowers selling bonds with $\theta_j < \frac{\bar{\theta}+\underline{\theta}}{2}$ receive a higher price than with symmetric information, while borrowers with $\theta_j > \frac{\bar{\theta}+\underline{\theta}}{2}$ are worse off. Accordingly, rent is redistributed from borrowers with high-quality bonds to those with low-quality bonds. Asymmetric information leads to redistribution within the group of lenders and borrowers while aggregate surplus is still maximized.

7.2.1.4 Signaling under Asymmetric Information

Each lender is now supposed to observe a bond-specific signal $s(\theta_j)$ on the quality θ of bond j that ranges between $[\underline{\theta}, \bar{\theta}]$. Each lender is assumed to believe in this signal as it provides information on bond quality that the lender would otherwise not have. For instance, this signal could be interpreted as a credit rating by a rating agency that is able to assess bond quality.[311] Technically, lenders' belief on bond quality is conditional on the signal and given by $\mathbb{E}[\theta_j|s(\theta_j)] = s(\theta_j)$. Obviously, if the signal reflects true quality, i.e. $s(\theta_j) = \theta_j \ \forall \ \theta_j$, asymmetric information would be resolved and the outcome under symmetric information would be mimicked. There are at least three possible

[311] In reality, credit ratings are not continuous as quality levels are pooled into rating notches. Here, a continuous distribution of θ and $s(\theta)$ is assumed for simplicity. However, the model could likewise be interpreted with discrete quality levels and signals.

explanations for a distorted signal. First, although the rating agency may have the necessary information available to correctly assess bond quality, it delivers a rating that does not fully reflect this information.[312] Second, borrowers who have to acquire the ratings may selectively disclose ratings, i.e. only disclosing the best rating available. This “ratings shopping” was observed prior to the financial crisis, especially for complex securities.[313] Note that the awareness for this behavior at rating agencies may in light of their competition with each other well lead to a race to the top in ratings issued, analogously to the race to the bottom described for regulatory frameworks in Sinn (2003b), which again leads to ratings not fully reflecting available information as described above. Third, the rating agency may systematically under- or over-value quality when its assessment technology is biased or affected by rating-contingent regulation.[314] With respect to the former, Katz et al. (2009) point to biased signals as the result of increased competition and the endeavor to increase profits. Accordingly, rating agencies relaxed rating criteria and avoided hiring new staff or investing in costly new databases and rating models prior to the financial crisis. With respect to rating-contingent regulation, the analysis by Opp et al. (2013) shows that the introduction of such regulation increases the volume of highly-rated securities.[315] This systematic misevaluation of bond quality is addressed in the following.

In this case, the signal reads $s(\theta_j) = \theta_j \pm \epsilon$, with $\epsilon > 0$ being a positive constant reflecting the misevaluation of bond quality.[316] Misevaluation implies that the bond quality perceived by lenders runs parallel to the 45°-line as exemplified in Figure 7.6. The figure depicts the case of a systematic overvaluation of quality, i.e. $s(\theta_j) = \max\left(\theta_j + \epsilon, \bar{\theta}\right)$.[317] Bonds j of quality $\theta_j \geq \bar{\theta} - \epsilon$ are signaled to be of the highest quality $\bar{\theta}$. Lenders' expectations are $\mathbb{E}[\theta_j | s(\theta_j)] = \max\left(\theta_j + \epsilon, \bar{\theta}\right)$, which gives the equilibrium price $\rho(\theta_j) = \max\left(\theta_j + \epsilon, \bar{\theta}\right)$. As borrowers still lack an alternative to selling their bond in the market, they accept any non-negative price and the set of marketing borrowers is again $\Theta(\rho) = \{\theta_j : 0 \leq \rho\}$. All lenders aside from the one buying the bond of quality $\bar{\theta}$ make losses, reflected by the shaded area in Figure 7.6. Specifically, each lender incurs a loss to the extent of ϵ up to bonds of quality $\theta_j > \bar{\theta} - \epsilon$ for which losses decrease towards 0 as θ_j increases. Compared to a situation without signal, borrowers are better off as R^B increases by the shaded area. Lenders' rent is given by[318]

$$R^L = -(\bar{\theta} - \underline{\theta} - \frac{1}{2}\epsilon)\epsilon < 0, \tag{7.4}$$

312 Rating agencies are private for-profit institutions and bond issuers pay them for ratings. There has been a diversified discussion concerning the conflicted interests of rating agencies in the light of the financial crisis, see e.g. Acharya and Steffen (2015), Ackermann (2008), Brunnermeier (2009), Stolper (2009), and White (2010).

313 On ratings shopping, see Section 4.3.1.2. See also Sangiorgi and Spatt (2015), who find that selective disclosure of ratings leads to inefficient investment decisions. Moreover, see Grossman and Hart (1980) as well as Milgrom (1981) for the literature on the efficiency of the voluntary disclosure of available information.

314 Amato and Furfine (2004) illustrate this by describing how ratings are often upgraded in economic boom periods and downgraded in recessions. See also Sinn (2010a) on the failure of rating agencies contributing to the recent financial turmoil.

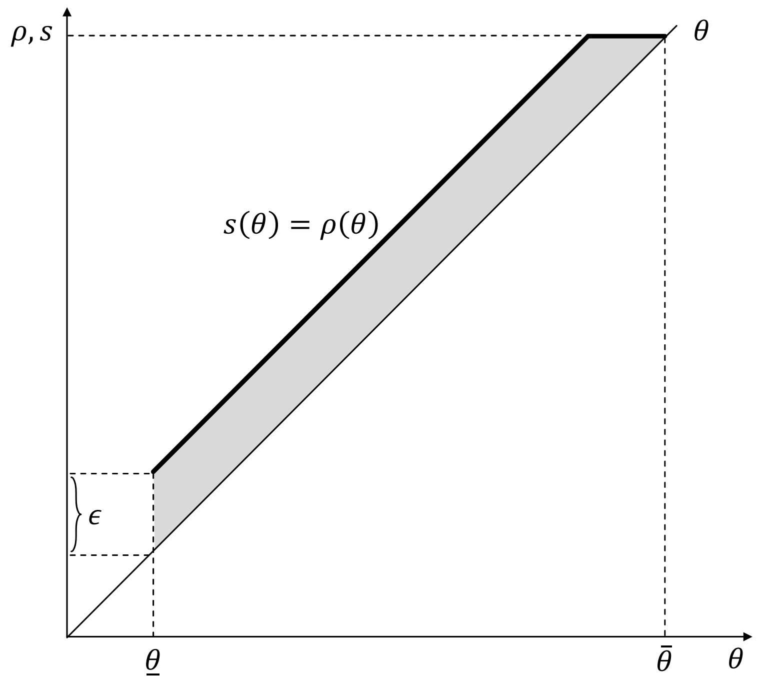
315 This finding is consistent with the view of e.g. Calomiris (2009), who argues that inaccurate ratings are desired by institutional investors as they do not fully internalize the negative effects on ultimate investors.

316 Misevaluation prevails during the opening leg but is resolved thereafter. Moreover, ϵ is strictly positive but smaller than $\bar{\theta} - \underline{\theta}$.

317 The maximum function is applied as no bond can be signaled as a quality higher than $\bar{\theta}$, i.e. the maximum quality in the market. Lenders believe in the multiple signaling of $\bar{\theta}$ without knowing as each lender receives an individual signal and cannot observe the signal provided to other lenders.

318 See the appendix for the derivation of (7.4). R^L is negative as ϵ can at maximum be equal to $\bar{\theta} - \underline{\theta}$.

Figure 7.6: Equilibrium with Positively Distorted Signal



Source: author's illustration.

while borrowers receive rent to the amount of[319]

$$R^B = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2} - \Big(\underbrace{-(\bar{\theta} - \underline{\theta} - \frac{1}{2}\epsilon)\epsilon}_{R^L}\Big), \tag{7.5}$$

which is strictly positive for $R^L < 0$ as $\bar{\theta} > \underline{\theta}$. For $\epsilon = 0$, rents are equal to the benchmark as the case of symmetric information would be mimicked. This is intuitive as lenders and borrowers play a zero-sum game, which implies an aggregate surplus to the amount of $R = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2}$, i.e. R remains unchanged. While asymmetric information leads to redistribution within the group of lenders and borrowers, a distorted signal involves a redistribution across groups. With a positively distorted signal, redistribution across groups is from lenders to borrowers. Preliminary findings are summarized in Lemma 7.1.

Lemma 7.1 (**Redistribution within and across groups through asymmetric information and distorted signal**).

i) With asymmetric information, rent is redistributed within the groups of lenders and borrowers, namely from borrowers with high-quality bonds to those with low-quality bonds. Likewise, rent is redistributed from lenders purchasing bonds of low quality to those purchasing high-quality bonds.

ii) With asymmetric information and a positively distorted signal, rent is redistributed across groups. Borrowers increase their rent at the expense of lenders.

[319] See the appendix for the derivation of (7.5).

7.2.1.5 Outside Option under Asymmetric Information

The signal is again neglected to follow the stepwise structure of the model. Instead, an outside option to selling bonds in the market is introduced, which is available to borrowers. The outside option could be provided by the central bank, through which borrowers can enter repos to receive liquidity (public repo). This liquidity can be used to make e.g. new loans, resulting in a positive return to borrowers. Despite the beneficial effect of collateralization in terms of mitigating counterparty risk, a private lender purchases a bond to realize a productive effect that arises from e.g. balance sheet effects or the benefit of using the specific bond (see Section 7.1).[320] By contrast, the central bank does not benefit from receiving a specific bond as collateral. In this model, the central bank solely takes collateral to mitigate counterparty risk. Hence, private repos are beneficial to both borrowers in terms of additional liquidity and lenders in terms of the productive use of the purchased bond, whereas the benefits of public repos are confined to borrowers. Of course, in terms of the model in Chapter 6, the central bank might be trading-off risk mitigation (and thus monetary stability) against financial or fiscal and economic stability resulting from the allocation effects in the repo market with different collateral qualities, which are explained in the following. However, for now, the focus is on the allocation effects in the repo market with different collateral qualities.

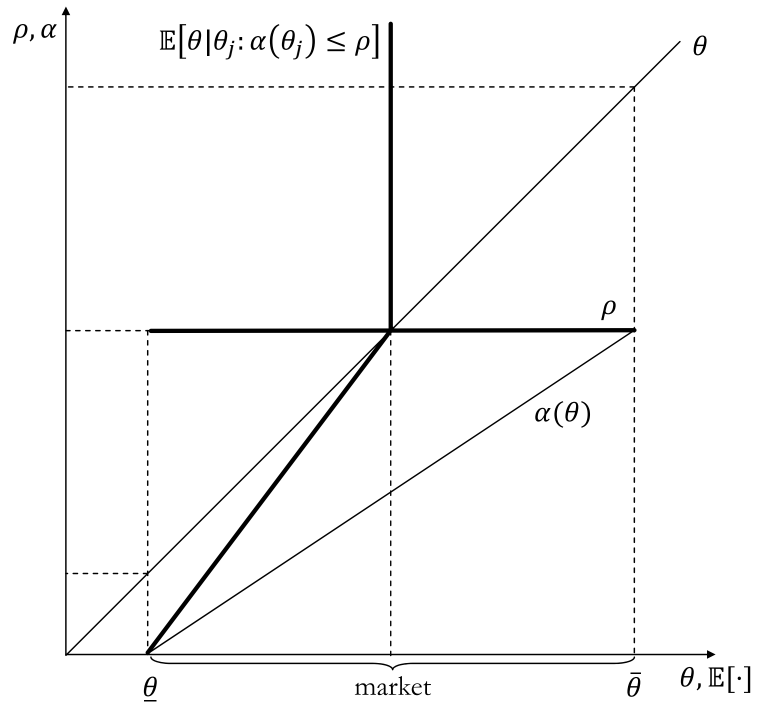
The outside option gives borrowers a return of $\alpha(\theta_j)$. Like selling the bond in the market, making use of the outside option is costless. Borrowers sell bonds in the market whenever $\alpha(\theta_j) \leq \rho(\theta_j)$ and turn to the outside option otherwise, i.e. selling the bond in the market is preferred over the outside option in case of indifference. Accordingly, the set of marketing borrowers is characterized as $\Theta(\rho) = \{\theta_j : \alpha(\theta_j) \leq \rho(\theta_j)\}$. As long as $\rho \geq \alpha(\theta_j)\ \forall\ \theta_j$, all borrowers will dismiss the outside option and the outcome is equal to the one without the outside option. However, with $\alpha(\bar{\theta}) > \mathbb{E}[\theta] = \rho$, at least the borrower owning the highest quality bond prefers the outside option over selling it in the market. Lenders would update their belief to $\mu = \mathbb{E}[\theta|\theta_j : \alpha(\theta_j) \leq \rho] < \mathbb{E}[\theta]$ in anticipation that the bond of highest quality will not be traded. Based on the updated belief, lenders offer a lower uniform bond price, which implies further borrowers with bonds of relatively high quality turning to the outside option. The phenomenon of adverse selection with different degrees of market unraveling depending on the outside option is examined in the following.

Outside Option and No Market Unraveling Figure 7.7 depicts the situation in which the market with asymmetric information is not affected by the outside option as $\alpha(\bar{\theta}) = \mathbb{E}[\theta]$ and $\alpha(\theta) < \mathbb{E}[\theta]\ \forall\ \theta_j < \bar{\theta}$. Borrowers sell all bonds in the market at the uniform price $\rho = \mathbb{E}[\theta]$, with rents being equal to those under asymmetric information without the outside option. The bold kinked line marking the expected marketed bond quality starts at the level of $\underline{\theta}$ at an offered price of $\rho = \alpha(\underline{\theta}) = 0$. Any increase in the price offered by lenders then draws additional bonds into the market such that the expected bond quality increases towards $\frac{\bar{\theta}+\underline{\theta}}{2}$, where all bonds can be expected to be marketed.[321] This is the case at a price offered of $\rho = \alpha(\bar{\theta})$. Further price increases

[320] Balance sheet effect refers to a benefit with respect to balance sheet composition, such as institutional requirements or risk management/diversification. This effect is likely to dominate in GC repos. A benefit arising from the specific bond arises from the security-driven motive and is likely to dominate in special repos.

[321] Note that the uniform distribution simplifies the calculation of the expected bond quality, which is the plain average of $\underline{\theta}$ and the respective highest bond quality that is simply indifferent between the outside option and private market.

Figure 7.7: Outside Option and No Market Unraveling



Source: author's illustration.

do not increase the expected bond quality in the market, such that the expectations line is kinked and vertical from then onwards.

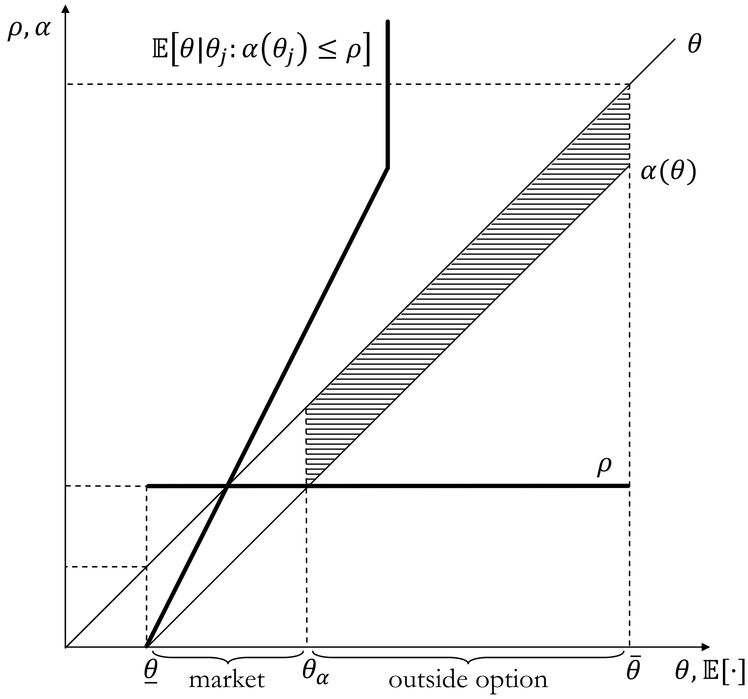
Outside Option and Partial Market Unraveling Figure 7.8 illustrates the situation in which adverse selection leads to good-quality bonds being partially driven out of the market. Even if lenders expected all bonds to be sold in the market, some borrowers would turn to the outside option as this would give them more than the expected market return. Lenders update their belief and the equilibrium price ρ is characterized by the intersection of the 45°-line and the line indicating expected bond quality. The reason is that at any higher price, the expected bond quality in the market would be lower than justified by this price. Hence, such a price would not have been offered in the first place, whereby this cannot represent an equilibrium. In turn, any price lower than that indicated by the intersection would imply an expected marketed bond quality leading to expected profits for lenders, such that such a price would be competed upwards. Borrowers for whom $\alpha(\theta_j) \leq \rho$ and hence $\theta_j \leq \theta_\alpha$ sell their bonds in the market. θ_α is the bond quality for which the owner is simply indifferent between selling the bond in the market and turning to the outside option. Taking into account that $\alpha(\theta) = \theta - \underline{\theta}$, as given in Figure 7.8, lenders realize zero rent while borrowers receive rent that equals aggregate surplus in the market and amounts to[322]

$$R^B = R = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2} - \underline{\theta}(\bar{\theta} - \theta_\alpha). \tag{7.6}$$

While aggregate surplus R was maximized and amounted to $\frac{\bar{\theta}^2 - \underline{\theta}^2}{2}$ in previous steps, it is now lower as $\alpha(\theta_j) < \theta_j \;\forall\; \theta_j$, i.e. the outside option yields less than the productive use of bonds by lenders.

[322] See the appendix for the derivation of (7.6).

Figure 7.8: Outside Option and Partial Market Unraveling



Source: author's illustration.

This is reflected in (7.6) as $\bar{\theta} > \theta_\alpha$. Inefficiency owing to the less productive use of bonds with the outside option is given by the hatched area in Figure 7.8. Through the adverse selection, the market size decreases (i.e. it partially unravels) and the outside option does not fully compensate for the unexploited market potential.

Outside Option and Complete Market Unraveling Complete market unraveling occurs for $\alpha(\underline{\theta}) = \underline{\theta}$ and $\alpha(\theta_j) < \theta_j \; \forall \; \theta_j > \underline{\theta}$, which is depicted in Figure 7.9. Progression of the outside option implies that $\rho = \underline{\theta}$ is the only price that would motivate a borrower to sell his bond in the market while being profitable for lenders. The borrower with the bond of quality $\underline{\theta}$ is simply indifferent between selling the bond in the market and turning to the outside option. If this borrower also turned to the outside option, the market would completely unravel. In this case, the outcome would be inefficient as aggregate surplus decreases relative to the benchmark case. This inefficiency corresponds to the hatched area in Figure 7.9.

The preliminary results of the analysis with respect to information structure, the effect of a signal and consequences of introducing an outside option for borrowers are summarized in Proposition 7.1.

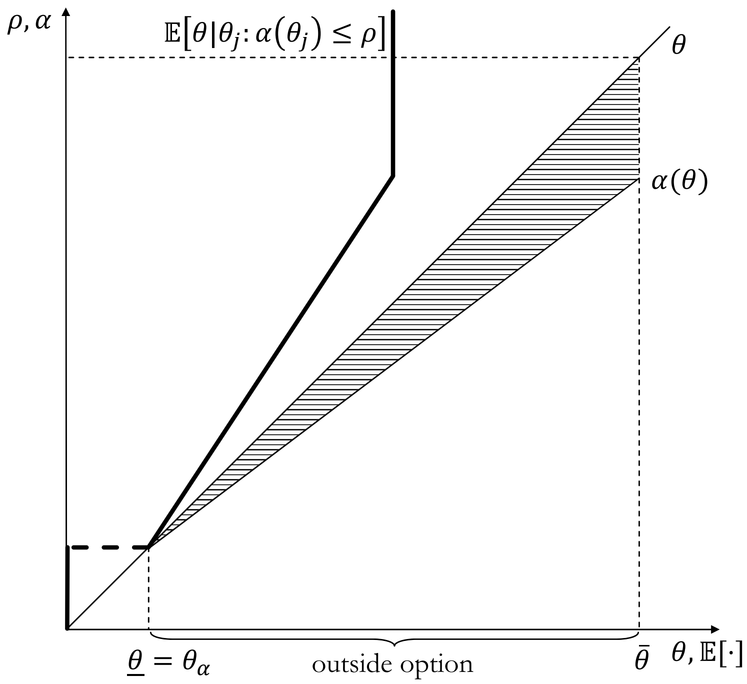
Proposition 7.1 (**Information structure, signal and outside option**).

i) With symmetric information, all bonds are traded at distinct prices that reflect bond quality and the equilibrium is efficient, i.e. aggregate surplus is maximized. With asymmetric information, the equilibrium remains efficient but all bonds are traded at a uniform price that reflects expected bond quality such that redistribution within the groups of lenders and borrowers takes place.

ii) An undistorted signal maintains efficiency and prevents redistribution among borrowers and lenders. If the signal was distorted, rents would be redistributed among and across borrowers and lenders as bonds are traded at distinct prices that reflect the distorted signal.

iii) Aggregate surplus decreases when borrowers are offered an outside option that is less productive than the use of bonds by lenders yet sufficiently high to drive better qualities out of the market.

Figure 7.9: Outside Option and Complete Market Unraveling



Source: author's illustration.

7.2.2 The Eurosystem as Provider of Public Liquidity

The outside option is now modeled in a way that more strongly reflects its interpretation as the possibility to use bonds in public repos, i.e. in repos with the Eurosystem. Therefore, the outside option is modeled according to the Eurosystem's practice of segmentally pooling refinancing conditions for assets with differing properties, such that characteristics that should be determining for these conditions are only considered in a blurry way in the public repo offering (see Section 4.5.6).

7.2.2.1 Segmental Pooling of Public Repo Conditions

Section 4.5.6 discussed how the Eurosystem clusters eligible assets into groups with respect to liquidity, residual maturity and credit quality, applying a pooling approach with respect to the definition of haircuts. Furthermore, it was addressed that the application of supplementary haircuts leads to a divergence of nominal and effective haircuts (Section 4.5.4.1). Along the lines of Section 4.5.6, the insufficient risk mitigation due to the imperfect haircut specification was pronounced. In addition, adverse selection of collateral pledged may be the result of the segmental pooling of public repo conditions, which is understood as the equalization of collateral values across assets of different intrinsic values. This has been suggested in Section 4.5.7 and shall now be theoretically substantiated.

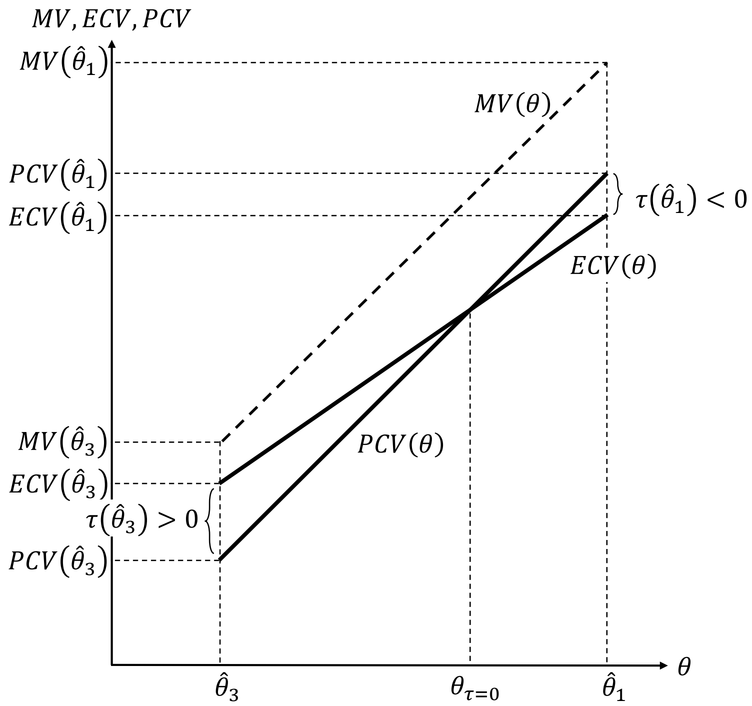
The market value of a bond equals the present value of future income flows related to that bond. For a given face value and interest rate, bonds of higher credit quality have a higher market value since their repayment is less uncertain. Consider e.g. two covered bank bonds of different credit quality and hence different market values: one is of high credit quality (Triple A) with a market value of 100 and the other is of lower credit quality (Single A) with a market value of 50. When being pledged as collateral, the Triple A bond should be assigned a higher collateral value than the Single A bond, e.g. 90 and 40. The pooling of repo conditions would imply that collateral values of the bonds are aligned, e.g. to 85 and 42.5. Perfectly-pooled repo conditions refer to a situation in which collateral values are uniform across bonds of different credit quality. This pooling of repo conditions is relevant for all eligible assets and particularly for own-use and non-marketable assets that are often subject to theoretical valuation. The relevance of theoretical valuation is underlined by Nyborg (2015), who provides a precautionary assessment concluding that about 77% by count or 17% by value of all eligible assets feature theoretical values. Moreover, he documents that the fraction of theoretically valued assets is larger for lower-quality assets. In the following, the effect of segmental pooling on public repo conditions is introduced along three steps:

1. the application of simplified haircuts that are too large for relatively high-quality collateral and too small for relatively low-quality collateral;
2. the application of supplementary haircuts irrespective of credit quality;
3. the theoretical valuation of assets.

Application of Simplified Valuation Haircuts Chapter 4.5 analyzed how the Eurosystem applies valuation haircuts to determine collateral values. Furthermore, the caveat was addressed that identical haircuts are applied within the same CQS to assets of different credit quality. In the following, private lenders are assumed to apply haircuts that fully reflect collateral risk. To distinguish the collateral value assigned by the Eurosystem from that assigned by private lenders, the former is labeled ECV and the latter PCV. The application of simplified haircuts by the Eurosystem has two implications: on the one hand, collateral risk is not fully mitigated; and on the other, a fraction of assets is subsidized relative to the market.

As discussed in Section 4.5.4.1, the Eurosystem differentiates haircut conditions along four determining dimensions of asset characteristics. This model focuses on the quality dimension and keeps all other assets characteristics constant (see above). Therefore, in order to analyze the pooling of public repo conditions along only one dimension of asset properties, bonds are considered as comparable in terms of coupon, duration and liquidity. For instance, jumbo covered bank bonds with a fixed-rate coupon and residual maturity of two years are considered, which only differ in credit quality. Of course, the application of the clustering approach of the Eurosystem to the other three dimensions of asset characteristics makes this discussion exemplifying for the pooling along the other three dimensions, which has a similar impact. Pooling public repo conditions through clustering asset properties is stylized in Figure 7.10 for fully-informed lenders. The figure illustrates the relation between bond quality θ (horizontal axis) and market value as well as collateral values in private and public repos (vertical axis). The range on the horizontal axis runs from $\hat{\theta}_3 \geq \underline{\theta}$ to

Figure 7.10: Segmental Pooling of Public Repo Conditions I: Subsidization of Collateral



Source: author's illustration.

$\hat{\theta}_1$ and reflects CQS 3,[323] such that $\hat{\theta}_3$ can be interpreted as the minimum credit rating threshold of the Eurosystem. Fully-informed lenders are willing to pay a price equal to the quality of the bond. Hence, lenders are assumed to apply haircuts h^L that are perfectly differentiated according to bond quality,[324] such that

$$PCV(\theta_j) = \Big(1 - h^L(\theta_j)\Big)MV(\theta_j) = \rho(\theta_j) = \theta_j. \tag{7.7}$$

The market value is reflected by $MV(\theta)$ with the slope $\partial MV(\theta)/\partial\theta = 1$. Likewise, the slope of $PCV(\theta)$ is[325]

$$\frac{\partial PCV(\theta)}{\partial\theta} = \frac{\partial MV(\theta)}{\partial\theta} - \frac{\partial h^L}{\partial\theta}MV(\theta) - \frac{\partial MV(\theta)}{\partial\theta}h^L \equiv 1. \tag{7.8}$$

Let h^{CB} denote the haircut that the Eurosystem applies to (eligible) bond j of quality θ_j and market value $MV(\theta_j)$. The Eurosystem pools repo conditions by applying identical haircuts to bonds of different quality within CQS 1/2 and CQS 3. This implies that $h^{CB}(\theta_j) = h^{CB}\ \forall\ \theta_j \in [\hat{\theta}_3, \hat{\theta}_1)$ and

[323] Note that the interpretation of θ as a broad argument of collateral quality (i.e. reflecting credit quality and liquidity) has now been narrowed to credit quality for technical convenience, i.e. liquidity is kept constant, as assumed above. CQS 1/2 summarizes eligible assets rated from Triple A (corresponding to $\bar{\theta}$) to Single A (corresponding to $\hat{\theta}_1$) while CQS 3 comprises all lower-rated assets down to the rating of Triple B (corresponding to $\hat{\theta}_3$), cf. Figure 4.13. Accordingly, CQS 1/2 is indexed by 1 and CQS 3 by 3 for the sake of simplicity. Repo conditions are pooled within both CQSs. In Figures 7.10 to 7.12, pooling is exemplified for CQS 3. However, replacing $\hat{\theta}_1$ with $\bar{\theta}$ and $\hat{\theta}_3$ with $\hat{\theta}_1$ would stylize pooling in CQS 1/2.

[324] Section 7.1.2 provided narrative evidence that lenders in the European repo market cluster collateral properties to a lesser degree than the Eurosystem. Moreover, bilateral repos can be assumed to imply no clustering as repo conditions are negotiated directly between counterparties for each repo.

[325] See Section 7.2.1.2. As $\partial MV(\theta)/\partial\theta = 1$, the condition for the identity to hold is $h^L = -(\partial h^L/\partial\theta)MV(\theta)$ with $\partial h^L/\partial\theta < 0$.

the following collateral value assigned by the Eurosystem to bond j:

$$ECV(\theta_j) = \left(1 - h^{CB}\right) MV(\theta_j). \tag{7.9}$$

The slope of $ECV(\theta)$ is given by

$$\frac{\partial ECV(\theta)}{\partial\theta} = \frac{\partial MV(\theta)}{\partial\theta} - \frac{\partial h^{CB}}{\partial\theta} MV(\theta) - \frac{\partial MV(\theta)}{\partial\theta} h^{CB}. \tag{7.10}$$

Owing to the pooling of public repo conditions, the slope of $ECV(\theta)$ is smaller than that of $PCV(\theta)$, i.e.

$$\frac{\partial ECV(\theta)}{\partial\theta} < 1 = \frac{\partial PCV(\theta)}{\partial\theta}. \tag{7.11}$$

Therefore, $ECV(\theta)$ is larger than $PCV(\theta)$ for bonds $\theta_j \in [\hat{\theta}_3, \theta_{\tau=0})$ but smaller otherwise. The bond of quality $\theta_{\tau=0}$ marks the threshold bond for which the Eurosystem assigns the same haircut and hence collateral value as private lenders.[326] The Eurosystem offers a subsidy to borrowers whenever repo conditions for a given bond are beneficiary in public repos compared to private repos. The value of this subsidy is given by

$$ECV(\theta_j) - PCV(\theta_j) = \underbrace{\left(h^L(\theta_j) - h^{CB}\right)}_{\tau(\theta_j)} MV(\theta_j), \tag{7.12}$$

with $\tau(\theta_j)$ representing the haircut subsidy rate. For all $\theta_j \in [\hat{\theta}_3, \theta_{\tau=0})$, $\tau(\theta_j) > 0$ which implies that $h^{CB} < h^L(\theta_j)$. Analogously, $\tau(\theta_j) < 0$ for all $\theta_j \in (\theta_{\tau=0}, \hat{\theta}_1)$ and $h^{CB} > h^L(\theta_j)$.

The notion that private lenders are supposed to apply haircuts that reflect true collateral quality has two important implications. First, the interpretation of the subsidy is twofold: on the one hand, it can be a subsidy in the sense that the Eurosystem provides better conditions than private lenders in the repo market; while on the other, it can be a subsidy in the sense that the Eurosystem applies haircuts that do not reflect true collateral quality. As the market is assumed to impose such haircuts, the first important implication is that both interpretations apply analogously here, i.e. the Eurosystem not only intervenes in the market but it also provides a "true" public subsidy (e.g. distinguished from a catalyst) in the sense that it helps to realize investment projects that would otherwise not be implemented. Second, adverse selection of collateral leads to increased risk exposure of the Eurosystem.[327] Segmental pooling in the way implemented by the Eurosystem thus implies public subsidies for adversely selected bonds and accompanying higher public risk exposure for as risk control is insufficient owing to overly-small haircuts.[328] Lemma 7.2 summarizes the insights on the segmental pooling of public repo conditions by the Eurosystem.

326 Note that by definition, $\theta_{\tau=0}$ corresponds to θ_α as θ_α is the bond quality for which the borrower was simply indifferent between the market and the outside option.

327 The risk exposure originates from the relation between the collateral value that the Eurosystem assigns to an asset and its true collateral value, stemming from its quality. On the other hand, adverse selection relates to the collateral value assigned by the Eurosystem relative to that assigned by private lenders. Here, private lenders are supposed to assign the true collateral value to a bond, whereby adverse selection implies higher risk exposure accordingly.

328 See also Gray (2011) for an example illustrating that the acceptance of bonds of lower quality at the same interest rate implies a de facto lower refinancing cost and hence a subsidy.

Lemma 7.2 (Subsidization of collateral by the Eurosystem). *Owing to the clustering of asset properties in the specification of public repo conditions, the Eurosystem subsidizes a fraction of eligible assets.*

i) A positive subsidy is provided to bonds of relatively low quality within each CQS as smaller haircuts are applied in public compared to private repos.
ii) A negative subsidy (a tax) is imposed to bonds of relatively high quality within each CQS as larger haircuts are applied in public than in private repos.
iii) For only one bond, no subsidy is provided as the same haircut is applied in a public and private repo.

Application of Supplementary Haircuts Section 4.5.5.2 provided an overview of supplementary haircuts (i.e. add-on haircuts and valuation markdowns) that the Eurosystem applies to a broad range of collateral. With the exception of own-use covered bank bonds, supplementary haircuts are not differentiated with respect to credit quality. Hence, the same supplementary haircut is applied to assets within CQSs and even across CQSs. Taking supplementary haircuts into account, ECV is expressed as[329]

$$ECV(\theta_j) = (1 - h_e^{CB})MV(\theta_j), \tag{7.13}$$

with

$$h_e^{CB} \equiv h_n + h_a + v - (h_n + h_a) \cdot v. \tag{7.14}$$

The last term reflects the interaction term, which biases the effective haircut downwards (see Section 4.5.4.1). This bias is larger for bonds of lower quality, i.e. those for which larger haircuts are applied. As the same valuation markdown is applied to theoretically valued assets irrespective of credit quality, assets in CQS 3 are deducted by a relatively smaller effective haircut than those in CQS 1/2. This implies that repo conditions are aligned even across CQS 1/2 and 3.

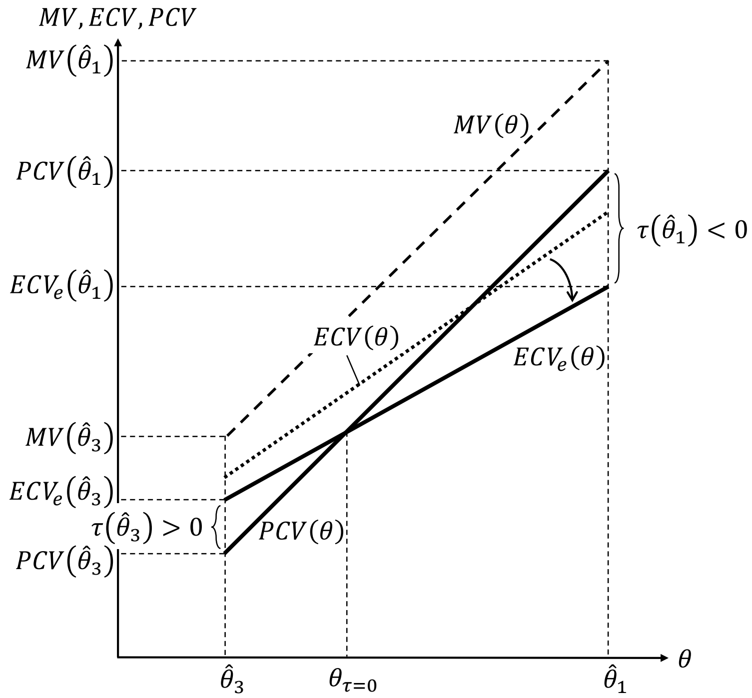
Within CQS 3, $h_n(\theta_j) = h_n \; \forall \; \theta_j \in [\hat{\theta}_3, \hat{\theta}_1)$ and hence $h_e^{CB}(\theta_j) = h_e^{CB} \; \forall \; \theta_j \in [\hat{\theta}_3, \hat{\theta}_1)$. The effective haircut applied to bonds in the same CQS is uniform but larger for any $h_a, v > 0$, i.e. $h_e^{CB} > h_n$. A larger effective haircut lowers the collateral value of a bond with higher market value more than the collateral value of a bond with lower market value. This effect is reflected in Figure 7.11, where ECV_e indicates the collateral value that the Eurosystem determines based on the application of the effective haircut (i.e. including supplementary haircuts). As $h_e^{CB} > h_n$, slopes of $ECV(\theta)$ and $ECV_e(\theta)$ differ, i.e.

$$\frac{\partial ECV_e(\theta)}{\partial \theta} < \frac{\partial ECV(\theta)}{\partial \theta} < 1 = \frac{\partial PCV(\theta)}{\partial \theta} \; \forall \; h_a, v > 0. \tag{7.15}$$

The threshold quality $\theta_{\tau=0}$ is shifted to the left such that more bonds are negatively subsidized and less positively. Hence, the pooling of public repo conditions is fostered for assets to which supplementary haircuts are applied. Accordingly, conditions are not only aligned through uniform valuation haircuts applied to akin assets of different credit quality within the same CQS, but also through the application of supplementary haircuts, which implies a larger uniform effective haircut.

[329] Note that h_e^{CB} is the effective haircut that the central bank applies, h_n is the nominal haircut, h_a the add-on haircut and v the valuation markdown (cf. Section 4.5.4.1).

Figure 7.11: Segmental Pooling of Public Repo Conditions II: Application of Supplementary Haircuts



Source: author's illustration.

Theoretical Valuation of Assets Section 4.2.4.2 addressed the Eurosystem's principles for collateral valuation, which hold crucial importance for determining collateral values and hence represent an important element of collateral policy with respect to shaping operational conditions, cf. Table 2.1. For non-marketable assets, a theoretical value or simply the outstanding amount is considered. The value of marketable assets is calculated based on the market price. If the last available market price is older than (or has not moved for at least) five days, the Eurosystem assigns a theoretical value. Moreover, theoretical valuation is important for own-use assets, i.e. securities pledged by the issuing counterparty itself as no market price exists. The relevance of theoretical valuation within the Eurosystem's eligible collateral pool is underlined by Nyborg (2015), who documents that about 77% by count or 17% by value of all eligible assets feature theoretical values. It is addressed in the following that theoretical valuation may foster pooling public repo conditions as it could give rise to valuation errors.

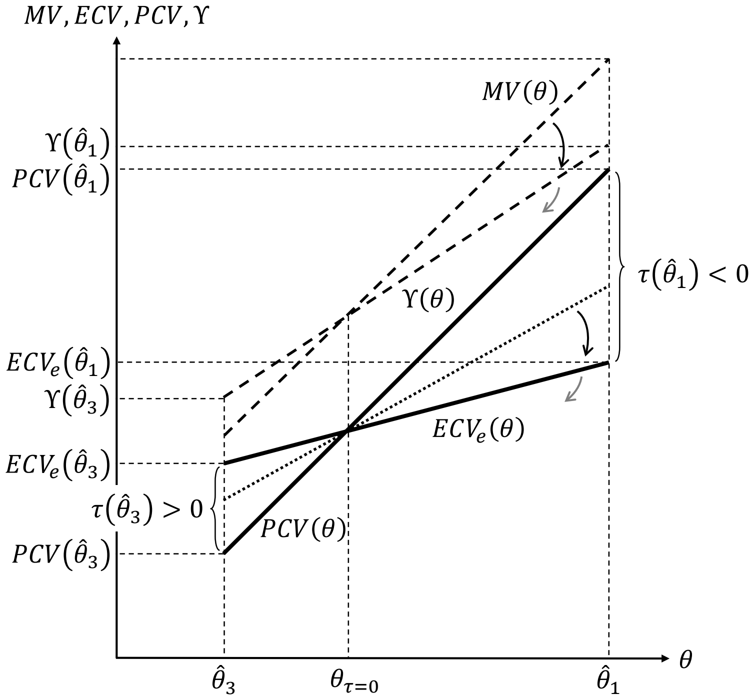
In case of valuation errors, the theoretical value $\Upsilon(\theta_j)$ that the Eurosystem assigns to bond j is given by

$$\Upsilon(\theta_j) = \Big(1 + \varphi(\theta_j)\Big) MV(\theta_j), \tag{7.16}$$

with $\varphi(\theta_j)$ being the valuation error.[330] The case of valuation errors is stylized in Figure 7.12 under the assumption that all bonds are theoretically valued. All bonds $\theta_j \in [\hat{\theta}_3, \theta_{\tau=0})$ are overvalued and their theoretical value corresponds to $\Upsilon(\theta_j) = (1 + \varphi(\theta_j))MV(\theta_j) > MV(\theta_j)$ as $\varphi(\theta_j) > 0$. By contrast, all bonds $\theta_j \in (\theta_{\tau=0}, \hat{\theta}_1)$ are under-valued such that $\Upsilon(\theta_j) = (1+\varphi(\theta_j))MV(\theta_j) < MV(\theta_j)$ with $\varphi(\theta_j) < 0$. Only the valuation of bond $\theta_{\tau=0}$ is unbiased, i.e. $\Upsilon(\theta_{\tau=0}) = MV(\theta_{\tau=0})$ as

[330] $\varphi(\theta_j)$ is characterized as follows: $\partial\varphi(\theta)/\partial\theta < 0$; $\partial^2\varphi(\theta)/\partial\theta^2 > 0$; $0 < \varphi(0) < 1$; $\varphi(\theta_{\tau=0}) = 0$; $\varphi(\theta_j) > 0\ \forall\ \theta_j \in [0, \theta_{\tau=0})$; $\varphi(\theta_j) < 0\ \forall\ (\theta_{\tau=0}, \infty)$.

Figure 7.12: Segmental Pooling of Public Repo Conditions III: Valuation Errors



Source: author's illustration.

$\varphi(\theta_{\tau=0}) = 0$. Incorrect valuations may be ascribed to the Eurosystem avoiding disperse theoretical valuation of bonds such that it tends to assign modest theoretical values.[331] Moreover, a general misperception of bond quality could prevail.

Valuation errors as described above imply a clockwise rotation of $\Upsilon(\theta)$ away from a fair theoretical value, which implies a further flattening of $ECV(\theta)$. The larger the misvaluation, the flatter $ECV(\theta)$. For all bonds $\theta_j \in [\hat{\theta}_3, \theta_{\tau=0})$, the subsidy $\tau(\theta_j)$ increases, while for all other bonds $\theta_j \in (\theta_{\tau=0}, \hat{\theta}_1)$, it becomes more negative. In the most extreme case, this could lead to the slope of $ECV(\theta)$ equal to zero and public repo conditions that are perfectly aligned within CQSs, i.e. $ECV_e(\theta_j) = ECV_e(\theta_{\tau=0})\ \forall\ \theta_j \in [\hat{\theta}_3, \hat{\theta}_1)$ and $\partial ECV_e(\theta)/\partial\theta = 0$.

In conclusion, public repo conditions are pooled within credit quality segments by clustering asset properties in three steps: *(i)* the application of simplified haircuts that imply a negative subsidy (a tax) on the use of high-quality bonds and provide a positive subsidy to low-quality bonds; *(ii)* the application of supplementary haircuts irrespective of credit quality; and *(iii)* the theoretical valuation of bonds when they lack a market value. However, $ECV(\theta)$ would become perfectly flat ($\partial ECV(\theta)/\partial\theta = 0$) only for a uniform theoretical valuation of all bonds within the same CQS. Perfectly-pooled repo conditions within CQSs are assumed as a simplification in the following extension of the basic model to elaborate on the implications of the design of the outside option as offered by the Eurosystem. All implications would qualitatively hold if repo conditions were not perfectly pooled within CQSs, i.e. $0 < \partial ECV(\theta)/\partial\theta < 1 = \partial PCV(\theta)/\partial\theta$.

[331] "Central tendency error", see e.g. Guilford (1954) as well as Rosenthal and Rosnow (1991).

7.2.2.2 Extended Model with Segmentally-Pooled Public Repo Conditions and *Correct* Ratings

The basic model with asymmetric information and correct ratings is extended by introducing segmentally pooled public repo conditions as derived in the previous section. The stylized case of perfectly-pooled public repo conditions within CQSs is modeled hereafter such that

$$\begin{aligned}\alpha(\theta_j) &= ECV_e(\theta_j) = \Big(1 - h^e(\theta_j)\Big)\Upsilon(\theta_j) \\ &= ECV_e(\theta_{\alpha_k}) = \Big(1 - h^e(\theta_{\alpha_k})\Big)\Upsilon(\theta_{\alpha_k}) = \alpha(\theta_{\alpha_k})\ \forall\ \theta_j, \theta_{\alpha_k},\end{aligned} \tag{7.17}$$

with $k \in \{1, 3\}$ indicating the CQS and θ_{α_k} the bond against which public repo conditions are perfectly pooled within the credit quality segments.[332] Bond quality is supposed to be unknown to lenders but signaled correctly by the rating agency such that $s(\theta_j) = \theta_j\ \forall\ \theta_j$. The Eurosystem defines CQSs according to credit ratings such that bonds rated between $\hat{s}_1$ and $\bar{s}$ are arranged in CQS 1/2 and those rated between $\hat{s}_3$ and $\hat{s}_1$ are summarized in CQS 3. Moreover, the Eurosystem ties down for each CQS k a rating s_{α_k}, implicitly determining the bond for which the owner is indifferent between entering a private or a public repo. Public repo conditions for bonds rated within the same CQS k are pooled and aligned to the private repo condition of this bond rated s_{α_k} that are given by $PCV(\theta_{\alpha_k}) = \rho(\theta_{\alpha_k}) = s(\theta_{\alpha_k}) = \theta_{\alpha_k}$. Hence, public repo conditions are determined by the Eurosystem such that $ECV_e(\theta_{\alpha_k}) = \alpha(\theta_{\alpha_k}) = \theta_{\alpha_k}$.

In CQS 1/2, $\alpha(\theta_{\alpha_1})$ is further specified as $\alpha(\theta_{\alpha_1}) \equiv \frac{\rho(\bar{s})+\rho(\hat{s}_1)}{b_1}$ with b_1 implicitly defining the fraction of bonds subsidized relative to private repos. b_1 is restricted by $[\underline{b}_1 \equiv \frac{\rho(\bar{s})+\rho(\hat{s}_1)}{\rho(\bar{s})}, \bar{b}_1 \equiv \frac{\rho(\bar{s})+\rho(\hat{s}_1)}{\rho(\hat{s}_1)}]$ with $\underline{b}_1$ being the lower and $\bar{b}_1$ the upper bound of b_1. For CQS 3, it holds analogously that $\alpha(\theta_{\alpha_3}) \equiv \frac{\rho(\hat{s}_1)+\rho(\hat{s}_3)}{b_3}$ with $b_3 \in [\underline{b}_3 \equiv \frac{\rho(\hat{s}_1)+\rho(\hat{s}_3)}{\rho(\hat{s}_1)}, \bar{b}_3 \equiv \frac{\rho(\hat{s}_1)+\rho(\hat{s}_3)}{\rho(\hat{s}_3)}]$. Hence, the Eurosystem can implicitly determine the fraction of bonds rated within each CQS k that it subsidizes relative to private repos through the choice of b_k.[333] The higher b_k, the lower the fraction of bonds in CQS k that are subsidized relative to private repos. As $s(\theta_j) = \theta_j\ \forall\ \theta_j$, public repo conditions are given by

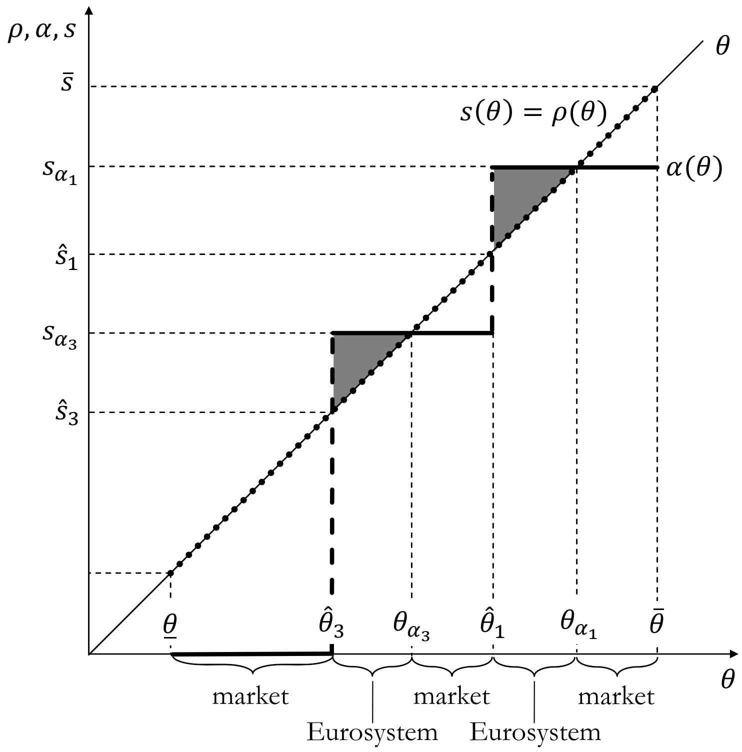
$$\alpha(\theta_j) = \begin{cases} 0 & \forall\ \theta_j : s(\theta_j) \in [\underline{s}, \hat{s}_3); \\ \frac{\hat{\theta}_1+\hat{\theta}_3}{b_3} & \forall\ \theta_j : s(\theta_j) \in [\hat{s}_3, \hat{s}_1); \\ \frac{\bar{\theta}+\hat{\theta}_1}{b_1} & \forall\ \theta_j : s(\theta_j) \in [\hat{s}_1, \bar{s}]. \end{cases} \tag{7.18}$$

Bonds rated below the minimum rating threshold $\hat{s}_3$ are ineligible in public repos such that the outside option of borrowers owning these bonds is to leave bonds unexploited and receive nothing. Bonds rated at or above $\hat{s}_3$ are eligible in public repos. Public repo conditions are pooled for bonds of different quality rated within the same CQS k and aligned to the conditions that private lenders would stipulate for the bond of quality θ_{α_k}. Hence, the value of the outside option for bonds rated within CQS 1/2 is $\alpha(\theta_j) = \frac{\bar{\theta}+\hat{\theta}_1}{b_1}\ \forall\ \theta_j : s(\theta_j) \in [\hat{s}_1, \bar{s}]$ and $\alpha(\theta_j) = \frac{\hat{\theta}_1+\hat{\theta}_3}{b_3}\ \forall\ \theta_j : s(\theta_j) \in [\hat{s}_3, \hat{s}_1)$ for bonds rated within CQS 3.

[332] Note again that for the sake of clarity, CQS 1/2 is indexed by 1 (and CQS 3 by 3).

[333] Note that $b_k > 1$. For $b_k = 2$, the bond rated θ_{α_k} would correspond to the median-rated bond in CQS k such that half of bonds are subsidized and the other half are discriminated relative to private repos.

Figure 7.13: Segmentally-Pooled Public Repo Conditions and Correct Ratings



Source: author's illustration.

The situation is stylized in Figure 7.13 with correct ratings being reflected by the dotted line. Borrowers who own a bond of quality $\theta_j < \hat{\theta}_3$ sell this bond in the market at the price $\rho(\theta_j) = s(\theta_j) = \theta_j$. The same holds for borrowers owning a bond of relatively high quality in each CQS – i.e. bonds of quality $\theta_j \in [\theta_{\alpha_3}, \hat{\theta}_1) \cap [\theta_{\alpha_1}, \bar{\theta}]$ – as the borrowers receive at least as much in the market as in a public repo, i.e. $\rho(\theta_j) \geq \alpha(\theta_j) \; \forall \; \theta_j \in [\theta_{\alpha_3}, \hat{\theta}_1) \cap [\theta_{\alpha_1}, \bar{\theta}]$. However, bonds of relatively low quality in each CQS – i.e. bonds of quality $[\hat{\theta}_3, \theta_{\alpha_3}) \cap [\hat{\theta}_1, \theta_{\alpha_1})$ – are pledged in public repos with the Eurosystem because the outside option gives the borrowers more liquidity, i.e. $\alpha(\theta_j) > \rho(\theta_j) \; \forall \; \theta_j \in [\hat{\theta}_3, \theta_{\alpha_3}) \cap [\hat{\theta}_1, \theta_{\alpha_1})$.

While private lenders are again left with zero rent ($R^L = 0$), the rent of borrowers corresponds to the aggregate surplus ($R^B = R$) and is given by[334]

$$R^B = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2} + \underbrace{\frac{\hat{\theta}_1^2 + \hat{\theta}_3^2}{2} + \frac{1}{2}\left(\frac{\hat{\theta}_1 + \hat{\theta}_3}{b_3}\right)^2 + \frac{1}{2}\left(\frac{\bar{\theta} + \hat{\theta}_1}{b_1}\right)^2 - \frac{\hat{\theta}_3(\hat{\theta}_1 + \hat{\theta}_3)}{b_3} - \frac{\hat{\theta}_1(\bar{\theta} + \hat{\theta}_1)}{b_1}}_{\text{additional rent from segmentally-pooled public repo conditions}}. \tag{7.19}$$

R^B is maximized for b_k equal to the lower bound, i.e. $b_1 = \frac{\rho(\bar{s}) + \rho(\hat{s}_1)}{\rho(\bar{s})}$ as well as $b_3 = \frac{\rho(\hat{s}_1) + \rho(\hat{s}_3)}{\rho(\hat{s}_1)}$, and is minimized for b_k equal to the upper bound, i.e. $b_1 = \frac{\rho(\bar{s}) + \rho(\hat{s}_1)}{\rho(\hat{s}_1)}$ and $b_3 = \frac{\rho(\hat{s}_1) + \rho(\hat{s}_3)}{\rho(\hat{s}_3)}$. In the former case, all eligible bonds (except for the bond for which the owner is indifferent) are pledged with the Eurosystem and only ineligible bonds – i.e. $\theta_j \in [\underline{\theta}, \hat{\theta}_3)$ – are sold in the market. In the latter case, no borrower turns to the Eurosystem and all bonds are sold in the market. In this case, the

334 See the appendix for the derivation of (7.19).

benchmark outcome (symmetric information) is mimicked as borrowers receive rent to the amount of $R^B = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2}$.

For any b_k smaller than the upper bound, the Eurosystem provides additional rent to borrowers, as reflected in (7.19) and indicated by the shaded areas in Figure 7.13. This provision is at the risk of the Eurosystem as it turns into a loss for the Eurosystem if the borrower fails to repurchase the bond in the closing leg. Hence, the Eurosystem bears risk that is equal to the additional rent provided to borrowers and corresponds to

$$R^{CB} = -\left(\frac{\hat{\theta}_1^2 + \hat{\theta}_3^2}{2} + \frac{1}{2}\left(\frac{\hat{\theta}_1 + \hat{\theta}_3}{b_3}\right)^2 + \frac{1}{2}\left(\frac{\bar{\theta} + \hat{\theta}_1}{b_1}\right)^2 - \frac{\hat{\theta}_3(\hat{\theta}_1 + \hat{\theta}_3)}{b_3} - \frac{\hat{\theta}_1(\bar{\theta} + \hat{\theta}_1)}{b_1}\right). \tag{7.20}$$

The Eurosystem pays prices $\alpha(\theta_{\alpha_k})$ and receives bonds that have to be liquidated in case of borrower default. Liquidation yields θ_j for each bond j such that the Eurosystem would be left with a loss amounting to $\alpha(\theta_{\alpha_k}) - \theta_j$ for each bond j. R^{CB} positively depends on b_k since an increase in b_k implies fewer bonds being subsidized by the Eurosystem and more borrowers turning to the market.

This represents a rationale for GLOC according to which there is adverse selection of collateral. The Eurosystem receives relatively low-quality bonds within each CQS, while bonds of relatively high quality are sold in the market. The reason for this finding is the subsidization of relatively low-quality bonds in each CQS through the pooling of repo conditions. Upon first glance, aggregate surplus in the market is increased beyond the benchmark case with symmetric information. Some borrowers enjoy such good conditions in public repos that they can realize a higher return than when selling the bonds in the market. The rent of lenders remains zero. Upon further consideration, additional rent for borrowers is at the cost of the Eurosystem, which bears risk in terms of a potential loss (illustrated by the shaded areas in Figure 7.13). In case of borrower default, bonds would have to be liquidated rather than being repurchased in the closing leg. The Eurosystem could then realize a liquidation value smaller than the liquidity provided in the opening leg. In case of this adverse outcome, the additional rent of borrowers in the opening leg is matched by a loss of the Eurosystem thereafter. This finding is summarized in the following Proposition 7.2. The loss for the Eurosystem will ultimately affect monetary stability, as described in Section 6.1.1. On the other hand, the subsidy leads to an additional rent for borrowing banks. Despite not being modeled here, Chapter 6 highlights the resulting positive effect on output – and hence fiscal and economic sustainability – that might be traded-off against this loss by the Eurosystem. However, even if the negative effect on monetary stability is compensated by the positive effect on fiscal and economic stability, a redistributive effect prevails, as elaborated in detail in Chapter 8.

The finding shows that borrowers turn to the central bank despite information on bond quality being de facto symmetric. Essentially, a borrower is assumed to seek the most profitable yet feasible utilization for his bond. Whenever the conditions offered by the central bank are better than in the repo market and the bond is eligible for a public repo, the borrower will turn to the central bank. Therefore, pooling of public repo conditions is one explanation for the observation that collateral was increasingly pledged with the Eurosystem rather than being sold in the market. Another possible explanation is that it is not feasible for borrowers to sell their bond in the market. Stiglitz and

Weiss (1981) describe such a constraint as a credit rationing of the supply side.[335] Contrasting the view that the underprovision of credit represents a temporary disequilibrium through an exogenous shock, a loan market in equilibrium may be characterized by credit rationing. Similarly, in the present model, the possibility to sell bonds in the market could be limited and borrowers would have to turn to the outside option. However, with pooling of public repo conditions, the Eurosystem would still underbid the market and provide better conditions than private lenders for at least a fraction of bonds. In particular, it takes a MMOLR role, which focuses on low qualities within each credit quality segment.

Proposition 7.2 (**Pledge of low-quality bonds in public repos**). *By offering a uniform outside option to bonds the Eurosystem attracts low-quality bonds within each CQS.*

i) While bonds of relatively high quality within each CQS are sold in the market,
ii) bonds of relatively low quality within each CQS are used in public repos with the Eurosystem.
iii) Rent of borrowers owning bonds of relatively low quality within each CQS is increased at the risk of the Eurosystem.

7.2.2.3 Extended Model with Segmentally-Pooled Public Repo Conditions and *Distorted* Ratings

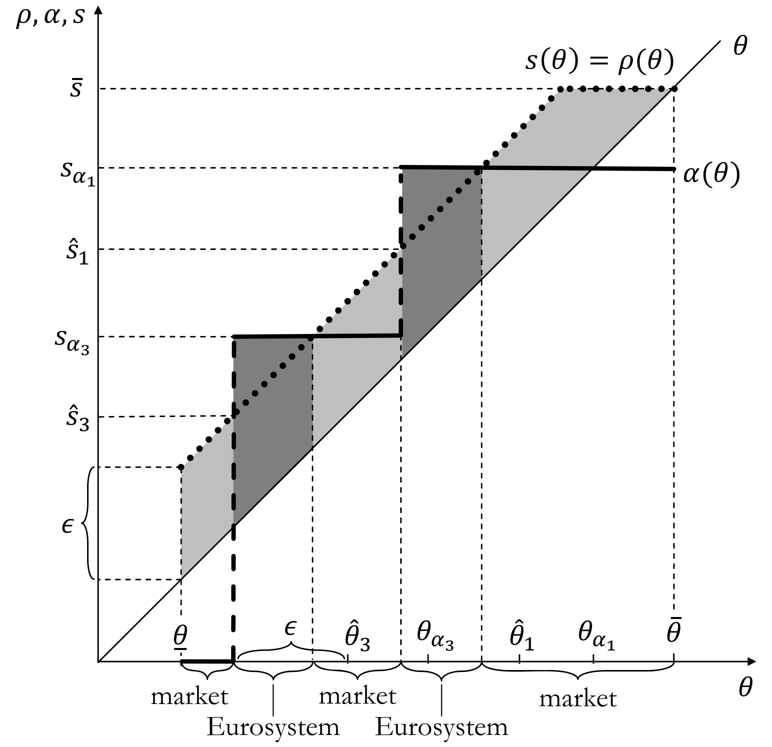
In the last step of the analysis, ratings of bond quality are no longer assumed to be correct but rather proportionally distorted in the opening leg. This corresponds to the case in which the quality assessment technology of the rating agency is systematically biased, e.g. owing to overly-optimistic or -prudent market sentiment.[336] Moreover, the outside option as modeled in the previous section (segmentally pooled) persists and information (before signals) is asymmetric. In the following, the two cases of systematically over- or under-valued bond quality are considered successively.

Positive Distortion With positive proportional distortion, bonds are rated $s(\theta_j) = \max[(\theta_j + \epsilon), \bar{\theta}]$ with $\epsilon > 0$. Distorted ratings result in a bias of $MV(\theta_j)$ and of $PCV(\theta_j)$ such that $PCV(\theta_j) = \rho(\theta_j) = s(\theta_j) = \max[(\theta_j + \epsilon), \bar{\theta}]$. Distorted ratings are depicted by the dotted line in Figure 7.14. As the Eurosystem defines rating thresholds for eligibility and between CQSs in terms of minimum ratings – i.e. $\hat{s}_k$ for $k \in \{1, 3\}$ – bond quality levels that are incorporated into CQSs de facto range from $\hat{\theta}_1 - \epsilon$ to $\bar{\theta}$ in CQS 1/2 and from $\hat{\theta}_3 - \epsilon$ to $\hat{\theta}_1 - \epsilon$ in CQS 3 as $s(\hat{\theta}_1 - \epsilon) = \hat{s}_1$ and $s(\hat{\theta}_3 - \epsilon) = \hat{s}_3$. Similarly, $s(\theta_{\alpha_k} - \epsilon) = s_{\alpha_k}$, and as $PCV(\theta_{\alpha_k} - \epsilon) = \rho(s_{\alpha_k}) = \theta_{\alpha_k} + \epsilon - \epsilon = \theta_{\alpha_k}$, it follows that public repo conditions do not change, cf. (7.18) and its derivation.

The borrower who is simply indifferent between entering a private and a public repo is no longer the owner of the bond of quality θ_{α_k} because bond quality implying indifference decreases due to the distortion to $\theta_{\alpha_k} - \epsilon$. While the number of subsidized bonds is unaffected (as $\theta_{\alpha_k} - \epsilon - \hat{\theta}_k + \epsilon = \theta_{\alpha_k} - \hat{\theta}_k$), subsidized bonds are of lower quality. Bonds of quality higher than $\hat{\theta}_3 - \epsilon$ are signaled to be of quality $\theta_j \geq \hat{s}_3$ and are eligible in a public repo at pooled conditions $\alpha(\theta_{\alpha_1}) = \alpha(\theta_j) \ \forall \ \theta_j \in [\hat{\theta}_1 - \epsilon, \bar{\theta}]$, i.e. within CQS 1/2, and $\alpha(\theta_{\alpha_3}) = \alpha(\theta_j) \ \forall \ \theta_j \in [\hat{\theta}_3 - \epsilon, \hat{\theta}_1 - \epsilon)$ within CQS 3.

[335] For a more recent discussion, see e.g. Arnold and Riley (2009).
[336] Of course, an alternative would be to think of the ratings as being correct but the market prices of bonds as being biased. Both result – directly or indirectly – in distorted market prices.

Figure 7.14: Segmentally-Pooled Public Repo Conditions and Positively Distorted Ratings



Source: author's illustration.

Figure 7.14 illustrates that bonds of quality $\theta_j \in [\hat{\theta}_3 - \epsilon, \theta_{\alpha_3} - \epsilon) \cup [\hat{\theta}_1 - \epsilon, \theta_{\alpha_1} - \epsilon)$ are pledged in public repos with the Eurosystem rather than being sold in the market. CQS 3 is effectively shifted to bonds of lower quality, while CQS 1/2 is extended to the extent of the distortion. As shown in Section 7.2.1.4, the positive distortion of ratings implies higher rents for borrowers at the expense of lenders who believe in the signal and are willing to pay excessive prices for the given bond quality. For lenders receiving bonds of quality $\theta_j > \bar{\theta} - \epsilon$, the adverse effect of distorted ratings decreases towards zero with increasing bond quality.

Lenders realize the following rent, which negatively depends on b_k and vanishes for $\epsilon = 0$:[337]

$$R^L = -\left(\bar{\theta} - \underline{\theta} - \frac{1}{2}\epsilon + \hat{\theta}_1 + \hat{\theta}_3 - \frac{\hat{\theta}_1 + \hat{\theta}_3}{b_3} - \frac{\bar{\theta} + \hat{\theta}_1}{b_1}\right)\epsilon, \tag{7.21}$$

Moreover, (7.21) resembles (7.4) for b_k set at the upper bound, while R^L is smaller for any smaller b_k as more collateral is pledged in public repos. By contrast, borrowers receive rent given by[338]

$$\begin{aligned} R^B = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2} &+ \underbrace{\frac{\hat{\theta}_1^2 + \hat{\theta}_3^2}{2} + \frac{1}{2}\left(\frac{\hat{\theta}_1 + \hat{\theta}_3}{b_3}\right)^2 + \frac{1}{2}\left(\frac{\bar{\theta} + \hat{\theta}_1}{b_1}\right)^2 - \frac{\hat{\theta}_3(\hat{\theta}_1 + \hat{\theta}_3)}{b_3} - \frac{\hat{\theta}_1(\bar{\theta} + \hat{\theta}_1)}{b_1}}_{\text{additional rent from segmentally-pooled public repo conditions}} \\ &+ \underbrace{\left(\bar{\theta} - \underline{\theta} - \frac{1}{2}\epsilon\right)\epsilon}_{\text{additional rent from rating distortion}}, \end{aligned} \tag{7.22}$$

[337] See the appendix for the derivation of (7.21).
[338] See the appendix for the derivation of (7.22).

which is convexly decreasing in b_k but always positive for $\epsilon > 0$. For $\epsilon = 0$, (7.22) resembles (7.19) as the case of correct ratings would be mimicked. Plugging in the upper bound of b_k – i.e. $\bar{b}_1 = \frac{\bar{\theta}+\hat{\theta}_1}{\hat{\theta}_1}$ and $\bar{b}_3 = \frac{\hat{\theta}_1+\hat{\theta}_3}{\hat{\theta}_3}$ – gives $R^B = \frac{\bar{\theta}^2-\underline{\theta}^2}{2} + \left(\bar{\theta} + \underline{\theta} - \frac{1}{2}\epsilon\right)\epsilon$, which mimics R^B under asymmetric information and a positively distorted signal but without an outside option as all bonds are sold in the market. Likewise, $R^L = -(\bar{\theta} - \underline{\theta} - \frac{1}{2}\epsilon)\epsilon$, i.e. R^L under asymmetric information and positively distorted signal but without an outside option. An increase in the value of the outside option from lowering b_k down to $\underline{b}_1 = \frac{\bar{\theta}+\hat{\theta}_1}{\bar{\theta}}$ and $\underline{b}_3 = \frac{\hat{\theta}_1+\hat{\theta}_3}{\hat{\theta}_1}$ makes R^L less negative toward $R^L = -(\hat{\theta}_3 - \underline{\theta} - \frac{1}{2}\epsilon)\epsilon$, while R^B increases convexly. Aggregate surplus in the market corresponds to

$$
\begin{aligned}
R = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2} + \frac{\hat{\theta}_1^2 + \hat{\theta}_3^2}{2} + \frac{1}{2}\left(\frac{\hat{\theta}_1 + \hat{\theta}_3}{b_3}\right)^2 + \frac{1}{2}\left(\frac{\bar{\theta} + \hat{\theta}_1}{b_1}\right)^2 - \frac{\hat{\theta}_3(\hat{\theta}_1 + \hat{\theta}_3)}{b_3} - \frac{\hat{\theta}_1(\bar{\theta} + \hat{\theta}_1)}{b_1} \\
+ \left(\frac{\hat{\theta}_1 + \hat{\theta}_3}{b_3} + \frac{\bar{\theta} + \hat{\theta}_1}{b_1} - \hat{\theta}_3 - \hat{\theta}_1\right)\epsilon,
\end{aligned}
\tag{7.23}
$$

which differs from aggregate surplus with correct ratings by the last term, i.e. for $\epsilon > 0$.

Risk to the Eurosystem is illustrated by the dark-shaded areas in Figure 7.14 and given by[339]

$$
\begin{aligned}
R^{CB} = -\left(\frac{\hat{\theta}_1^2 + \hat{\theta}_3^2}{2} + \frac{1}{2}\left(\frac{\hat{\theta}_1 + \hat{\theta}_3}{b_3}\right)^2 + \frac{1}{2}\left(\frac{\bar{\theta} + \hat{\theta}_1}{b_1}\right)^2 - \frac{\hat{\theta}_3(\hat{\theta}_1 + \hat{\theta}_3)}{b_3} - \frac{\hat{\theta}_1(\bar{\theta} + \hat{\theta}_1}{b_1})\right) \\
- \epsilon\left(\frac{\hat{\theta}_1 + \hat{\theta}_3}{b_3} + \frac{\bar{\theta} + \hat{\theta}_1}{b_1} - \hat{\theta}_3 - \hat{\theta}_1\right),
\end{aligned}
\tag{7.24}
$$

which again positively depends on b_k and mimics risk to the Eurosystem in case of correct ratings, i.e. (7.20), for $\epsilon = 0$. As the value of the outside option for eligible bonds is implicitly determined by private repo conditions, it is upward-distorted, just like prices in the market. In addition, the Eurosystem deems eligible bonds of quality lower than its initial quality threshold $\hat{\theta}_3$ to the extent of $\hat{\theta}_3 - \epsilon$. Therefore, the quality of bonds pledged with the Eurosystem is lower as CQS 3 is effectively shifted to bonds of lower quality and CQS 1/2 is extended to the extent of the rating distortion. Note that the Eurosystem cannot control this shifting as it is driven by ϵ, i.e. the stronger the distortion, the stronger the shifting. The coincidence of pooling of public repo conditions and upward distortion of credit ratings amplifies risk to the Eurosystem. For each bond pledged with the Eurosystem, the risk corresponds to the distance between the price that the Eurosystem pays $\alpha(\theta_j)$ and true quality θ_j as in case of counterparty default the Eurosystem has to liquidate the bond. The Eurosystem generates additional rent for borrowers exceeding the additional rent that private lenders already provide owing to distorted ratings (light-shaded area). The value of the subsidy that it provides relative to the market does not increase. However, this time the (increased) risk for the Eurosystem amounting to the dark-shaded areas in Figure 7.14 is not matched by the additional rents achieved for borrowers, which are only represented by the triangles above the dotted line of the dark-shaded areas.[340] The findings are summarized in Proposition 7.3.

Proposition 7.3 (Intensified pledge of low-quality bonds in public repos owing to positively distorted ratings). *With the systematic overvaluation of bond quality owing to a positively*

[339] See the appendix for the derivation of (7.24).

[340] These also represent the subsidy relative to the market.

distorted signal, the Eurosystem's attraction of low-quality bonds is intensified. Both CQSs are expanded beyond the control of the Eurosystem to the extent of the rating distortion.

1. *While bonds of relatively high quality in each CQS are sold in the market, eligible bonds of relatively low quality in each CQS are used in public repos with the Eurosystem. The quality of bonds attracted by the Eurosystem is lower than in the case without rating distortion.*
2. *Additional rent for borrowers comes at the risk of private lenders owing to the distorted signal. For borrowers owning bonds of relatively low quality within each CQS, the rent is even further increased at the risk of the Eurosystem.*

Negative Distortion The opposite case of signals that are negatively and proportionally distorted shall only be briefly stylized as the effects are analogous to the positive distortion. However, implications hold importance from a LOLR perspective. The quality is now signaled by the rating agencies as being systematically too low, such that $s(\theta_j) = \min[\underline{\theta}, \theta_j - \epsilon]$.[341] The distorted ratings are represented by the dotted line in Figure 7.15, which stylizes the effects of a negative distortion that is not too major, such that the number of subsidized bonds remains unaffected. Again, the public repo conditions remain unaffected. Bonds pledged in public repos are endogenously shifted upwards to higher qualities just as the credit quality segments. The eligible collateral pool is endogenously diminished. Moreover, in CQS 1/2 most borrowers choose the outside option over the market solution, while in CQS 3 the fraction of borrowers pledging their bonds in public repos remains ceteris paribus the same in comparison to the previous cases.

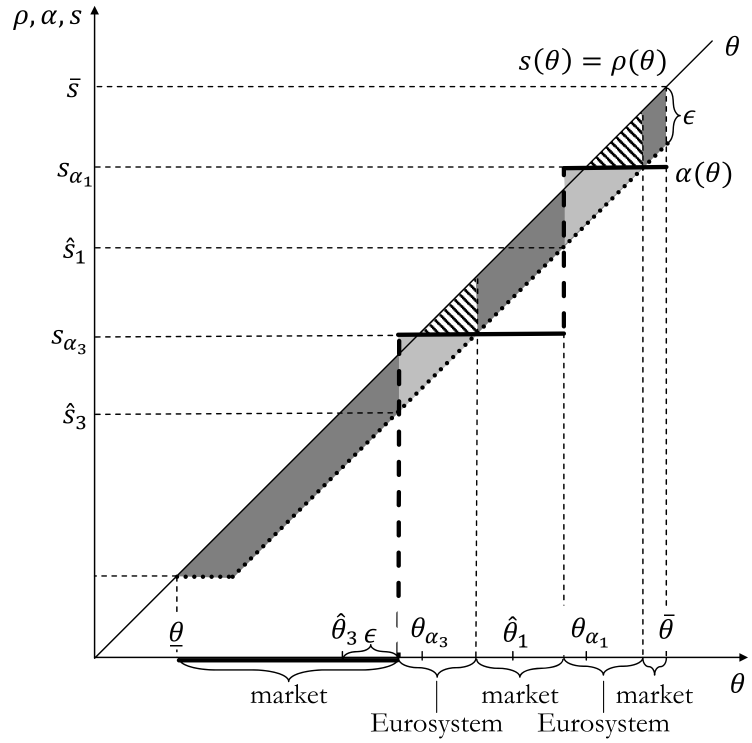
Lenders' rent is inverted compared to the case of positive distortion. It is positive because lenders now pay lower prices. They receive bonds of higher qualities and walk away with profits. Borrowers' rents are diminished to the amount of the dark-shaded areas, although they do not represent losses as long as bond production is costless. The possibility of using the outside option mitigates the diminished rent for borrowers of relatively low-quality bonds within each eligible segment. In contrast to all previous cases, in this case of negative distortion aggregate surplus is reduced (and not only redistributed) by the hatched areas. Borrowers owning the concerned bonds make use of the outside option, although this does not generate a bond price that reaches the quality level of the bond. Moreover, the productivity of the bond is not exploited by a lender as it is only used as collateral at the Eurosystem. Proposition 7.4 summarizes.

Proposition 7.4 (**Alleviated pledge of low-quality bonds in public repos owing to negatively distorted ratings**). *With the systematic under-valuation of bond quality due to a negatively distorted signal, the Eurosystem's attraction of low-quality bonds is alleviated. The eligible asset pool is diminished beyond the control of the Eurosystem to the extent of the rating distortion.*

1. *Bonds of relatively high quality in each CQS are sold in the market, albeit to a lesser extent than in the case without rating distortion, while eligible bonds of relatively low quality in each CQS are used in public repos with the Eurosystem. The quality of bonds attracted by the*

[341] As in the previous case of positively distorted ratings, an alternative would be to think of the ratings as being correct but the market prices of bonds as being biased. Both result – directly or indirectly – in distorted market prices.

Figure 7.15: Segmentally-Pooled Public Repo Conditions and Negatively Distorted Ratings



Source: author's illustration.

Eurosystem is higher than in the case without rating distortion as CQSs are endogenously shifted upwards.

2. *The rent of borrowers is diminished at the benefit of private lenders owing to the distorted signal. For borrowers owning bonds of relatively low quality within each CQS, the diminishing of the rent is mitigated by the Eurosystem at the cost of a reduced aggregate surplus.*

The importance from a LOLR perspective results from the comparatively riskless outside option that the Eurosystem provides to borrowers and is amplified if the assumption of a costless bond production is lifted. First, the provision of the outside option is comparatively riskless for the Eurosystem, as the subsidization compared to *normal* market conditions is mitigated by the distortion such that public collateral values remain below true collateral qualities and the risk to the central bank's balance sheet is limited. This also distinguishes the Eurosystem's action as a LOLR action in contrast to the MMOLR character that the outside option contained throughout the previously-discussed scenarios of correct or positively distorted ratings. Second, should the Eurosystem have believed in a scenario like the one presented, where prices are artificially low due to an overly prudent valuation, it would have mitigated a possible (refinancing) credit crunch as a LOLR. Costly bond production could e.g. be represented by loan-making (financing of investment projects) to create assets that can subsequently be used as collateralizing assets in refinancing repos. The distortion of ratings would then not only result in diminished rents but also losses for banks and ultimately a credit crunch in the real economy, which would consecutively be mitigated due to the outside option provided by the central bank. On the other hand, the risk for the public lender would be comparatively low, as most bonds would be pledged at conditions below their quality levels. The shortcoming of the segmental pooling approach as an automatic LOLR instrument is that the eligible collateral pool is endogenously tightened owing to the definition of eligibility in terms of credit ratings. Taking the financial crisis hitting in fall 2008 as an example yields the following. Only CQS 1/2 bonds had been eligible, such that in the wake of the beginning market prudence, bonds of qualities below $\hat{\theta}_1 + \epsilon$ were ineligible, which included bonds that had been eligible for central bank refinancing before the crisis. However, for most of the borrowers with bonds above this shifted threshold, the (refinancing) credit crunch had been automatically mitigated by the outside option of the Eurosystem. The lowering of the minimum credit rating threshold in effect introduced a new segment of eligibility (CQS 3) such that bonds of lower qualities could also make use of the public outside option, which was pooled on the level of s_{α_3}. By designing relatively favorable refinancing conditions in CQS 3 – i.e. choosing b_3 close to its lower bound $\underline{b}_3$ – the fraction of subsidized bonds could be increased such that almost all borrowers could profit from the outside option. Of course, in the strictest sense of the inertia principle, the action can only be defined as a LOLR action if $\hat{\theta}_1 = \hat{\theta}_3 + \epsilon$, which needs a sufficiently large distortion. In other words, previously Single A-rated bonds would have been rated Triple B in the aftermath of the crisis. In any case, the LOLR action comes at the cost of reduced aggregate surplus, as discussed above.

7.3 Evidence on Within-Segment Quality of Collateral Pledged

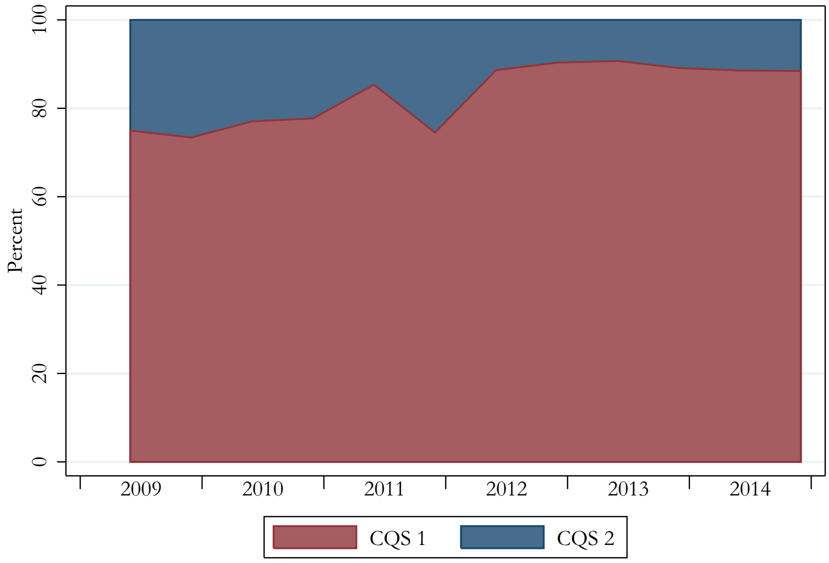
The main prediction of the above model is that relatively low-quality assets are attracted to public repos due to the segmental pooling approach in the collateral policy of the Eurosystem. In other words, it is subsumed that banks pledge their relatively high-quality collateral within each credit quality segment originating from the Eurosystem's pooling to refinancing options in the private money market, where they receive relatively better refinancing conditions. Relatively low-quality collateral is used in refinancing operations at the central bank. As already noticed, the Eurosystem does not publicly offer information on the quality distribution of its eligible collateral pool, let alone on the quality distribution of pledged collateral. The inductive outside-in analysis presented in Section 4.6.2 offers some insight into the quality of the eligible collateral pool, albeit only on a segment level. In Section 8.7, it will be estimated what the likely distribution *across* credit quality segments of the collateral actually used in public refinancing operations looks like. Therefore, the contribution of the above model is to provide an estimation of the quality distribution *within* the segments. The three pieces of evidence presented in the following shall provide some confirmation to the theoretical predictions made.

Figure 7.16 shows the development of the distribution of credit qualities pooled into the Eurosystem's CQS 1/2 – i.e. credit ratings of Triple A and Double A (CQS 1) as well as Single A (CQS 2) according to the ECAF – that were pledged in European tri-party repos (the money market). Over time, the fraction of CQS 1 qualities pledged in the private European repo market increased within the depicted credit quality Segment 1. As predicted by the model, relatively high qualities (CQS 1) have been used in private refinancing operations while relatively low qualities (CQS 2) are used to a lesser extent, being driven out of private repos over time.

In turn, the model predicts the use of relatively low assets in refinancing operations with the central bank. Figure 7.17 shows the average effective haircuts applied to potential and actual eligible collateral, i.e. to all eligible marketable assets versus the pledged assets.

Figure 7.16: Distribution of Within-Segment 1 Collateral Qualities Pledged in Tri-Party Repos

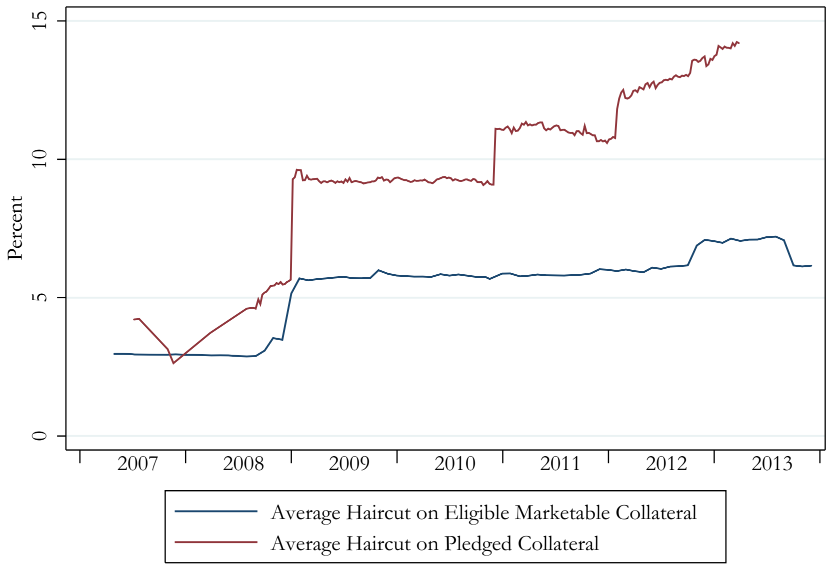
The figure shows the fractions of CQS 1 (Triple A and Double A) versus CQS 2 (Single A) collateral used in tri-party repos in the private European repo market. As predicted by the model, the fraction of relatively low qualities within the depicted credit quality Segment 1 is small, i.e. relatively high-quality collateral is predominantly used in private repos. Moreover, the fraction of relatively high-quality collateral increased over the crisis years. In terms of the model, this reflects a revalued outside option of public refinancing from the Eurosystem for relatively low-quality collateral within each credit quality segment due to the segmental pooling approach, which subsidizes relatively low-quality collateral.



Source: author's calculation; ICMA (2009, 2010, 2011, 2012, 2013, 2014).

Figure 7.17: Average Effective Haircut to Eligible Marketable and Pledged Collateral

The figure shows the development of two haircuts: first, the value-weighted average haircut applied to eligible marketable assets; and second, the value-weighted average haircut imposed to pledged assets, according to European Central Bank (2013b). It reveals that average haircuts developed asymmetrically as the average haircut to pledged assets increased more than the average haircut to eligible marketable assets.



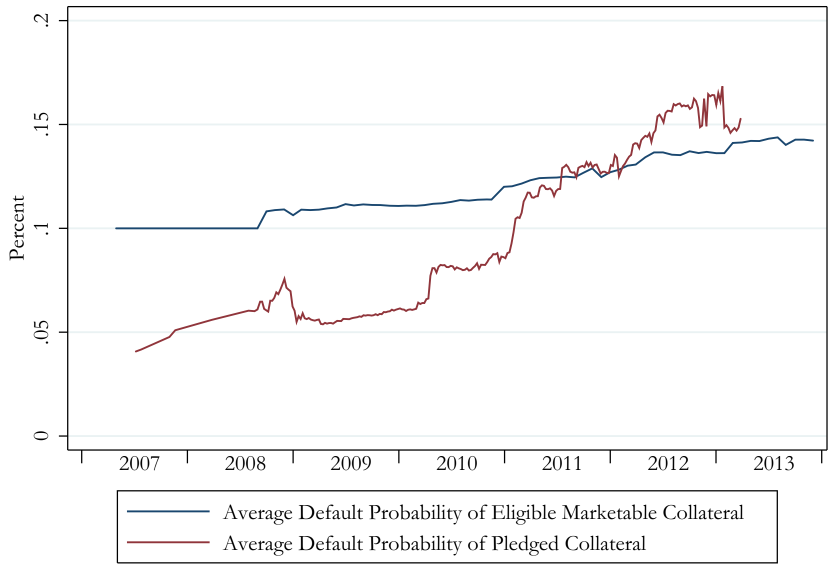
Source: author's calculation; ECB, Eligible Assets Database; European Central Bank (2013b).

Naturally, both lines in Figure 7.17 show an increasing course as the eligible asset pool was extended to lower qualities and riskier asset types, which were assigned higher haircuts, cf. Chapter 4. The step in fall 2008 is illustrative for the qualitative broadening as it represents the lowering of the minimum credit rating threshold. While both lines start on a comparable level before the crisis, two differences stand out. First, the increasing course – through both the steps and the slopes – is stronger for the average haircut of the pledged assets, in line with the predictions of the model. Apparently, the pledged assets were of over-proportionally lower qualities as relatively low-quality assets were preferably used at the central bank.[342] In addition, the step between 2010 and 2011 is only visible for pledged assets. As it occurs due to the increase of nominal haircuts for LCs 3 to 5 (see Section 4.5.4.2), it suggests that these LCs – comprising e.g. bank bonds and ABS – have been pledged over-proportionally to their relative presence in the eligible assets pool. Second, the upwards sloping parts of the line graph illustrate the process of gradually using assets of ever-lower qualities in the Eurosystem's refinancing operations. They only appear in the development of the average haircut of pledged assets and thus cannot be driven by haircut changes. The analyses by e.g. Cheun et al. (2009), European Central Bank (2013b), Fecht et al. (2015), and Nyborg (2015) support the view that the increase of the average haircut on pledged collateral can be ascribed to a changing composition of pledged assets in Eurosystem refinancing operations.

Finally, the average default probability of pledged assets is higher than the respective probability for all eligible marketable assets, as Figure 7.18 shows.

Figure 7.18: Average Default Probability of Eligible Marketable and Pledged Collateral

The figure shows how the average probability of default within the next year developed for eligible marketable assets (blue line) and pledged assets (red line). The blue course of the blue line was calculated using the probabilities of default as stated by the Eurosystem (see Footnote 102) for the respective inferred credit quality segments. The red line is according to European Central Bank (2013b). The stronger increase in the average default probability of pledged assets over time (from 0.04% in August 2007 to 0.15% in April 2013) compared to all eligible marketable assets (from 0.1% in May 2007 to 0.14% in December 2013) becomes apparent. This confirms the predictions of the above-presented model regarding the adverse selection of low qualities pledged at the central bank.



Source: author's calculation; ECB, Eligible Assets Database; European Central Bank (2013b).

[342] Over-proportionally in comparison with the overall reduction of average quality in the eligible asset pool.

The information revealed in the figure is a second indication for the reinforced use of low-quality assets at the central bank, which are of higher default risks as a result. Interestingly, the average default probability of assets pledged at the Eurosystem was originally much lower than the respective probability in the overall pool. The gap narrowed but did not change sign, even throughout the first crisis years. However, in the wake of the European debt crisis, the lines intersect as the qualities of collateral used in public refinancing operations deteriorated. All three pieces of evidence can be explained by the above model. The within-segment quality of collateral received by public lenders is relatively low, while private lenders receive the better qualities within each credit quality segment.

Chapter 8

Distribution Effects of Collateral Policy

Chapter 6 presented a technical formulation of the central bank's objective-targeting and discussed the process of trading off elements of the objective function when deciding on the collateral policy implementation, in which positive and negative effects are netted out. This chapter draws upon the theoretical framework of Chapter 6 while more closely investigating the accompanying distribution effects of the collateral policy-making. The focus is placed upon the trade-off between monetary stability and fiscal and economic stability.[343] It was already noted in Chapter 6 that market segments can be asymmetrically affected by collateral policy. Therefore, the schematic model introduced in the following (Section 8.1) explicitly considers two market segments. Three possible interpretations of these market segments are discussed: *(i)* branches/industries, *(ii)* regional economies and *(iii)* national economies. Thus, the peculiarities of the jurisdictions of the four central banks considered in detail in Part II (ECB, Fed, BoE and BoJ) move into the applicability of the model. It is concluded from the technical analysis (Sections 8.2 and 8.3) that the interpretation of the market segments matters for the importance of the effects of collateral policy from a distribution perspective. While collateral policy can be *(i)* conducted to the benefit of the national economy if targeted at distinct branches/industries and *(ii)* is able to induce a Pareto improvement for the case of regional economies if a national redistribution mechanism exists, *(iii)* it leads to redistribution between countries in a monetary union such that some members benefit at the cost of others. Due to the incentives, the redistributive policy-making is an objective function comprising a fiscal and economic stability objective in addition to the monetary stability objective sets to the central bank, which consequently takes an aggregate perspective and nets out country perspectives. This might be problematic and labeled as a constructional flaw if no fiscal union exists providing compensational redistribution mechanisms.[344]

The costs of refinancing at the central bank for the certain collateralizing asset (type and quality) disposable to the banks in the respective country relative to the relevant private refinancing conditions in the money market are determining for whether a member is a net beneficiary or net contributor to the redistribution. The model presented in Chapter 7 thus contributes a defining

[343] Financial stability is thus left aside. However, in principle it can be substituted in for fiscal and economic stability and similar distribution effects would occur.

[344] Cf. e.g. James (2013) for a discussion of design flaws of the EMU. For a discussion of differences to the case of a common central bank in a fiscal union in light of the issues emerging within the EMU during the European debt crisis, see e.g. Bertola et al. (2013).

ingredient for the analysis in this chapter, presenting in detail the impact of segmentally-pooled refinancing conditions and showing how relatively low-quality collateral is subsidized in comparison to relatively high-quality collateral. The Eurosystem's practice of segmental pooling (cf. Section 4.5.7) is thus also introduced into the following model (Section 8.4). Hence, the asymmetric collateral policy-making – which leads to the distribution effects presented in this chapter – can not only target market segments through *(a)* diverging haircut policy for different asset types and *(b)* diverging haircut policy for different credit quality segments, but also through *(c)* segmentally-pooled haircut policy discriminating credit qualities *within* credit quality segments.

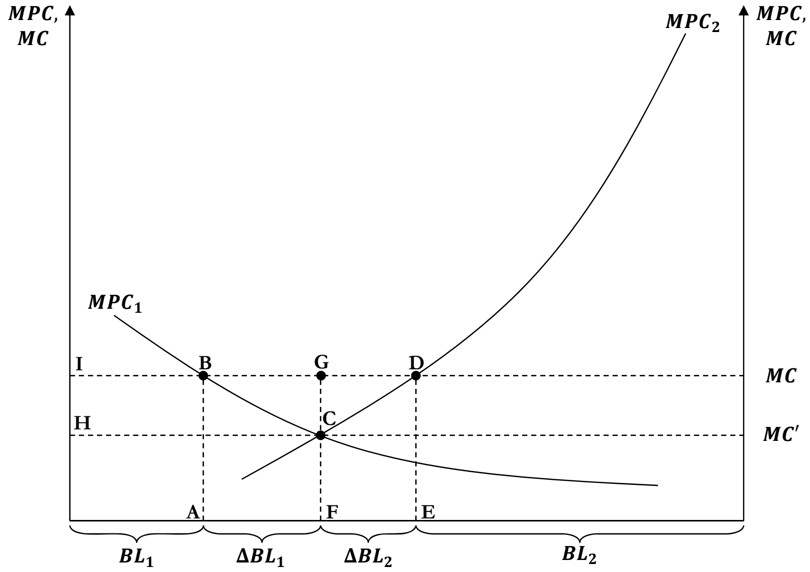
In order to underpin the relevance of the technically derived distribution effects for the Eurozone, it is consecutively shown that the national collateral indeed differs with respect to three dimensions between the Eurozone member countries: *(1)* a home bias in banks' balance sheets, *(2)* differences in the asset type composition and *(3)* differences in the quality structure of national eligible asset pools are carved out in Section 8.5. The differences along all three dimensions underwent intensification during the crisis period after 2007, not least triggered by the loosening collateral policy measures of the Eurosystem. In addition, anecdotal evidence of freeriding behavior – i.e. the striving of NCBs to further stretch regulatory space in the definition of segmentally-pooled refinancing conditions – is provided (Section 8.6). As a result, the redistribution within the EMU is predicted to work from non-crisis to crisis countries. Finally, an attempt is made to measure the redistributive effects with the help of the TARGET balances data and thus confirm the prediction (Section 8.7). The redistribution is visible in a reduction of the recourse to central bank refinancing credit in non-crisis countries, which are inferred to predominantly use higher-quality assets of types that are less favored by the collateral criteria of the Eurosystem. On the other hand, the use of central bank refinancing credit in crisis countries sky-rocketed and is inferred to be collateralized as predicted by lower-quality assets of types favored by the segmentally-pooled refinancing conditions that the Eurosystem offers.

8.1 Model Setup

To compare the effects of central bank policy in two different market segments and deduct distributive effects, it is helpful to show both market segments in one graph, as in Figure 8.1.[345] The interpretation for the two market segments shall be threefold: *(i)* One can think of the two market segments as two industries, branches or sectors of one national economy with one national central bank. *(ii)* They could just as well represent two regional economies of one fiscal union that is also a monetary union with a common central bank. Examples include the state economies within the USA and the Fed or German Länder economies within the Federal Republic of Germany and the Bundesbank before the European monetary unification. *(iii)* A third possibly interpretation that

[345] The setup of the figure is inspired by Sinn (2010b), who extends on Sinn and Koll (2000). Sinn (2010b) explains the reallocation of capital within the EMU, where capital markets were integrated and nominal interest rates converged. However, at the same time, due to prevailing differences in inflation rates (cf. also Sinn and Reutter, 2000) lower effective interest rates for the southern countries of the EMU led capital flows thereto. The role of divergent inflation rates for differing real interest rates in the EMU is also highlighted by Hellwig (2011). The argument was formalized by Arnold and Weber (2012), who confirm that a lack of internalization of differing default risks (or the non-credibility of the no-bailout rule) in a monetary union leads to disincentives for governments towards higher debt levels.

Figure 8.1: Distributional Effects of Symmetric and Asymmetric Central Bank Policy



Source: author's illustration.

will be discussed is two national economies within a monetary (but not fiscal) union. The natural example for this case is the European countries participating in the EMU and the ECB.

On the ordinates of Figure 8.1, the levels of the marginal productivity of capital (MPC) and the marginal costs (MC) from the bank's perspective are shown. The first-named is given by

$$MPC_i = p_i \cdot G_i'(BL_i) \; \forall \; i \in \{1, 2\}, \tag{8.1}$$

and depicted as a monotonously decreasing and convex function in Figure 8.1 owing to the characteristics presented in Section 6.1.2. The marginal product of capital is equal to the internal rate of expected interest of the investment project available to the bank to finance with an additional unit of bank lending. Hence, the curve incorporates these projects in reversed order (from the highest internal rate of interest to the lowest). The marginal costs of an additional unit of bank lending for the bank are the constant refinancing costs either in the money market or at the central bank. Hence, they are given by

$$MC_i^{MM} = pr^{MM} + (1-p)m_i^{MM} = pr^{CB} + (1-p)m_i^{MM} \qquad \forall \; i \in \{1, 2\}, \tag{8.2}$$

$$MC_i^{CB} = pr^{CB} + (1-p)m_i^{CB} \qquad \forall \; i \in \{1, 2\}, \tag{8.3}$$

and can be derived from (6.2). As (8.2) shows, it is assumed that the money market offers an interest rate equal to the central bank policy rate due to its competitive structure, such that only the haircut can differ from the central bank refinancing conditions. Figure 8.1 presents the case of a less productive (denoted by 1) versus a productive market segment (denoted by 2), such that MPC_1 is running flatter than and below MPC_2 for any level of BL. The levels of bank lending can be read off the abscissa, from the left origin to the right for market segment 1 and from the right origin to the left for market segment 2.

8.2 Symmetric Policy

Initially, it is assumed that both types of collateral are of the same risk ($z_1 = z_2$), such that there is an identical marginal refinancing cost MC for bank lending to both market segments.

8.2.1 Interest Rate Policy

Interest rate policy is symmetric per se as a discrimination of the interest rate by market segment is not possible. The central bank can induce a lowering of MC to MC' – as depicted in Figure 8.1 – through a lowering of its policy rate r^{CB}. If refinancing goes through the money market, the money market will lower its refinancing costs (8.2). Accordingly, if refinancing goes through the central bank, (8.3) decreases.[346] In market segment 1, bank lending will increase by ΔBL_1 and in market segment 2 it will increase by ΔBL_2. The reason is that at the lower marginal cost of refinancing, the bank increases bank lending to more (less productive) investment projects, which now also pay off. Output in market segment 1 increases by the additional area underneath the marginal productivity curve – i.e. $\overline{ABCF}$ – and in market segment 2 by $\overline{FCDE}$, respectively. As Figure 8.1 shows, the additional output in market segment 1 is higher than in market segment 2 because the curve is flatter. Market segment 1 thus profits more from the policy measure compared with market segment 2.

Bank lending overall increases by $\Delta BL = \Delta BL_1 + \Delta BL_2$. Therefore, there will be higher inflation, as discussed in Chapter 6. If the initial level of bank lending $BL_1 + BL_2$ represented the optimal level from a monetary stability perspective, such that $\pi^T = \pi(BL_1 + BL_2)$, the additional output comes at the cost of a negative inflation gap. This is illustrated in Figure 8.2, showing the relationship between inflation and bank lending, which is depicted (and assumed) as convex here. The underlying argument is that overshooting of the inflation target is fueled very quickly, incorporating the phenomenon of galloping prices, while deflationary tendencies need stronger triggers in the sense of greater changes in bank lending levels.

8.2.2 Haircut Policy

A lowering of MC to MC' through haircut policy is only possible for the central bank if all refinancing credit is directly taken from the central bank facilities. Subsequently, a symmetric lowering of the haircuts on collateral – which are identical on both types of collateral i – induces more bank lending into both market segments, as in the previous case of interest rate policy. The additional bank lending leads to an inflation gap as illustrated in Figure 8.2 and described above.

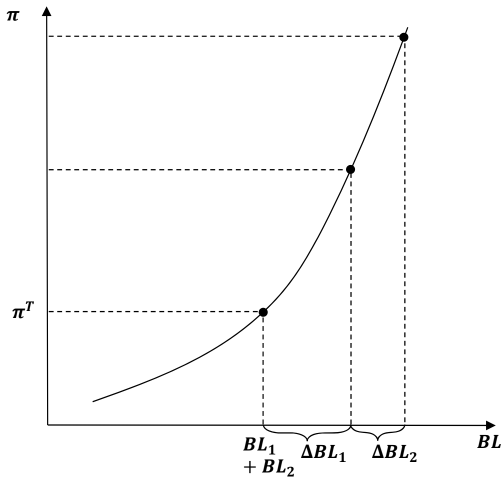
8.2.3 Distribution Effects

Distribution effects in this chapter are analyzed along the lines of the three possible interpretations of the two market segments, see Section 8.1. Moreover, distribution effects are sub-divided following the central bank objective function, cf. (6.1), into a weighted sum of monetary stability and fiscal and economic stability.[347] Furthermore, it shall be defined as the initial situation that the inflation

[346] Figure 8.1 leaves open whether refinancing goes through the money market or the central bank as the focus is on distributive effects of the central bank policy, the transmission of which occupies secondary importance here.

[347] Financial stability is omitted as it does not depend on the level of bank lending, changes in which drive both changes in both monetary stability and fiscal and economic stability in the schematic analysis conducted here.

Figure 8.2: Relationship between Inflation and Bank Lending



Source: author's illustration.

level is at target, the output gap in market segment 2 is zero and the output gap in market segment 1 is positive, such that output is below target.

- Ad *(i)*. In both described cases of symmetric (interest rate or haircut) policy, the output gap in economy sector 1 can be closed, while it turns negative in sector 2 as output grows too much there. However, as shown in Figure 8.1, the first-named positive effect outweighs, such that for the overall economy a positive output gap of the size $\overline{ABCF}$ can be turned into a negative output gap that is smaller in magnitude: $-\overline{FCDE}$. Hence, from the fiscal and economic stability perspective, the central bank policy measure is desirable as $\overline{FCDE} - \overline{ABCF} > 0$. However, the national economy also suffers from higher inflation because bank lending increases by $\Delta BL_1 + \Delta BL_2$, cf. Figure 8.2. This represents a negative effect on monetary stability. Both the positive economic stability and the negative monetary stability effects affect the whole national economy and there is only redistribution between the sectors of the economy. Whether the policy measure is desirable from the central banks perspective depends on the size of the two effects relative to another and the weights in the central bank loss function.

- Ad *(ii)*. If the two market segments represent regional economies, the sizes of the effects are as in *(i)*. The negative effect on monetary stability has to be borne by both regions jointly. However, the output effect benefits region 1 to the extent of $\overline{ABCF}$, while region 2 is additionally disadvantaged by a negative regional output gap to the extent of $-\overline{FCDE}$. Of course, in a fiscal union this redistribution between regions can be compensated at the national level. This is especially true in light of the magnitude of the economy-wide output gap, which is – as in *(i)* – diminished from $\overline{ABCF}$ to $\overline{FCDE}$.

- Ad *(iii)*. In case of a monetary union, the negative effect of higher inflation as in *(ii)* affects both countries. The output effect is positive for country 1 but negative for country 2. Although the overall net output effect is positive, there is no compensation mechanism in favor of country 2 owing to the lack of a fiscal union. This illustrates the dilemma of a central bank in a monetary union of heterogeneous national economies. If it uses symmetric policy tools, it can only choose a value of interest rate or haircut somewhere in between the values optimally trading off the stability objectives for each country individually. As a result, there is a redistribution effect that cannot be addressed at the union level.[348]

8.3 Asymmetric Policy

8.3.1 Haircut Policy

Asymmetric central bank policy is only possible using haircut changes, considering the results of the analysis in Chapter 6. Consider again Figure 8.1. Based on a situation where both the money market refinancing conditions and the central bank refinancing conditions are at MC, regardless of the collateral type pledged the central bank can use asymmetric haircut policy to foster bank lending into one but not the other market segment. It would subsequently lower e.g. the refinancing conditions for market segment 1 to MC'. As a result, bank lending into market segment 1 would increase by ΔBL_1 and all bank loans to investment projects in this segment would be refinanced at the central bank. Meanwhile, bank lending into market segment 2 would remain at the level of BL_2 and be refinanced in the money market. The additional output – given by the area $\overline{ABCF}$ – would entirely benefit market segment 1.

8.3.2 Distribution Effects

- Ad *(i)*. The output gap in economy sector 1 can be closed without opening a negative gap in economy sector 2. Moreover, the resulting inflation gap is smaller because bank lending only increases to the amount of ΔBL_1. As Figure 8.2 illustrates, this leads to disproportionately less inflation.[349] For the national economy as a whole, there is a large positive effect compared to the initial situation with respect to economic stability, whereby the overall output gap now equals zero. In addition, a negative inflation effect arises, although this is smaller than in the case of symmetric policy, cf. Section 8.2 and Figure 8.2. Moreover, note that the refinancing into sector 1 would now be subsidized by the central bank relative to market conditions. The subsidy is shown in Figure 8.1 in the area $\overline{HIGC}$.

- Ad *(ii)*. If there were two market segments regional economies within a political union, region 1 would contribute to national output with a positive output effect as its regional output would increase up to the target level. Output in region 2 would not change. Both regions would have to equally bear the consequences of excessive inflation due to the increased bank lending into region 1. Nonetheless, this negative effect on monetary stability is smaller and the overall output effect is larger compared to the case of symmetric policy (see Section 8.2). As in the case of symmetric policy, region 2 can also be compensated for the negative monetary stability effect from the means of the increased output in region 1. As in *(i)*, the central bank provides a unilateral subsidy to region 1 to the amount of $\overline{HIGC}$ relative to the market conditions.

[348] Moreover, this redistribution has not been decided in the first place by a democratically-determined common government at the union level, but rather results from the central bank policy measure.

[349] The reason is that the relationship between bank lending and inflation in Figure 8.2 is assumed in a convex way, see explanation above.

- Ad *(iii)*. The effects in a monetary but not fiscal union case are similar to *(ii)*. However, although country 2 does not experience a negative output effect, it still participates in the negative effect on monetary stability due to the excessive inflation. Given that this effect is smaller than in the case of symmetric policy, one could conclude that asymmetric policy is strictly better than symmetric policy from the perspective of country 2 and represents a useful tool for a central bank in a heterogeneous monetary but not fiscal union. However, this view clearly neglects any costs from the subsidy that the central bank provides to country 1.

8.4 Segmental Pooling

For the following part of the analysis, the assumption of identical risks on the collateral is lifted; rather, it is now assumed that collateral reflects the risk of the investment projects in a market segment because ultimately bank loans to existing investment projects – i.e. assets on a bank‘s balance sheet – become the collateral used in refinancing credits.[350] Therefore, the risk of default of collateral in market segment 1 is now higher than that in market segment 2, i.e. $z_1 < z_2$. The money market will incorporate this in the determination of the refinancing conditions that it offers, such that $MC_1^{MM} > MC_2^{MM}$. This is depicted in Figure 8.3. The reason is that the haircut taken by the money market is defined by $m_i^{MM} = \frac{r^{CB}}{z_i}\ \forall\ i \in \{1, 2\}$ whenever (8.2) holds. If the central bank was initially offering the exact same conditions as the money market, such that all refinancing was going through the money market, the level of bank lending in market segment 1 would be given by BL_1, as marginal refinancing costs would meet the marginal product of capital in point C. Analogously, BL_2 would denote the level of bank lending to market segment 2, because the MC_2^{MM} meet the MPC_2 in point B.

8.4.1 Segmentally-Pooled Central Bank Haircuts

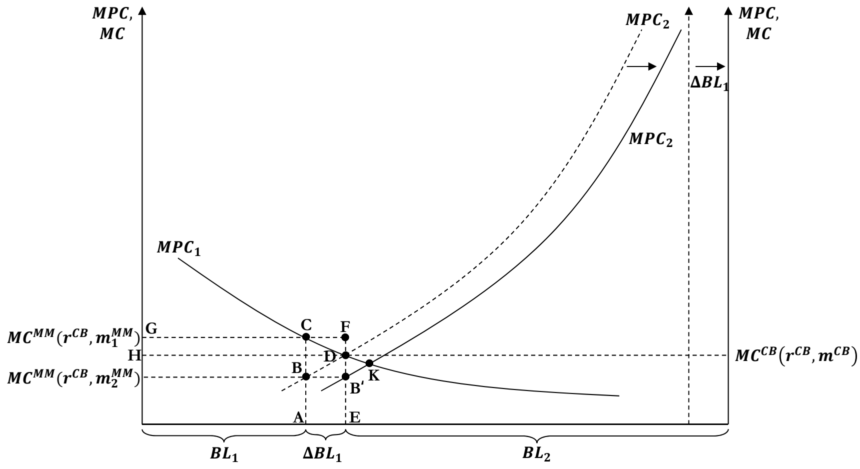
In Section 4.5.7, the ECB’s practice of segmentally pooling refinancing conditions for collateral of different quality levels was presented, while in Section 7.2.2.1 it was theoretically substantiated. Introducing segmentally-pooled central bank refinancing conditions into Figure 8.3 yields an expansion of bank lending in market segment 1 to the amount of ΔBL_1, resulting in a tearing apart of the graph to the right in the depicted case. The bank lending in market segment 1 now entirely goes through the central bank, while bank lending in market segment 2 is not affected.

8.4.2 Policy Mix

However, if $BL_1 + BL_2$ represented the level of bank lending leading to the target inflation rate, the additional bank lending would also trigger excessive inflation. In order to contrast the case of a monetary stability-neutral policy – i.e. keeping the amount of bank lending on the abscissa to the target level – the following policy mix is presented and illustrated in Figure 8.4. According to (8.2), an increase in the central bank policy rate would lift money market refinancing conditions to $MC^{MM}(r^{CB'}, m_i^{MM})\ \forall\ i \in \{1, 2\}$. Mixing the interest rate increase with an introduction of segmentally-pooled central bank refinancing conditions at the level of $MC^{CB}(r^{CB'}, m_i^{MM}) = MC^{MM}(r^{CB'}, m_2^{MM})\ \forall\ i \in \{1, 2\}$ leaves total bank lending at the level of $BL_1 + \Delta BL_1 + \Delta BL_2 + BL_2 = BL_1 + BL_2$ (where $\Delta BL_2 < 0$) unchanged.

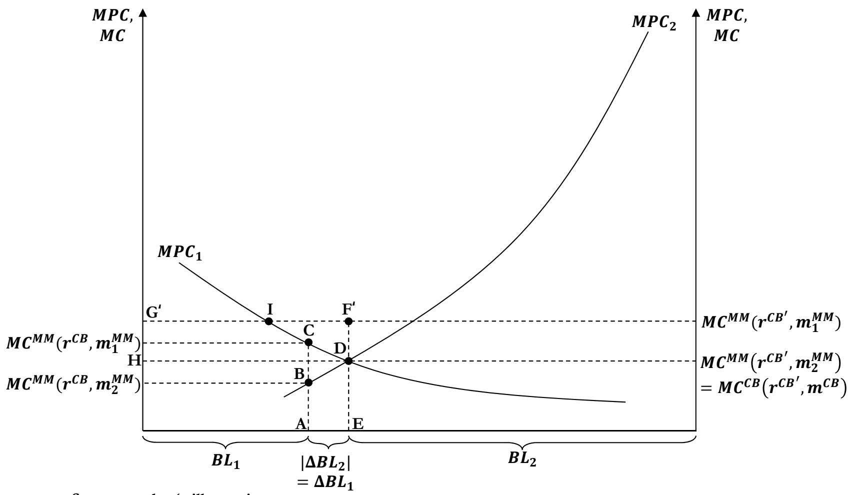
[350] See e.g. van Bekkum et al. (2015) for a description of such behavior in the Netherlands.

Figure 8.3: Distribution Effects of Segmental Pooling



Source: author's illustration.

Figure 8.4: Distribution Effects of an Inflation-Neutral Policy Mix



Source: author's illustration.

8.4.3 Distribution Effects

- Ad *(i)*. The segmental pooling policy of the central bank leads to a positive output effect in economy sector 1 depicted by the area $\overline{ACDE}$, cf. Figure 8.3. Output in economy sector 2 remains unchanged. The national economy also has to bear the negative effect on monetary stability due to the increased bank lending leading to $\pi(BL_1 + BL_2 + \Delta BL_1) > \pi^T = \pi(BL_1 + BL_2)$. However, implementing the policy mix restricts bank lending to $BL_1 + BL_2 + \Delta BL_1 + \Delta BL_2 = BL_1 + BL_2$ and thus eliminates the negative effect on monetary stability, cf. Figure 8.4. In turn, in this policy mix case a negative output effect for economy sector 2 joins in, thus diminishing output in that sector by $\overline{ABDE}$. The national economy overall still profits from higher output to the amount of $\overline{BCD}$, because the risk differences in the collateralization led the money market to finance investment projects in economy sector 2 up to a lower marginal product of capital than in economy sector 1. Hence, the quality of the collateralization needed to discipline the bank not to lend to overly-risky projects (moral hazard) is adjusted for by the money market. In the initial situation, this led to a forgone output triangle $\overline{BDC}$, such that the last financed investment project in sector 2 was of much lower productivity than the last investment project receiving financing in sector 1. In other words, some of the stock of inflation target-conform bank lending was not used in the most productive way owing to the inability of the banks financing sector 1 to collateralize the loans with higher-quality collateral.

By implementing the segmentally-pooled refinancing conditions, the central bank ignores the differences in the risk of the collateral. As a result, the financing of investment projects is extended up to lower marginal products as in economy sector 2, albeit refinanced at the central bank's conditions, which are subsidizing relative to the market.[351] The subsidy provided by the central bank is equal to $\overline{HDFG}$ in the case of just segmental pooling (Figure 8.3) and $\overline{HDF'G}$ in the policy mix case (Figure 8.4). The difference in realized marginal productivities is entirely extinguished in the policy mix case (Figure 8.4) and diminished to the triangle of forgone output $\overline{B'DK}$ in the segmental pooling case in Figure 8.3.

To summarize, segmental pooling leaves a national economy better off compared to the initial situation. It can even be implemented inflation-neutrally, i.e. without a cost in terms of a negative effect on monetary stability (policy mix). Subsequently, there is redistribution from sector 2 to sector 1, although this is over-compensated on aggregate. This might be an incentive for the central bank to implement the segmental pooling in the first place. As a matter of fact, this view (of the central bank) neglects the subsidy, which might be costly. In any case, the cost would be shared (e.g. through even higher inflation or a similar erosion of the currency) within the national economy.

- Ad *(ii)*. In case of a regionally segmented economy, region 2 either suffers from a redistribution owing to the higher inflation affected to the same extent as region 1, or in case of the described policy mix it suffers from a redistribution of output because its output shrinks by $\overline{ABDE}$, while output in region 1 increases by $\overline{ACDE}$. Of course, this redistribution can be addressed at the national level. Owing to the overall increased output (the area $\overline{BCD}$), the optimization of the central bank's objective function (6.1) indicates the implementation of the segmental pooling, as in case of *(i)* at acceptance of the described subsidy.

- Ad *(iii)*. In a monetary union, redistributive effects of segmental pooling are most pronounced. The additional output to the amount $\overline{ACDE}$ entirely benefits country 1, while country 2 either suffers from the higher inflation – and hence a negative impact on its monetary stability – or in case of the policy mix, from an output loss. Moreover, the subsidy only favors country 1, although if costs for the subsidization occurred, they would be shared. Moreover, in the absence of a fiscal union, there is no entity able to redistribute such that the overall welfare increase – the area $\overline{BCD}$ – cannot be distributed but entirely goes to country 1. However, from the perspective of the common central bank's objective function (6.1), which nets out the effects and thus takes a purely aggregated perspective, it is an incentive to implement segmental pooling.

[351] GLOC – attracting the lower-quality collateral to the central bank – is also apparent here (as in the model presented in Section 7.2).

8.5 National Differences in the Eurosystem's Collateral Pool

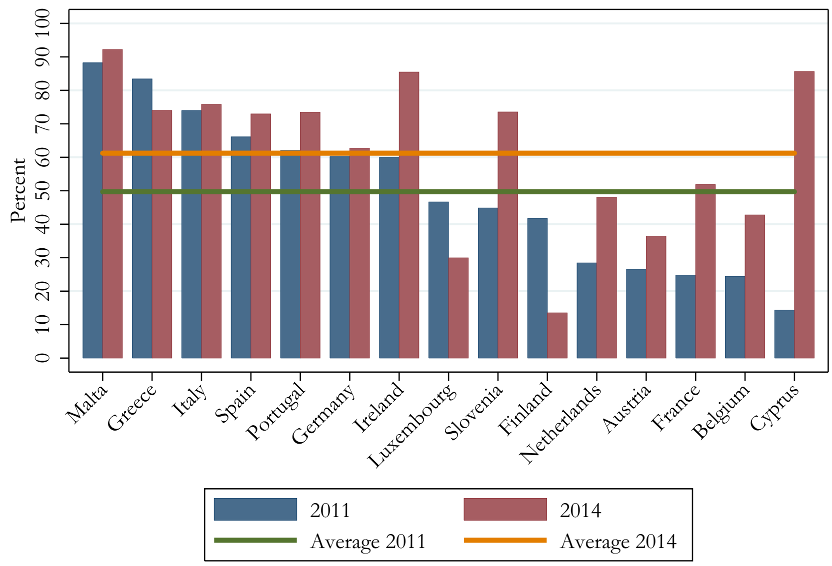
A crucial assumption in the above analysis, showing how segmentally-pooled refinancing conditions affect two market segments differently and have redistributive effects, was that the market segments differ in terms of productivity, resulting in assets in the banks' balance sheets of different quality. As these assets ultimately serve as collateral for new refinancing loans, the segmental pooling of central bank refinancing conditions benefit one market segment relative to the other. As discussed, in a monetary union the benefits are nationalized while costs are mutualized. The following section shows that differences between the national eligible collateral pools indeed exist in the Eurozone, which found possible redistributive effects through the segmental pooling approach of the ECB's refinancing conditions. National differences that are named are threefold: a home bias in government securities on banks' balance sheets (Section 8.5.1), differences in the asset composition (Section 8.5.2) and different quality structures (Section 8.5.3).

8.5.1 Home Bias[352]

Figure 8.5 shows the fraction of exposure to home sovereigns in the total sovereign exposure on banks' balance sheets in the euro area.[353] The data was collected by the European Banking Authority (EBA) in the course of the EU stress test.

Figure 8.5: Share of Banks' Exposure to Home Sovereign in Total Sovereign Exposure

The figure shows the fraction of securities issued by the respective home government in the government securities portfolio of banks in the country named on the abscissa. A home bias was already apparent in 2011 (average of 50%) but intensified throughout the European debt crisis until 2014 (average of 61%). The home bias is (especially) pronounced in crisis countries.



Source: author's illustration; EBA, EU-wide stress testing 2011, 2014.

352 The argument that the home bias leaves room for asymmetric monetary policy-making, as described here, has already been made by Cassola and Koulischer (2014, 2016), albeit only using data for 2011.

353 More precisely, the data available is for the euro area of fifteen members. Data for Slovakia and Estonia was not yet available for 2011 and data for later-joining members was omitted because they were not members in 2011.

It is evident from the data that a home bias exists in the euro area, manifesting in the predominance of securities of the respective home government within the government securities portfolio of banks. The average fraction of home government securities in the Eurozone was already at 50% in 2011 (green horizontal line in Figure 8.5). Throughout the European sovereign debt crisis, the bias amplified to an average of 61% in 2014 (orange horizontal line in Figure 8.5). The home bias had already been especially pronounced in some crisis countries such as Malta, Greece, Italy, Spain and Portugal in 2011 and even strengthened in the following.[354] Strikingly, the troubled countries yet not in the list in 2011 – Ireland, France and Cyprus – joined in forcefully until 2014. In fact, all countries except Luxembourg and Finland experienced an increase in home bias between 2011 and 2014. The increase was stronger the lower the home bias had been in 2011. German banks also already had a strong home bias in 2011. It only increased very slightly and marked more or less the average of around 60% in 2014.

As described in Chapter 4, the Eurosystem defines identical refinancing conditions for the government bonds of its member countries, which are only differentiated between two credit quality segments (segmental pooling). As banks have their balance sheets loaded with their home governments' securities, some of them must experience subsidized refinancing conditions at their NCB relative to the money market, while others are likely to face better conditions in the money market. Banks from crisis countries probably choose the central bank over the money market because they receive cheaper conditions there.[355] This is in itself again a reason to increase the home bias in one‘s government securities portfolio. Hence, the redistributive effects described in Section 8.4.3 would be from Eurozone members with stronger government finances to those of less sustainability.

8.5.2 Asset Type Composition of National Eligible Collateral Pools[356]

A next starting point for the asymmetric impact of segmentally-pooled refinancing conditions is the composition of national eligible collateral pools with respect to asset types, as shown in Figure 8.6. Moreover, any imbalance between these compositions leads to an immediate redistributive effect of asymmetric haircut policy (cf. Section 8.3). It became apparent from the extensive analysis in Section 4.5 that changes to the Eurosystem's collateral framework particularly favored some asset types, especially bank assets and (lower-quality) government securities, as concluded from Chapter 4. If these asset types were to be found surpassingly often in a national collateral pool, the respective nation profited above average from the collateral policy measure. In the following, the development of the asset type composition of some important national eligible collateral pools is described. The selection contains Germany, France, Spain and Italy, as well as the smaller crisis countries Greece, Ireland and Portugal.

The German eligible collateral pool only increased relatively moderately by about 8% during the time depicted in Figure 8.6, namely from May 2007 until December 2013. The composition also remained relatively stable throughout this period. A large portion of the pool comprises government

[354] The only named country where the bias weakened is Greece, where the debt restructuring of 2012 explains the development in the data (see Choi and Gulati, 2016; Gulati et al., 2013, for details on the Greek debt restructuring).

[355] Cf. also Brutti and Sauré (2014), who partially ascribe a "repatriation of debt" to the collateral policy of the Eurosystem.

[356] This section bases on joint work with Jakob Eberl (Eberl and Weber, 2015), which has also been used in his dissertation (Eberl, 2016).

securities, which increased from just above 40% to around 50%,[357] mainly because more regional government securities became eligible. The share of covered bank bonds decreased, while in turn the fraction of uncovered bank bonds grew (at times substantially). ABS and corporate bonds play almost no role in the German collateral pool. Other marketable assets containing e.g. central bank assets, assets from supranational issuers and agency securities also increased to around 15%. The value of newly-eligible assets per month sky-rocketed after the major relaxation of collateral criteria in October and November 2008 and was also relatively high throughout 2012. The composition of newly-eligible assets follows the above-described developments, with newly-eligible uncovered bank bonds dominating the picture.

In Spain, there was considerable growth of the national eligible collateral pool by about 56% during the depicted time. Initially, government bonds did not play a major role, although they were the main driver behind the overall increase following the main crisis events in the fall of 2008. ABS constituted a very high fraction of the eligible asset pool in Spain compared to other Eurozone countries. They lost importance after the tightening policy on eligibility criteria for ABS the Eurosystem conducted in March 2009, such as the determination of the minimum credit rating at Triple A (cf. Section 4.3.5.1). In turn, corporate bonds and particularly covered bank bonds gained shares in the collateral pool, representing large fractions of the values of newly-eligible assets. This probably illustrates a bypassing of the tightened criteria because banks might simply have issued e.g. covered bonds themselves rather than founding SPVs to issue ABS through them.

The French eligible collateral pool almost doubled in size (90% increase), largely due to uncovered bank bonds, which also dominate the picture of newly-eligible assets. In absolute terms, government securities also increased, although their haircut-adjusted – and hence effectively pledgable – share remained relatively constant at around 50% after October 2008. The dynamics in the development of the share of uncovered bank bonds can be explained by the eligibility of bank bonds traded on non-regulated markets from October 2008 to December 2010 and as of January 2012. Corporate bonds are also of relatively large importance in France. Due to the centralized organization of the French Republic, regional government bonds are neglectable.

The Greek collateral pool almost exclusively comprised government bonds until the breakout of the Greek (and European) sovereign debt crisis around May 2010. Subsequently, uncovered bank bonds gained in importance, although they were guaranteed by the Greek government to a large extent (cf. also Section 9.5 on the guaranteeing behavior of governments). From May 2007 to January 2012, the Greek pool grew by 64%. Thereafter, eligible Greek collateral cracked in February 2012 because the Eurosystem revoked the suspension of the minimum credit rating for bonds issued or guaranteed by the Greek government. In March 2012, the suspension was re-introduced, albeit conditional upon the provision of a buy-back scheme (cf. Section 4.3.2). When Greek government bonds were deemed ineligible even if a buy-back scheme was provided as of July 2012, the Greek collateral pool completely drained. Ineligibility lasted until December 2012, when the minimum credit rating was again waived. Changes to eligibility are also reflected in the development of newly-eligible assets, indicating two spikes in newly-eligible government bonds: the first spike coincides with the introduction of the conditional suspension of the minimum rating in March 2012 and

[357] Named percentage shares refer to the haircut-adjusted nominal value, i.e. the effectively pledgable value of the national pool.

the second with the re-introduced unconditional suspension in December 2012. Interestingly, the Eligible Assets Database indicates that the Greek collateral pool was empty between July and November 2012 although only bonds issued or guaranteed by the Greek government were subject to changes in collateral criteria.

From the beginning of the financial crisis in the fall of 2008 to the end of 2010, the Irish eligible collateral pool increased by 54%. Subsequently, it declined in size again to a level comparable to that in the fall of 2008. Even more than in Spain, the Irish pool comprises ABS, which also counted for most of the newly-eligible assets during the first-named time. A little later, government bonds and uncovered bank bonds also contributed to the increase of the pool until summer 2010. The Eurosystem suspended the minimum credit rating for Irish government and government-guaranteed bonds in April 2011, although no government bond became newly eligible thereafter until January 2012. By contrast, most newly-eligible assets during that period were corporate bonds and bank bonds, which enjoyed government guarantees (cf. also Section 9.5 on the guaranteeing behavior of governments). Later, at the beginning of 2013, the Irish pool slightly increased again owing to a chunk of newly-eligible government bonds.

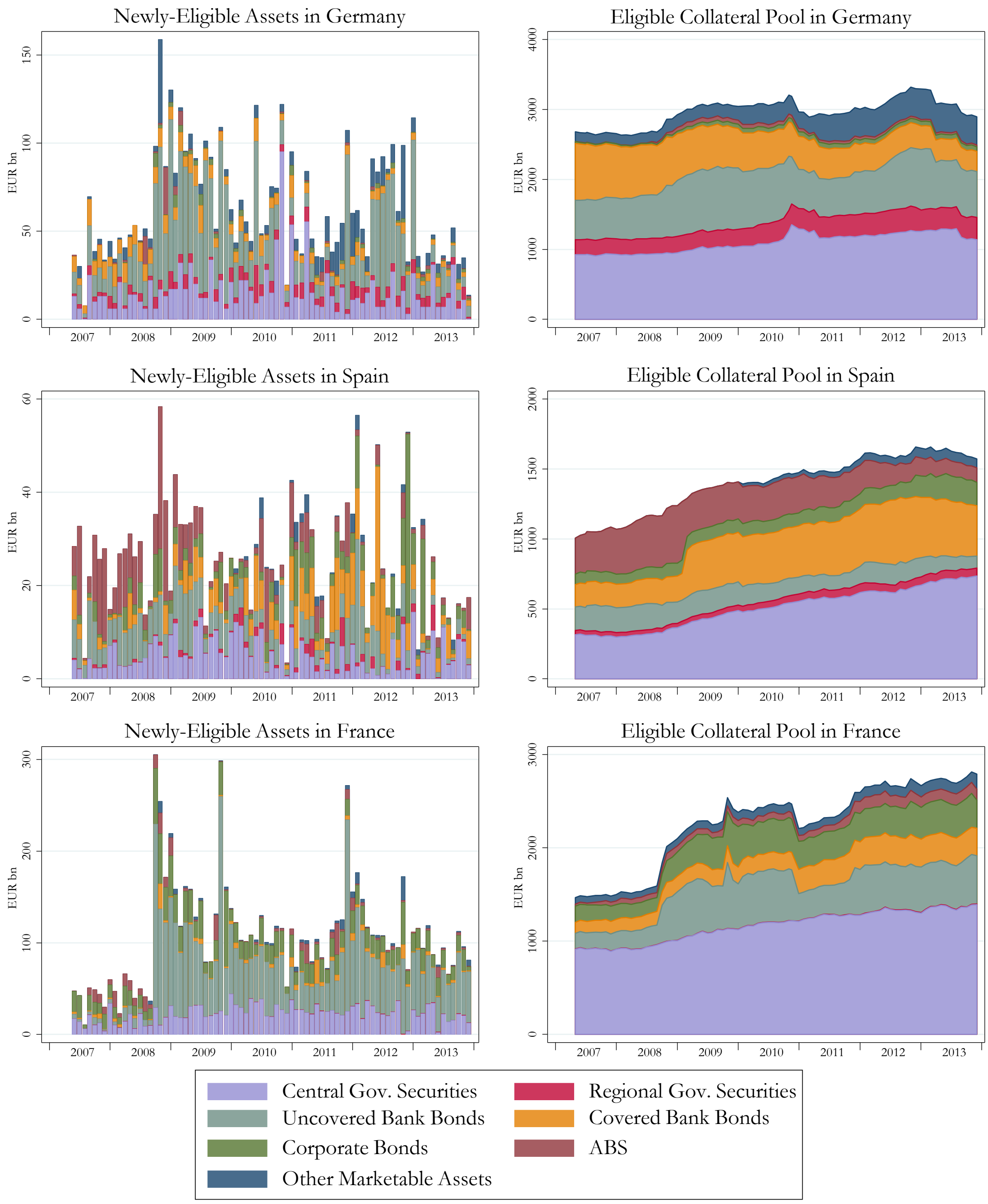
In Italy, the eligible collateral pool steadily increased by 52% during the depicted period. The share of government bonds in the Italian pool is considerably high across the period, at around 70% to 80%. Government bonds drove the increase in the pool to a large extent, joined by uncovered bank bonds, which especially represented a remarkably large fraction of the spikes in the newly-eligibly asset development around the turn of 2011/2012 (see also Section 9.5). Covered bank bonds gained in importance during the second half of the depicted period. Moreover, a significant fraction of the pool comprises ABS.

Finally, the Portuguese eligible collateral pool increased by 63%. Although government bonds account for more than half of the pool, they were not a driver behind this increase, at least until the beginning of 2012. By contrast, the amounts of eligible covered and uncovered bank bonds – as well as ABS to some extent – increased until the end of 2011. In 2012, the pool collapsed to a much lower size, as all uncovered bank bonds disappeared because the Eurosystem released the obligation for NCBs to accept government-guaranteed bank bonds, which were only eligible due to the suspension of the minimum credit rating for countries under an EU/IMF program, i.e. they did not fulfill the regular eligibility requirements on credit quality. The release lasted until April 2013, when the amount of eligible uncovered bank bonds increased again.

The above analysis can be summarized around three aspects. First, it became clear that the national eligible collateral pools increased to different extents. This suggests that some countries profited more from the Eurosystem's changes in policy on collateral criteria and the identified broadening of the eligible collateral pool, cf. Section 4.6.6. While the German collateral pool only slightly increased over the period between May 2007 and December 2013, the pools of all crisis (or troubled) countries extensively increased. The French pool almost doubled. A contributing factor – particularly indicated by the analysis of the newly-eligible asset types – was that financial institutions and governments of the crisis countries eagerly made available collateral, e.g. through issuing particular asset types or granting guarantees. This leads to the second result from the above analysis: the asset types driving the growth in national eligible asset pools differed between countries, although they predominantly comprised asset types, which particularly profited from the

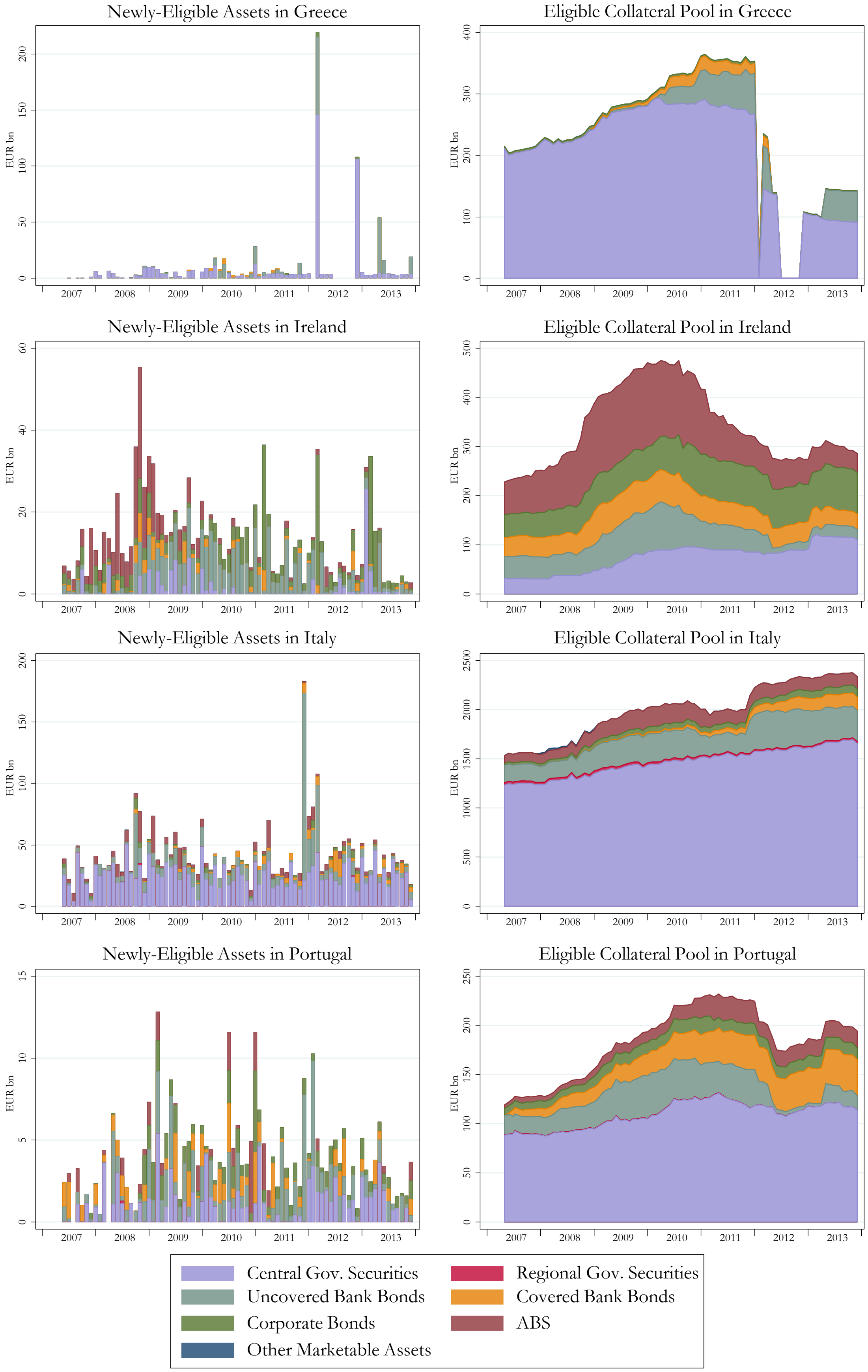
Figure 8.6: Newly-Eligible Marketable Assets and National Collateral Pools by Asset Type

The figure shows the distribution of asset types of newly-eligible assets per months by country (left panels), i.e. assets joining the respective national eligible collateral pool. The resulting developments of theses national collateral pools between May 2007 and December 2013 is depicted in the right panels. The national pools grew to different extents, such that troubled countries profited more from the changes in collateral criteria from this angle. Moreover, the composition of national eligible collateral pools differs with respect to asset types. This is also true for the newly-eligible assets.



Source: author's calculation; ECB, Eligible Assets Database.

Figure 8.6: Newly-Eligible Marketable Assets and National Collateral Pools by Asset Type (Continued)



Source: author's calculation; ECB, Eligible Assets Database.

loosening of the Eurosystem's eligibility criteria, such as bank assets or lower-quality government securities, from 2011 also ABS (cf. Chapter 4). Third, the composition of national eligible collateral pools inherently differs across the evaluated countries. Not only the fraction of government securities within the pool is different, but also e.g. the share of ABS or corporate bonds varies between countries.

The three outcomes indicate *(i)* that it is possible to asymmetrically support some countries through collateral policy over others owing to the different composition of asset types within the national eligible collateral pools, *(ii)* that the Eurosystem conducted collateral policy that especially favored some asset types and thus seemed targeted at the crisis countries and *(iii)* that crisis countries increased the potential profit they could draw from the collateral policy of the Eurosystem through increasing their collateral pools in a way suiting the favorable central bank refinancing conditions in comparison to the money market conditions such that they could utilize them to a larger extent. To conclude, the prerequisites were created for redistribution from non-crisis to crisis countries within the euro area through conducting collateral policy. Section 8.7 investigates whether and to what extent these effects were measurably realized.

8.5.3 Quality Structure of National Eligible Collateral Pools[358]

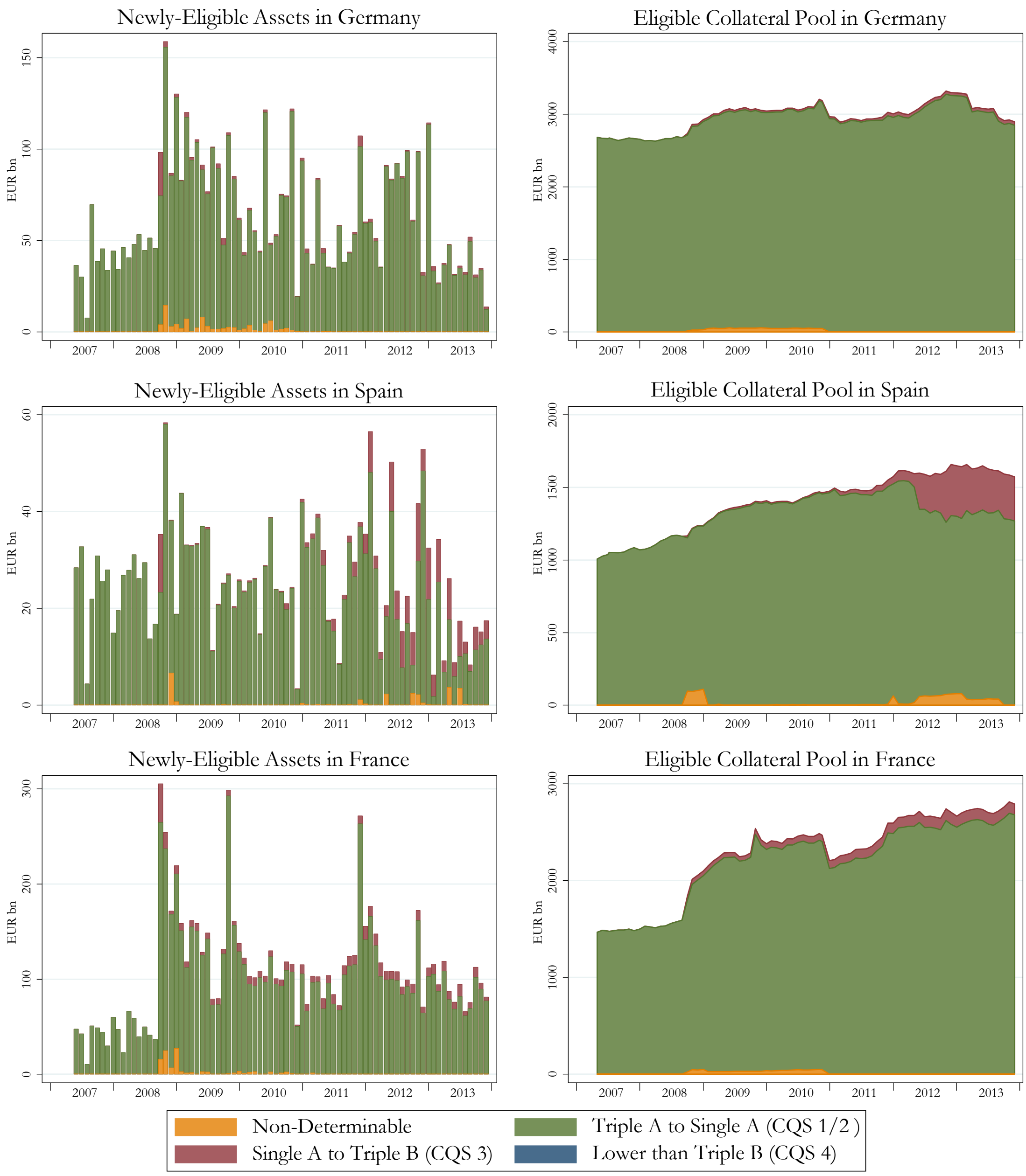
As a third starting point for the asymmetric impact of segmentally-pooled refinancing conditions, the quality structure of national eligible collateral pools is analyzed. The extended model of the previous chapter (Section 7.2.2) has shown that segmental pooling is of service for refinancing credit collateralized by assets of relatively low quality. In this case, the conditions of the central bank are subsidized relative to the market conditions and the preferred option for banks drawing refinancing credit. GLOC (cf. Section 7.2) leads to central banks attracting these relatively low qualities. Moreover, following the discussion of distributive effects of the practice of segmental pooling in this chapter (cf. Section 8.4), the policy of a common central bank in a monetary union leads to a redistribution from countries of higher productivities and hence the availability of collateral of higher quality to countries of lower productivities and hence the availability of collateral of lower quality. In the following, light will be shed on the quality structure of the national eligible collateral pools of the above-named selection of important Eurozone member countries. Combining the results with the above-made arguments would suggest that countries with collateral pools of lower qualities benefited from redistributive effects within the EMU at the cost of countries with collateral pools of higher qualities.

Figure 8.7 shows the development of the national eligible collateral pools during the period from May 2007 to December 2013 with respect to quality and the quality composition of newly-eligible assets. The information on quality in terms of the CQS is inferred using the method described in Section 4.6.2. Note that Figure 8.7 shows the sum of the *nominal values* of all eligible assets, rather than the number. The percentage values stated in the following complement the description by giving the fractions of the *number* of credit quality segment 1, 2 or 3 assets. This illustrates that particularly in some countries, many smaller assets in terms of nominal value volumes were of lower credit qualities.

[358] This section bases on joint work with Jakob Eberl (Eberl and Weber, 2015), which has also been used in his dissertation (Eberl, 2016).

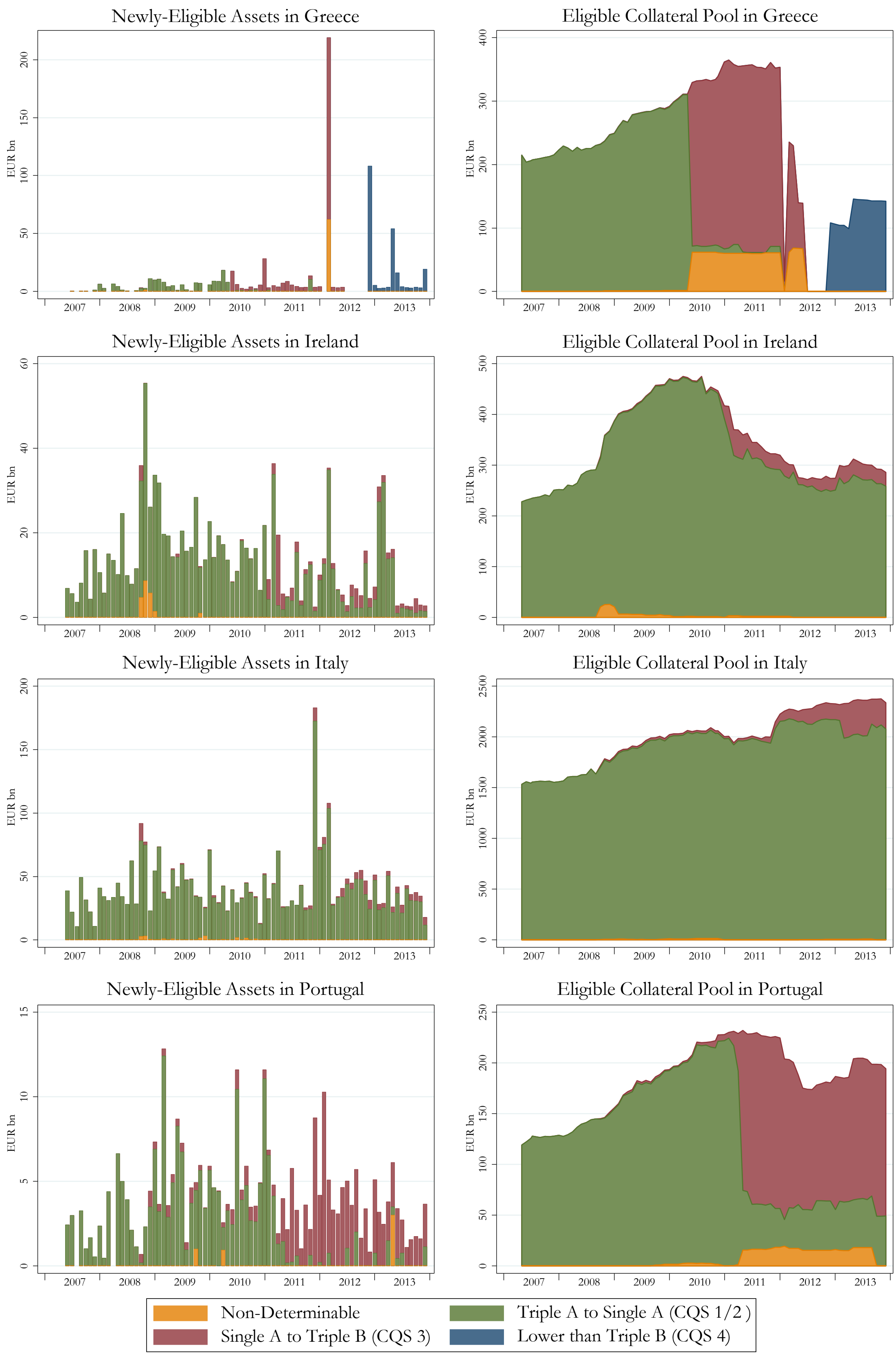
Figure 8.7: Newly-Eligible Marketable Assets and National Collateral Pools by Credit Quality

The figure is analogous to Figure 8.6, but based on the distribution of asset qualities. The left panels show the quality distribution of newly-eligible assets per month for selected countries, while the right panels state the quality distribution of the respective national eligible collateral pool. The quality within national collateral pools only started deteriorating with the beginning of the European debt crisis. Particularly in Greece and Portugal, large fractions of the assets joining the national pool were only rated within CQS 3 or even CQS 4. Significant fractions of lower credit qualities of newly-eligible assets are also visible in Spain and Ireland, to a lesser degree also in Italy and Spain. The differing composition of credit qualities within the national collateral pools makes asymmetric collateral policy and the asymmetric impact of segmentally-pooled refinancing conditions (as theoretically described above) possible.



Source: author's calculation; ECB, Eligible Assets Database.

Figure 8.7: Newly-Eligible Marketable Assets and National Collateral Pools by Credit Quality (Continued)



Source: author's calculation; ECB, Eligible Assets Database.

In Germany, almost no assets within the pool were of lower qualities in terms of CQS 3. Even at peak times, only less than 4% of all eligible assets were rated within CQS 3. Moreover, most lower-quality assets became eligible in October 2008 during the financial crisis. Later, during the European sovereign debt crisis, only very small fractions of the newly-eligible assets were rated in CQS 3. Similarly, in France, the fraction of assets rated in CQS 3 never exceeded 10% of the pool. Nevertheless, a significant fraction of these assets steadily built up since fall 2008. The Spanish case is much different: in addition to the lower-quality assets that became newly eligible after the lowering of the minimum credit rating requirement by the ECB in October 2008, many assets rated in CQS 3 joined the eligible asset pool from 2011 onwards, but especially during the second half of 2012 and during 2013, such that more than 40% of number of assets in the pool consisted of CQS 3. Of course, downgrades in ratings can also contribute to the deterioration in the pool, whereby Section 9.3 takes a closer look at downgradings. The Italian case is similar to the Spanish one, although in both countries the nominal value of the fraction of the assets in the pool rated within CQS 3 was lower than 40%. Moreover, the Italian pool comprised more than 40% assets of lower qualities at times in early 2013 and the building up of this fraction started rather late, particularly in comparison to Greece, Ireland and Portugal. In these three countries, the deterioration started in 2010, connected to the beginning of the European sovereign debt crisis. All three countries also profited from the waiving of the minimum credit rating requirement for government or government-guaranteed assets by the Eurosystem (cf. Chapter 4). However, only in Greece did assets rated within the resulting CQS 4 also appear in the national eligible asset pool. After the Greek debt restructuring in 2012, all assets were of this worst quality, as depicted in Figure 8.7. Hence, no marketable assets would have been eligible in Greece at the end of 2013 if the Eurosystem had not waived the rating requirement. In both Greece and Portugal, the vast majority of assets were of lower credit qualities since mid-2010 (Greece) and mid-2011 (Portugal), respectively. For Ireland, the respective share built up to more than 40% of the number of eligible assets in 2013.

While the description above already revealed that the quality structures of the eligible collateral pools deteriorated much differently in the discussed countries, while the pools of crisis countries comprised much higher fractions of lower-quality assets from 2010 onwards, it is also important to consider the quality structure *within* the credit quality segments. As concluded in Section 7.2.2, subsidies are given to (and hence distributive effects driven by) the relatively low-quality assets within each segment of pooled refinancing conditions. Therefore, countries that have downward-loaded within-segment quality distributions – in the sense that many assets within a credit quality segment bear relatively low credit ratings – are likely to benefit more from redistributive effects than those described in Section 8.4.

Figure 8.8 offers a refinement of the quality structure by reconstructing the distribution of eligible marketable assets across credit rating notches.[359] For reasons named in Section 4.6.2 this is only possible for one day – in this case March 6, 2015 – and involves a complex manual procedure. In doing so, both short- and long-term as well as issue and issuer ratings of eligible marketable assets were collected from Bloomberg and the rules of the Eurosystem for determining the pivotal credit rating were adapted (see Section 4.2.4.3). Subsequently, the first-best rule was applied in case of distinct ratings and issue ratings were preferred over issuer ratings (when both ratings were

[359] The fractions rely on the number of assets, unweighted by nominal values.

available).[360] On March 6, 2015, 77% of the eligible marketable assets were assigned ratings that allowed the classification into CQS 1/2, while 16% were affiliated to CQS 3. Neither an issue nor an issuer rating was available for the residual 7% of the assets.

It becomes apparent from Figure 8.8 that in the overall eligible collateral pool most assets can be assigned a Tripe A rating when they are used as collateral at the Eurosystem. However, a combined 56% of all assets in the pool are also assigned into CQS 1/2 despite being of lower qualities. One-third of them form CQS 2 (comprising the rating notches A-, A and A+ in the figure) but still receive the same refinancing conditions as Triple A-rated assets. Within CQS 3, most assets are assigned the highest rating notch of BBB+. To summarize, the within-segment distribution in the overall eligible collateral pool is loaded towards the better qualities – i.e. rating notches – but still very flat, such that the shares of lower qualities do not remain far behind. For CQS 1/2 assets, the picture is comparable for the German pool and to some extent for the French pool.[361] Nonetheless, in Germany, the share of assets assigned a rating within CQS 1 (rating notches from AA- upwards) is much higher (57%). In turn, almost no German assets are rated within CQS 3.

On the contrary, the distributions for Spain, Italy and Portugal are very much shifted towards lower qualities. Not only is the share of assets assigned ratings within CQS 3 much higher – in Italy the fraction of the number of CQS 3 assets has even increased to around a combined 50% compared to the 40% of early 2013, as described above – but also the within-segment distribution is much more loaded towards lower qualities and is also not flat. For example, in Portugal, all assets within CQS 1/2 fall upon the lowest two of the seven rating notches. Moreover, in CQS 3, around 18% of the Portuguese assets are rated the lowest of the three rating notches. Similarly, in Spain (41%) and Italy (19%), most assets within CQS 1/2 carry ratings of A- or A.

The descriptive analysis in this section showed three aspects of relevance for the evaluation of distribution effects within the EMU. *(i)* The quality structure of the national eligible collateral pools is indeed very different. Compared to the pools of countries like Germany and France, especially countries in trouble during the financial crisis starting in 2007/2008 and the European sovereign debt crisis have much higher fractions of lower-quality assets. *(ii)* During the crisis years, these countries added high shares of lower-quality assets to their national eligible asset pools and intensified the differences in quality structures to other Eurozone countries. *(iii)* Furthermore, the within-segment distribution of quality differs between the crisis and non-crisis countries. While the overall pool distribution already reveals that the majority of assets are distributed on lower than top rating notches of each segment and hence potentially profit from segmentally-pooled refinancing conditions, this potential is enlarged for crisis countries. In contrast to e.g. the German distribution, the distributions of crisis countries are downward-loaded, i.e. focused on relatively low rating notches.

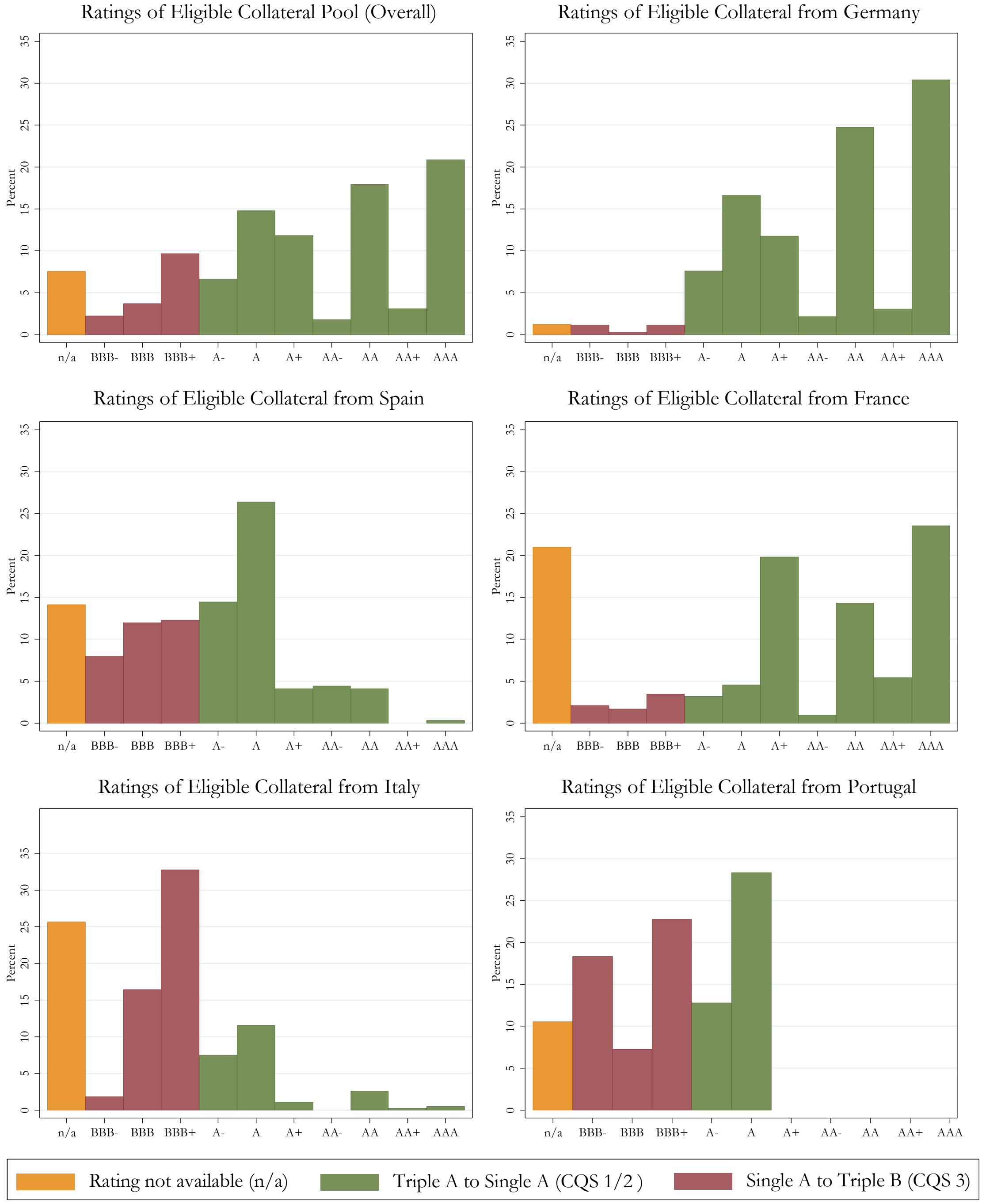
All this again points towards redistribution from non-crisis to crisis countries. The causes for this redistribution were already established before the outbreak of the financial crisis and the loosening collateral policy measures of the Eurosystem because the segmental pooling of all credit qualities within CQS 1/2 already existed. Nonetheless, it was boosted by the lowering of the minimum credit rating requirement in October 2008 and the addition of an even lower CQS 4 – which primarily

[360] Ratings were translated into the rating scale of S&P for the sake of simplicity.
[361] Assets are assigned to countries using the country code contained in the asset's ISIN.

applied to crisis countries – as well as the creation of ever-higher shares of lower-quality assets that were added to the national eligible asset pools in these countries.

Figure 8.8: Distribution of Eligible Marketable Assets within Credit Quality Steps

The figure shows how marketable asset qualities were distributed *within* credit quality segments (and CQSs) on March 6, 2015, for the overall Eurosystem eligible collateral pool (upper left panel) and for selected countries. The information is based on the number of assets per rating notch (depicted according to S&P rating scale), as nominal values were unavailable. The within-segment distribution differs across countries. It is loaded towards better qualities in the overall pool, Germany and France, but rather loaded towards lower qualities in Spain, Portugal and Italy. Segmentally-pooled refinancing conditions thus affect countries differently.



Source: author's calculation; ECB, Eligible Assets Database; Bloomberg.

8.6 Incentives for Freeriding

The analysis thus far has shown that the ECB implemented segmental pooling (cf. Section 4.5.7), which favors refinancing credit collateralized with lower-quality assets. Moreover, it has become clear that the home bias in banks' balance sheets and the differences in the quality structure of the national eligible collateral pools – which was laid out in Section 8.5.3 – make the redistributive effects of segmental pooling an issue of redistribution between member countries of the Eurozone. The described benefit from segmental pooling in a monetary union for the less productive country is the higher the more assets of different quality are pooled into equal refinancing conditions and the closer these pooled refinancing conditions are to the money market refinancing conditions for the more productive country.[362] Each member country thus has an incentive to have as many assets as possible owned by its banks within the highest possible segment. Within the Eurosystem, the NCBs are responsible for classifying eligible assets into the segments of refinancing conditions, i.e. to determine the applicable haircut. From the work of Brendel et al. (2015), it becomes apparent that interpretation scopes have been exhausted and at times exceeded in pursuit of the incentive to increase the positive effect of higher output on the national fiscal and economic stability, while imposing the associated negative effect of higher inflation on monetary stability on the monetary union as a whole.[363]

For example, in March 2015, the authors of the case study detected 99 bonds of three Spanish banks to the amount of EUR 726 million that have been listed as eligible by the Banco de Espana, although the minimum rating requirements were not fulfilled by these assets. In April 2015, the same issue occurred with two bonds valued at EUR 155 million.[364] In terms of the above model, the declaration of eligibility of these bonds by the Banco de Espana and the resulting applicability of the pooled refinancing conditions at the central bank lowered the marginal costs of refinancing associated investment projects in the Spanish real economy for the three Spanish banks and thus increased bank lending and output. While this positive effect on economic stability only favors the Spanish economy, the negative effect on monetary stability of the increased bank lending refinanced at the central bank is shared by the monetary union as a whole.

The above-described failure in eligibility decisions is the most severe outcome of the interpretation scope that the ECAF leaves in the determination process of the decisive credit rating applicable for a collateralizing asset, as it leads to eligibility where there should not be any. The peculiarities of the ECAF were elaborated in detail in Section 4.2.4.3. While the first-best rule and the pecking order per se favor the determination of a rather low haircut for any collateral, there can be additional room for interpretation in deciding whether an existing rating is applicable for a certain asset or – if not – whether one can move down along the pecking order to a better rating, which is then applied to achieve a lower haircut and thus lower refinancing costs at the central bank and ultimately the profitability of bank lending to lower marginal productivities of capital, leading to higher output for the national real economy. This becomes especially apparent when no unambiguous issue rating

[362] Note that in Figure 8.3 the pooled central bank refinancing conditions were set in between money market refinancing conditions for the two countries, while in Figure 8.4 they were set equal to the money market refinancing conditions for the more productive country, as the most extreme case of segmental pooling, but also the most favorable to country 1.

[363] A "competition of laxity" in quality regulation (Sinn, 1997), due to the limited liability of (quality-regulating) NCBs for the consequences, see Sinn (2003a,b, 2008).

[364] The bonds were later removed from the list of eligible assets after the authors informed the ECB about the issue.

exists for an asset. In case program ratings for a batch of assets from the same issue tranche exist, which could be applicable to the respective assets but would result in a filing into a lower segment of refinancing conditions as e.g. the application of a (better) issuer rating, the pledging bank has an interest in denying the applicability of the program rating such that the issuer rating becomes relevant. Additional complexity may apply due to the elective eligibility of long-term credit ratings (in addition to short-term credit ratings) for short residual maturities (cf. Section 4.2.4.3). The authors of the above-named case study identified bonds issued by the Italian bank Monte dei Paschi to the amount of EUR 19.92 billion that were not filed according to program ratings but according to the best issuer rating, because – as stated by the ECB – the existing program ratings were not applicable. In another case of Spanish *short-term* bank bonds, a *long-term* issuer rating was applied rather than the existing short-term issuer rating because it allowed better refinancing conditions at the central bank. The ECB itself admitted in its conversation with the authors: "Sometimes the rules, which overall are deemed appropriate, may lead to counterintuitive results," (Brendel et al., 2015, p. 46). One counterintuitive consequence of the ECAF is that an unrated asset may receive more favorable refinancing conditions than a rated one. The above-discussed model shows that this leads to the possibility of freeriding of less productive member countries in a monetary union.

8.7 Distribution Effects in the European Monetary Union[365]

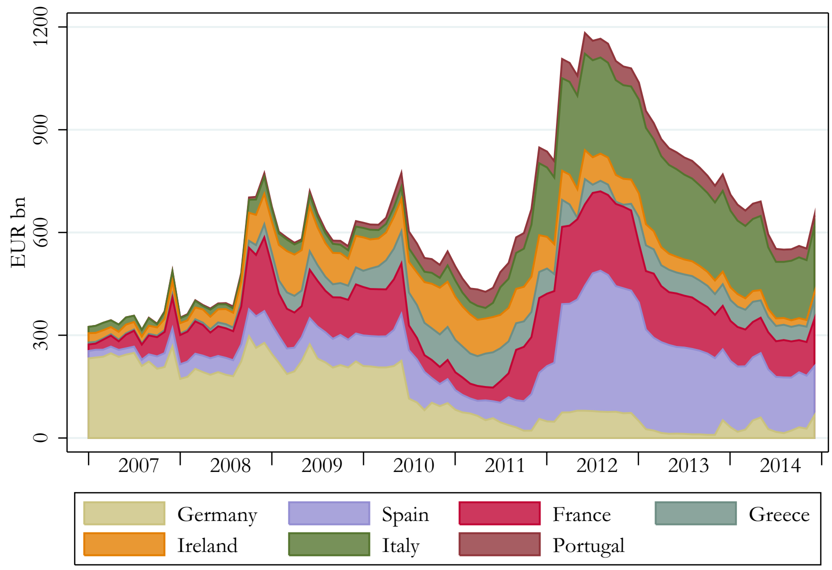
The goal of this section is to attempt a quantification of the redistributive effects that have been derived in the theoretical sections (cf. Sections 8.1 to 8.4) of this chapter and whose presence in the EMU has been suggested by the results of the descriptive analyses of the previous two sections (cf. Sections 8.5 and 8.6). The predicted outcome of the segmentally-pooled collateral policy of the Eurosystem is a stronger reliance of crisis countries on refinancing at the central bank, pledging assets types that particularly benefited from the looser collateral policy of the Eurosystem, such as bank assets or (lower-quality) government securities (cf. Chapter 4). Moreover, as segmental pooling especially favors the use of lower-quality collateral, the crisis countries are supposed to have used relatively more of this. On the other hand, non-crisis countries are likely to have reduced their refinancing from the central bank as their banks predominantly hold assets that are cheaper to use as collateral for money market refinancing.

As a first step, Figure 8.9 offers the development of refinancing credit drawn by banks in the selected Eurozone member countries from their respective NCB. The picture clearly shows that before the outbreak of the financial crisis most refinancing credit was granted into the largest Eurozone economy, Germany. With the beginning of the crisis in fall 2008, all other countries shown in the picture began to dramatically extend their reliance on central bank refinancing credit. As a result, the refinancing credit drawn from the Eurosystem into the depicted countries approximately doubled overall. Most of the credit during this first crisis period went to France and Ireland (apart from Germany). The next phase started in 2010 with the beginning of the European sovereign debt crisis. The refinancing credit of the Eurosystem almost completely shifted away from Germany towards the other depicted crisis countries: in addition to France, Italy and Spain drew most loans from the NCBs. Resulting from this were the TARGET balances within the Eurosystem, which

[365] This section bases on joint work with Jakob Eberl (Eberl and Weber, 2015), which has also been used in his dissertation (Eberl, 2016).

Figure 8.9: Eurosystem Refinancing Loans by Selected Countries

The figure shows the development of refinancing credit drawn by banks in the selected Eurozone member countries from their respective NCB. The picture clearly shows that before the outbreak of the financial crisis most refinancing credit was granted into the largest Eurozone economy, Germany. With the beginning of the crisis in fall 2008, all other countries shown in the picture began to dramatically extend their reliance on central bank refinancing credit. The picture indicates the attractiveness of public refinancing in the respective countries.



Source: author's illustration; NCBs.

consequently represent a measure for the redistribution within the EMU in terms of the model presented in this chapter.[366][367]

With the help of the data on refinancing drawn, the scarce publicly-available data on the collateral pledged at the Eurosystem (cf. Figure 4.21) can be enriched, adding a geographical distribution and increasing the frequency from yearly to monthly data. The result is shown in the left panel of Figure 8.10, which shows the inferred use of collateral for refinancing credit from the Eurosystem by country. While the geographical development is analogous to that described for Figure 8.9, it becomes apparent that peaks in the pledging of collateral stand out, which have not been visible in the yearly published data (cf. Figure 4.21).

The right panel of Figure 8.10 adds information on the likely quality composition of the collateralization of the refinancing credit granted by the Eurosystem from the quality structure of the eligible asset pool, which was deduced as described in Section 4.6.2. The panel thus offers a more sophisticated estimate of the quality structure of collateral pledged to the Eurosystem than a pure

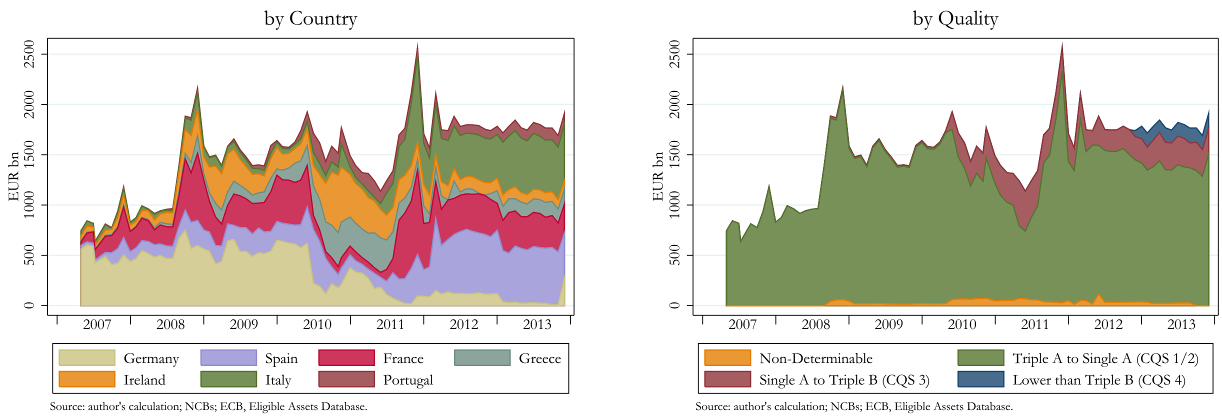
366 TARGET is an acronym for the Trans-European Automated Real-time Gross Settlement Express Transfer System operated within the Eurosystem. Piling up TARGET balances have first been pointed to by Sinn, H.-W., "Deutschland Drohen Neue Belastungen," *Wirtschaftswoche*, 21 February 2011, `http://www.wiwo.de/politik/ausland/denkfabrik-deutschland-drohen-neue-belastungen/5245288.html`, see also Sinn (2011). The importance has later been discussed in detail, as well as redistributive effects revealed by Sinn (2012b, 2014a) and Sinn and Wollmershäuser (2012). On the topic, see also Cour-Thimann (2013), Potrafke and Reischmann (2014), and Sinn (2012c) as well as the overview given at CESifo, *Ifo Policy Issue: Target Balances*, `https://www.cesifo-group.de/ifoHome/policy/Spezialthemen/Policy-Issues-Archive/Target.html`, last accessed 22 April 2016.

367 Moreover, as Reis (2013) ascertains, the Eurosystem could do nothing to stop the shifting towards crisis-stricken member countries.

application of the quality distribution inferred for the eligible asset pool (cf. right panel of Figure 4.16) to the conjecture on the quality distribution of pledged collateral because it factors in different quality structures of national collateral pools and the uneven geographical distribution of the drawn refinancing credit. Overall, the quality of the collateralization is likely to have significantly deteriorated towards lower-quality collateral from CQSs 3 and 4 over crisis times. However, while the financial crisis period has not seen much lower collateral qualities pledged, most of the deterioration took place during the European debt crisis period, with only 78.9% of pledged collateral inferred as being rated within CQS 1/2 at the end of 2013.

Figure 8.10: Inferred Use of Collateral for Central Bank Refinancing Credit

The figure shows the inferred pledged collateral by country (left panel) and by quality (right panel). The left panel combines information from Figure 8.9 on the monthly movements and the geographical distribution of refinancing credit drawn with information from Figure 4.21 on the amount of pledged collateral and thus provides a more detailed and richer estimate of collateral use at the Eurosystem. The right panel adds information on the likely quality composition of the used collateral, taking both the induced quality structure of the eligible collateral pool and the national differences into account.



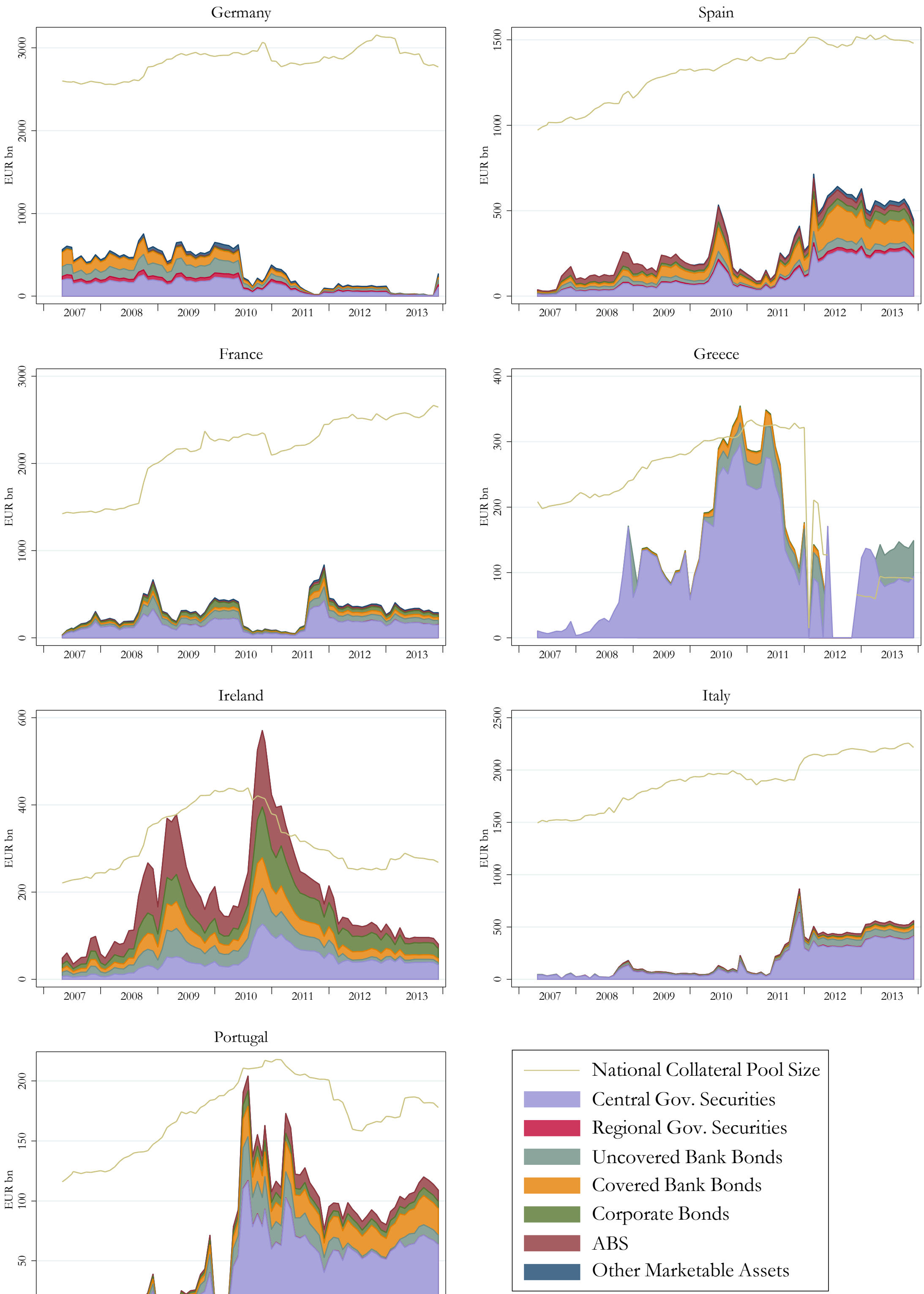
Figures 8.11 and 8.12 detail the development of the refinancing credits drawn from the Eurosystem – which are indicative for the redistribution – by offering the inferred national compositions with respect to asset type and quality, as well as a comparative perspective versus the national eligible collateral pool sizes. The inference is achieved through a combination of the individual national asset type composition of the eligible collateral pool (cf. Figure 8.6), as well as the (as described in Section 4.6.2 derived) relevant quality structure, respectively (cf. Figure 8.7), with the estimated use of collateral pledged for refinancing credit drawn from the respective NCB (cf. left panel of Figure 8.10).

The inferred use of collateral for Germany estimates that the reliance on central and regional government bonds as well as bank bonds almost drained with the beginning of the euro crisis and collateral used was exclusively of higher quality. At all times, the pledged collateral is far below the national eligible collateral pool: in other words, the "potential".[368] This is similar for France, although the use of collateral there spiked after the onset of the financial crisis and as the euro crisis intensified in 2011. In both France and Italy, the spike in December 2011 coincided with the first of three LTRO of three-year maturity ("big bazooka"). Predominantly central government bonds were used as collateral in France and the quality of the pledged collateral deteriorated – unlike in

[368] The lines mark the size of the haircut-adjusted values of the national collateral pools and hence the collateral values potentially pledgable at the Eurosystem.

Figure 8.11: Inferred National Use of Central Bank Refinancing Credit by Asset Type

The figure shows the inferred national use of collateral by asset type and contrasts it to the national collateral pool size. The estimated composition of assets differs, whereby government securities take a dominant role in some but not all depicted countries. Some crisis countries used large amounts of central bank refinancing relative to their national collateral pools, while Germany and France only pledged a small fraction of the "national potential".



Source: author's calculation;
ECB, Eligible Assets Database.

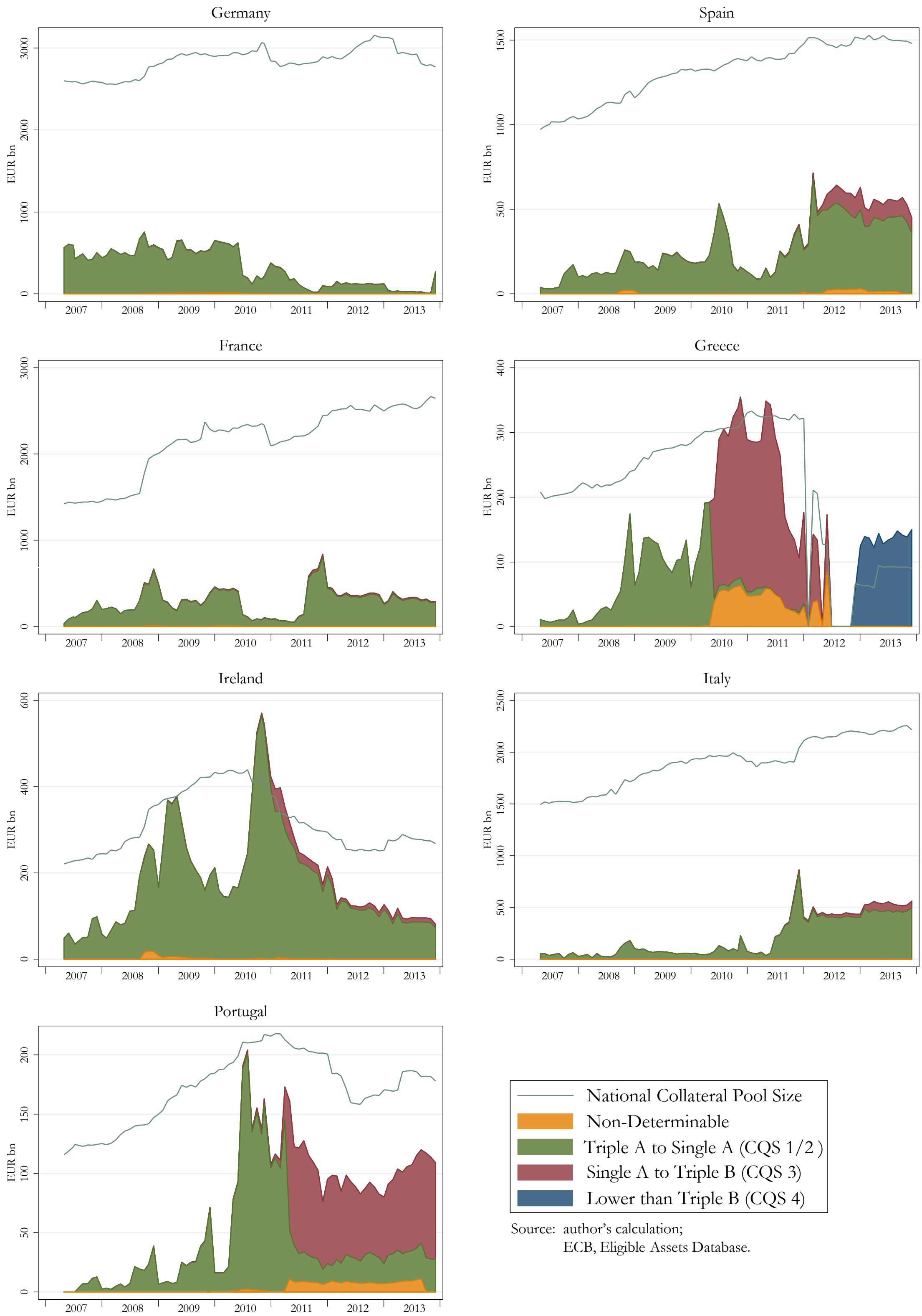
Germany – albeit only very slightly. Nonetheless, it can be clearly stated that the level of collateral used after the crises onsets is higher than before in France, as with all countries besides Germany. Spain and Italy are in between France and the heavily crisis-stricken countries in the sense that they used a considerably higher amount relative to their pledgable collateral potential (around one-third in Spain) during the crisis years but were far from reaching the national collateral pool size. Spain used particularly many and Italy particularly few non-government securities. Especially in Spain, the deterioration in the quality of pledged collateral is clearly visible in the figure. Greece, Ireland and Portugal made extensive use of central bank refinancing. During the high time of the euro crisis in 2010 and 2011 (for Ireland also already in 2008/2009), the refinancing credit drawn by all three countries reached levels comparable to the national collateral pool sizes and even exceeded them in the case of Ireland and Greece. Of course, the stacked areas and the lines of Figures 8.11 and 8.12 are only put into one graph to gain an impression of the relative size of the collateral used versus the national pool, such that an overshooting of the stacked areas beyond the line is unsurprising for two reasons. First, it is possible to collateralize refinancing credit with non-marketable assets while the national eligible collateral pool sizes given here are calculated from the Eligible Assets Database, which only contains marketable assets. The growing importance of non-marketable assets as collateral has been emphasized in Figure 4.21. Parts of the overshooting thus can be attributed to the use of these non-marketable assets in Greece and Ireland. Second, of course it is allowed for banks to pledge assets that have not been issued in the home country. This cross-country pledging (as well as the use of international assets from non-EMU countries) is the second explanation for the overshooting of the actually-used collateral beyond the national pool size. Nevertheless, this observation is remarkable as it clarifies the enormousness of the public refinancing credit drawn from the NCB in these three crisis countries.

While Greece, Ireland and Portugal are comparable in terms of the sizes of the refinancing drawn relative to the national pool size, the asset type compositions and the quality structures differ. One observation is that the quality deteriorated completely in Greece or to a large extent in Portugal but hardly in Ireland. Combining it with another observation – namely that Greece almost exclusively used government securities (and later some government-guaranteed bank bonds), while Portugal used to around one-third private securities like bank bonds, ABS and some corporate bonds but Ireland used many more of the latter and in turn only a small fraction of government bonds – yields an argument in line with the predictions from the previous sections: the assets that were identified as marking a difference between the national eligible asset pool compositions of non-crisis and crisis countries and were also particularly favored by the loosening collateral policies of the Eurosystem are lower-quality government securities and bank bonds. Apparently Ireland used predominantly the latter while Greece used predominantly the first-named.[369] Each crisis country benefited from the Eurosystem collateral policy, albeit differently, in the sense that different asset type-quality combinations carried the subsidized refinancing conditions explaining the recourse to central bank refinancing credit.

[369] This observation is likely connected to the characteristics of the crises developments in Greece and Ireland. A detailed description of these is e.g. given in Sinn (2012b, Ch. 4) and Sinn (2015b), respectively.

Figure 8.12: Inferred National Use of Central Bank Refinancing Credit by Quality

The figure is analogous to Figure 8.11, showing the estimated quality distribution rather than asset type composition. Particularly in Portugal and Greece, the collateral used is estimated to be of overwhelmingly lower quality. Significant fractions of lower-quality assets are also likely to have mixed with the pledged collateral in Spain, Ireland and Italy throughout the European debt crisis.



Source: author's calculation;
ECB, Eligible Assets Database.

Chapter 9

Collateral Policy and Market Impact: Lessons from the Eurosystem Collateral Pool[370]

In the beginning of Part III of this dissertation, collateral policy has been integrated as a central bank policy instrument into the central bank decision-making and its policy choice, whereby the transmission process and the opportunities of collateral policy have been presented in this context (Chapter 6). Thus, the way in which impact is achieved was exposed. Consecutively, it was theoretically argued and empirically substantiated that the impact of collateral policy is likely to bring quality effects (Chapter 7) and distribution effects (Chapter 8). The goal of this chapter is to finally reveal traces of the collateral policy measures in asset markets and thus present evidence of this impact, which subsequently unleashes the described effects. The analysis is based on the available data from the Eligible Assets Database, i.e. the Eurosystem Collateral Pool. Whenever it is possible to discover such traces, this would also facilitate the classification of a collateral policy measure as a MMOLR or a LOLR measure in the sense contrasted in Table 2.2. The reason is that any affection of market behavior due to such a measure discloses its pivotal character in terms of below (normal) market operational conditions. This is an important distinguishing criterion of market-making along the value-level dimension of the collateral policy configuration, as described in Chapter 2.

As a first step, in Section 9.1 the collateral policy measures of sizable impact on the Eurosystem Collateral Pool are identified: first, the October 2008 package, most prominently containing the lowering of the minimum credit rating threshold and the eligibility of bank bonds traded on the STEP market; second, the November 2008 package, most prominently containing foreign currency-denominated assets; third, policy measures affecting government-guaranteed assets; and fourth, policy measures referring to ABS stand out. These policy measures can also be expected to have the most distinguishable influence on the behavior of asset markets. Consecutively, three impact-identifying criteria are presented in detail in Section 9.2, along which the policy measures can

[370] This chapter bases on joint work with Jakob Eberl (Eberl and Weber, 2015), which has also been used in his dissertation (Eberl, 2016).

be evaluated, comprising: *(i)* the structure of affected assets and markets, which reveals targeted market segments and market participants; *(ii)* movements in market prices and bid-ask spreads, which identify calming or subsidizing effects of a market intervention; and *(iii)* a changing issuance behavior, which market participants show as a reaction to policy measures.

Within Section 9.3, the analysis of *(i)* the structure of affected assets and markets is divided into a geographical and an economy sector dimension and additionally distinguishes between the periods of financial crisis and European debt crisis, yielding the following results. While all Eurozone countries – but in particular France and Germany – were affected in the earlier crisis years, this shifted towards the crisis-stricken countries later on. Of the latter, Greece, Portugal, Spain and Italy also particularly profited from the qualitative broadening of the eligible collateral pool on the vertical dimension during the European debt crisis phase. In the course of this, the profiting from the qualitative broadening happened in two ways, through newly-eligibly assets of lower qualities and due to downgradings of already-eligible assets. Economy sectors profiting from newly-eligible assets of lower qualities were corporate bonds during the financial crisis, as well as bank bonds and government bonds from the crisis countries during the European debt crisis. The downgrading benefited government sectors in Greece and Portugal and non-government sectors in Spain and Italy. In the early crisis times, the banking sector can be identified as primarily being targeted by quantitatively-broadening measures. Furthermore, the November 2008 package is a classical LOLR measure with a broad focus on all asset types and economy sectors. For ABS, the tightening period more strongly mirrors in the eligible asset pool rather than the loosening period that followed.

Collateral policy measures are evaluated along the second impact-identifying criterion of *(ii)* market prices and bid-ask spreads within Section 9.4. Bid and ask prices of eligible assets are added to the dataset for this purpose. As a general impression resulting from the analyses of prices and spreads around the eligibility event for each newly-eligible asset, a higher price level after rather than before eligibility and a lower bid-ask spread prevail. The market impact suggested from this is strongly driven by crisis countries, in particular Greece and to lesser degrees Italy and Portugal. For less crisis-stricken countries, asset eligibility affects market valuations to lesser degrees (or not at all) such that the central bank conditions have likely not been pivotal there. It can thus be concluded that the collateral policy showed the most impact in the countries and economy sectors that it targeted most. Greek government bond prices are particularly illustrative. Moreover, an alignment of the bid-ask spreads of high- and low-quality assets after eligibility is remarkable, suggesting a disappearing importance of credit quality from a market perspective after assets made it into the eligible pool. In addition to low-quality and crisis country assets, the movements of prices and spreads for uncovered bank bonds indicate a market impact of central bank eligibility.

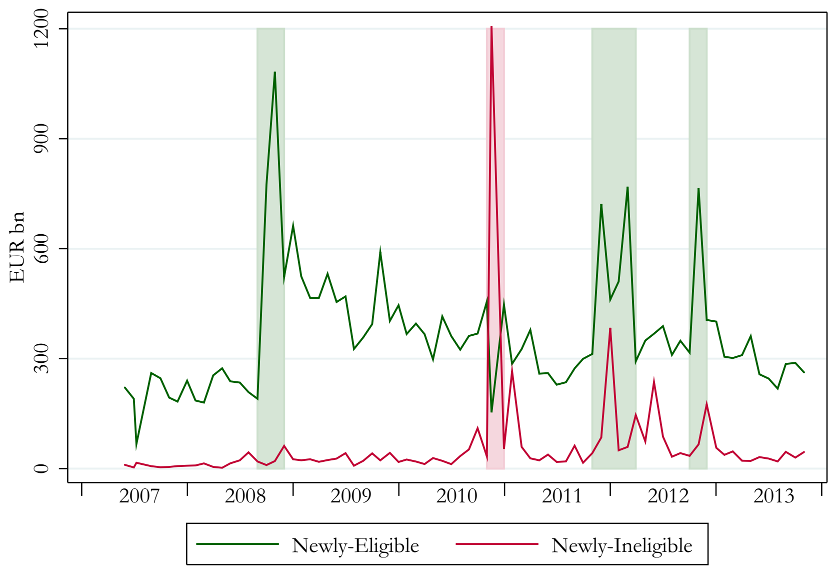
Finally, three elements of *(iii)* changing issuance behavior are identified within Section 9.5. First, an increased pre-eligibility issuance behavior is apparent for CQS 3 assets but not for foreign currency assets, such that the market is affected by the qualitatively-lowering but not the quantitatively-broadening measure. Second, the issuance of government guarantees changed its pattern between the financial crisis and the European debt crisis. While both periods mark peaks of government guarantee provision, these were rather granted to already-eligible assets during the first and newly-eligible assets during the second period. It is argued that not least due to the allowance of own-use government-guaranteed assets, the Eurosystem thus seems to have incentivized a shifting from a market behavior rather supporting the financial stability objective to a market behavior more strongly fostering fiscal and economic stability. A geographical change towards governments from crisis countries primarily providing guarantees is accompanied. Third, a striving for access to central bank refinancing is identifiably in crisis countries during the European debt crisis, while an opposite course prevails in Germany and France. Both the number of eligible issuers and the reliance of each individual issuer on central bank-eligible collateral increased. A specific view on the banking sector confirms that increasing shares of banks' balance sheets became central bank-eligible over the European debt crisis period.

9.1 Movements into and out of the Eligible Collateral Pool

The collateral policy measures of the Eurosystem described in Chapter 4 led to large movements into – and at times also out of – the eligible collateral pool. Figure 9.1 shows the aggregate nominal value of assets becoming newly eligible and ineligible per month over the period from May 2005 to December 2013. It is apparent that overall many more assets joined rather than left the eligible assets pool, as the green line rests above the red line most of the time, corresponding to the broadening of the eligible assets pool (see also Section 4.6). Loosening collateral policy measures implemented in the aftermath of the financial crisis breakout are mirrored in almost exclusive additions to the pool until mid-2010. The figure helps to identify points of time in which a particularly strong impact on asset markets was exerted by the Eurosystem, as several spikes are visible from the plot.

Figure 9.1: Newly-Eligible and Newly-Ineligible Marketable Assets

The figure shows the aggregated nominal values of newly-eligible and newly-ineligible assets per month during the period from May 2007 to December 2013. Ineligibility due to maturity has been controlled for. The overall broadening of the eligible collateral pool mirrors in the course of the green line above the red line. Spikes stand out and can be traced to loosening or tightening collateral policy measures conducted by the Eurosystem. They also mark the most important – i.e. sizeable – moments of impact on the asset markets.



Source: author's calculation; ECB, Eligible Assets Database.

The first spike of the newly-eligible asset line marks the October 2008 package, most prominently including the lowering of the minimum credit rating threshold to Triple B for all eligible asset types except ABS, as well as the acceptance of bank bonds traded in the STEP market. It is closely followed by the declaration of eligibility of foreign currency-denominated assets in November 2008. The latter two asset groups also contribute to the sharp spike of newly-ineligible assets in December 2010, as both bank bonds traded in the STEP market and foreign currency denominations were ineligible throughout 2011, although their eligibility was renewed in January 2012 and November 2012, respectively. Both renewed eligibilities lead to spikes of the newly-eligible line once again. However, the spike lasting from December 2011 to March 2012 has an additional cause, as two LTROs of three-year maturities were offered by the Eurosystem in December 2011 and March 2012 (at that time called “big bazooka”). Many assets became eligible with the help of government guarantees at that time, although the pledge of own-use government-guaranteed debt instruments had already been permitted since February 2009. The spikes of the newly-ineligible line throughout 2012 can largely be attributed to changes of the collateral criteria applicable to bonds issued or guaranteed by the Greek government, such as the withdrawal of the suspension of the minimum credit rating threshold for these bonds in February and July 2012. The tightening measures to ABS are not quite visible from the movements of the newly-ineligible line, because these measures occurred step-wise, implied transitional periods for legacy ABS and ABS constituted only a relatively small fraction of the eligible asset pool in terms of nominal value. Hence, ABS were gradually faded out from the eligible asset pools until December 2011, when the period of loosening of collateral criteria for ABS began (cf. Section 4.3.5).

The identified policy measures of sizable impact visible in the pool can also be expected to have the most distinguishable influence on the behavior of asset markets. Therefore, traces of these changes of the collateral criteria in the asset markets shall be searched in the following along three impact-identifying criteria.

9.2 Impact-Identifying Criteria

Throughout this chapter, market impact shall be analyzed along three identifying criteria: *(i)* the structure of affected assets, *(ii)* their market prices and bid-ask spreads between supply and demand and *(iii)* changes in the market behavior, broadly subsumed as issuance behavior.

Ad *(i)*. The structure of affected assets according to their types, country of issuance and credit quality identifies market segments and market participants targeted by the respective policy measures. Recall from Chapter 2, that a broad collateral framework affecting all asset markets evenly is characteristic of a sustained financial stability objective, while selective targeting of market segments and asset types – especially those related to real economic or fiscal activities – can be attributed to a pursuit of the fiscal and economic stability objective. Models presented in Chapters 6, 7 and 8 show how collateral policy favoring some assets more than others makes asymmetric central bank policy possible. However, it also leads to distributive effects between the different market segments.

Ad *(ii)*. The impact of collateral policy on prices is a result of the so-called “eligibility premium”, which is described e.g. by Bindseil and Papadia (2006) or Bank for International Settlements (2015). The certainty of being able to pledge an asset at the central bank to obtain fresh liquidity drives up demand for this asset, making it ceteris paribus more expensive and thus affecting its price.[371] As a result, the trading of eligible collateral is easier and markets become more liquid. Thus, the spread between prices bid and asked by demanding and supplying market participants reduces. At the same time, already-eligible collateral becomes relatively cheaper to some degree, as its scarcity is lessened. Bindseil and Papadia (2006, p. 23) declare the eligibility premium in normal times as relatively small, "in the order of magnitude of a few basis points only."[372] However, e.g. Bartolini et al. (2011) quantify the premium at at least five basis points. In Bank for International Settlements (2015), several pieces of evidence are summarized, including the case of the Bank of Australia's quantitative broadening by adding additional government debt instruments to the eligible collateral pool, where a reduction of the spread of 15 basis points was measured. Bank for International Settlements (2015) also emphasizes the importance of the relative size of affected assets to the overall affected asset market. For example, the declaration of eligibility of foreign currency collateral usually has a negligible effect.

Ad *(iii)*. Finally, market impact can be observed in changing market behavior as a reaction to a collateral policy measure. In particular, the issuance behavior of assets may change.[373] If an asset type is made eligible or its pledge relatively more attractive, markets will try to issue more of this asset to profit from the central bank refinancing option provided and vice versa if eligibility criteria for an asset type are tightened. The intensification of producing the respective asset type can imply more loan-making to the respective market segment backing the asset, e.g. in case of ABS. However, it can also trigger a shifting securitization behavior from one asset type to another. According to Bindseil and Papadia (2006), the first-named behavior is only worthwhile if the eligibility premium is sufficiently large, while the second is independent of the size of this premium.

Spikes in Figure 9.1 mark effects on already-issued assets and hence the market impact connected to these specific assets becoming eligible in the respective month can be best discussed along the identifying criteria *(i)* structure and *(ii)* prices. A change in *(iii)* issuance behavior can only be applicable to these assets if the collateral policy measure had been announced or expected. Subsequently, more of the affected assets would have been issued closer prior to the introduction of the policy measure. However, any issuance behavior after the spike months can only be identified (and is expected) for similar assets.

9.3 Structure of Affected Assets and Markets

Information on the structure of newly-eligible assets is added in Figure 9.2. The monthly flows of assets into the eligible collateral pool are decomposed with respect to the country of issuance (left panel) and the asset type (right panel). Thus, the area underneath the green line in Figure 9.1 is illuminated. What stands out across the entire period depicted in the figure is a substantial amount of newly-eligible collateral from France and unnamed "Others", comprising other Eurozone countries as well as particularly the UK and the US, which are the issuance countries of most foreign currency-denominated assets deemed eligible by the Eurosystem. Furthermore, a significant

[371] Of course, the operational conditions – most importantly haircuts – also play a role in this respect. Tight conditions should have the tendency to reduce the eligibility premium.
[372] See also Bindseil and Papadia (2009).
[373] See also Bindseil et al. (2009b) and Bindseil and Papadia (2006).

fraction of newly-eligible collateral comes from Italy, especially around the turn of 2011/2012, i.e. during the "big bazooka" period (more details below). Moreover, it is evident that much of the newly-eligible collateral originates in Germany. Nevertheless, the German amount among the newly-eligible collateral is only slightly higher or even comparable to the pre-crisis levels, while the amounts and shares of all crisis-afflicted Eurozone countries increased much more strongly. The right panel shows that within the asset type classification, most of the amount of newly-eligible collateral falls upon uncovered bank bonds and government securities, to a lesser degree also upon covered bank bonds. Other marketable assets play a significant role occasionally.[374]

Figure 9.2: Newly-Eligible Marketable Assets by Country and by Asset Type

The figure adds information on the structure of newly-eligible assets with respect to country and asset type, i.e. detailing the area below the green line in Figure 9.1. Although newly-eligible collateral was spread across countries, a substantial fraction was issued in France. The right panel confirms that predominantly government securities and uncovered bank bonds became newly eligible.

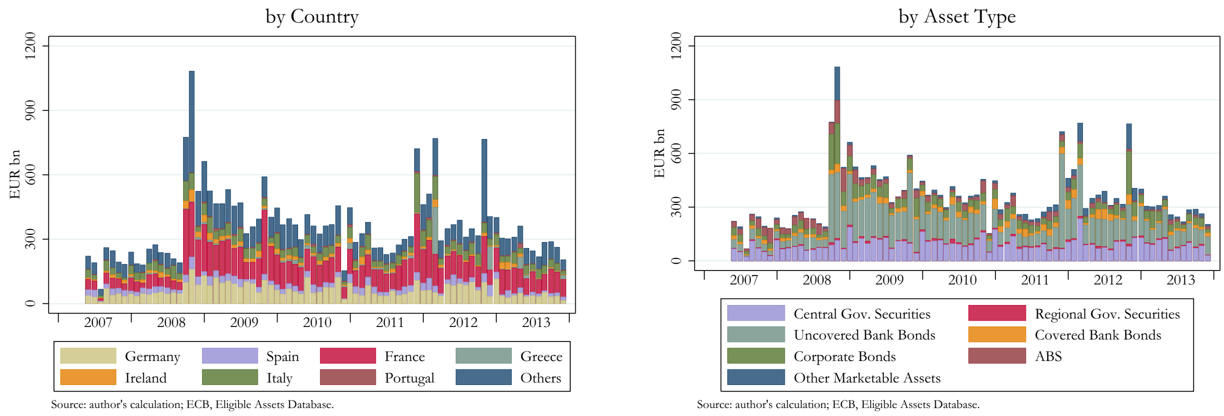


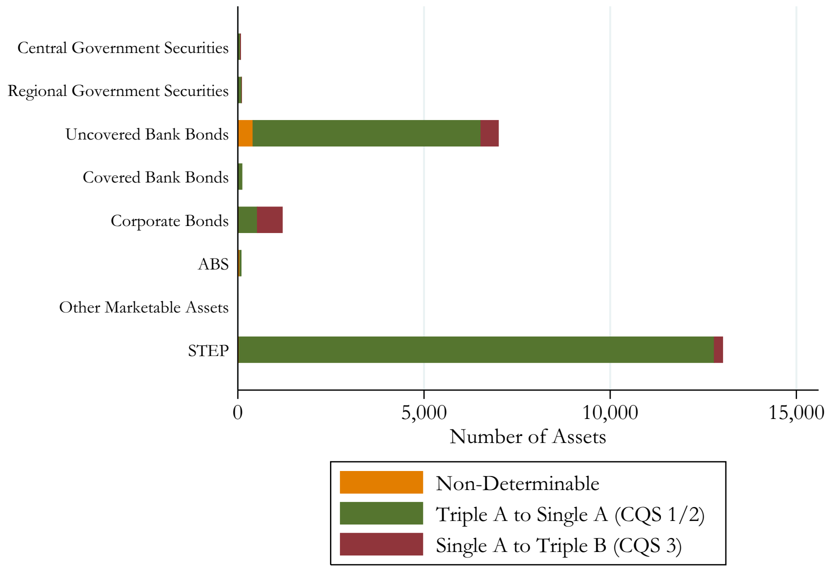
Figure 9.3 places a particular focus on the structure of the October 2008 package, which massively broadened the Eurosystem eligible collateral pool and marks the most pronounced spike of the green line in Figure 9.1. Additionally, the number of newly-eligible assets is stated rather than the nominal value, such that the affected asset types are shown notwithstanding the extent of their affection. It is confirmed that almost all newly-eligible assets were issued by banks and more precisely the overwhelming majority were traded on non-regulated markets. The reason is that newly-eligible bank bonds of qualities within CQS 1/2 were only newly eligible in October 2008 due to the introduced acceptance of bank bonds traded on non-regulated markets. The importance of the STEP market within these non-regulated markets is illustrated by showing respective assets in a separate bar. To sum up the message from Figure 9.3, almost all assets becoming newly eligible were uncovered bank bonds traded on non-regulated markets, typically on the STEP market. The collateral broadening was hence targeted at the banking sector. The qualitative broadening through the lowering of the minimum credit rating threshold only affected a small fraction of

374 Other marketable assets comprise assets from 41 public or semi-public agencies and institutions, inter alia (in the order of magnitude in each group) assets issued by supranational and national development banks such as the European Investment Bank, the German Kreditanstalt für Wiederaufbau, the NRW.Bank and the Landeskreditbank Baden-Württemberg (Förderbank), the International Bank for Reconstruction and Development (World Bank), the European Bank for Reconstruction and Development, the Inter-American Development Bank, as well as European institutions such as the European Investment Bank, the European Financial Stability Facility or the European Economic Community and national institutions as the French Caisse d'amortissement de la dette sociale, the German FMS Wertmanagement, the Spanish Instituto de Crédito Oficial or Freddie Mac from the US.

the newly-eligible assets. However, the corporate bond market particularly benefited from the measure, whereby more than half of the newly-eligible corporate bonds were of lower qualities. The collateral policy package thus also benefited financing for corporates of lower credit quality through the corporate bond market.

Figure 9.3: Asset Types and Quality of Newly-Eligible Assets in October 2008

The figure shows the number of newly-eligible assets in October 2008 according to asset type and credit quality. The broadening package benefited the banking sector since almost all newly-eligible assets were uncovered bank bonds traded in non-regulated markets, in particular the STEP market, which is depicted separately. The impact of the lowering of the minimum credit rating threshold was of subordinate importance, although corporate issuers of lower-quality bonds profited over-proportionately.



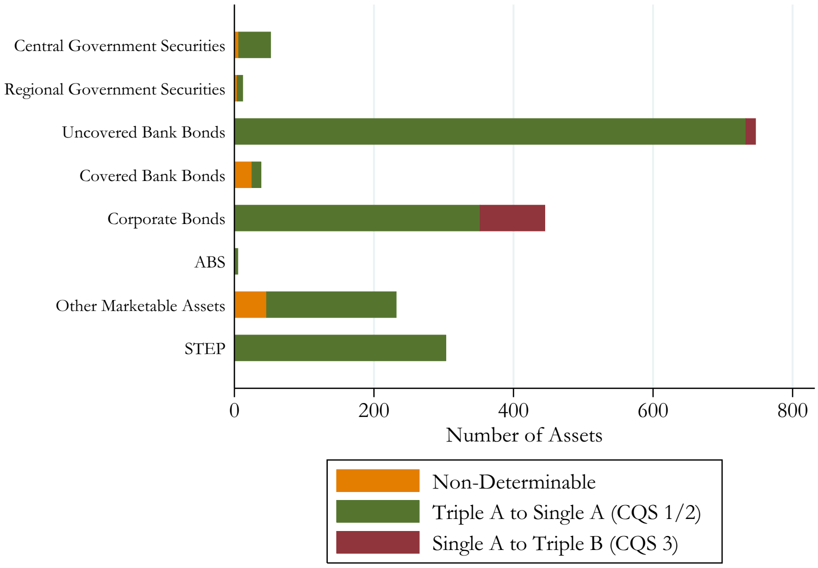
Source: author's calculation; ECB, Eligible Assets Database.

The distribution among asset types of assets newly-eligible in November 2008 strongly differs owing to the eligibility of foreign currency denominations, cf. Figure 9.4. The picture shows a classical LOLR measure: newly-eligible assets are of all types, distributed similar to the overall pool distribution, not targeted to a specific market segment and not different in quality from already-eligible assets. Additional risk for the central bank arises as exchange rate risk (cf. Proposition 4.7), although it has been addressed in the presented case by an add-on haircut (see Section 4.5.6).

ABS were strongly affected by the Eurosystem's collateral policy measures, as described in Section 4.3.5. However, collateral policy on ABS differed from the general collateral policy stance. Therefore, Figure 9.5 exclusively shows the development of ABS within the eligible collateral pool. Immediately after the financial crisis broke out, collateral criteria for ABS were tightened in contrast to the overall collateral policy stance. While transitional periods – fading out eligibility of ABS rather than cutting ABS not complying with the criteria from the pool sharply on the date of effectiveness of the regulation – make it difficult to connect the development of newly-ineligible ABS to collateral policy decisions, a change in newly-eligible ABS is clearly identifiably from March 2009 onwards, when the minimum rating requirement for ABS was increased to Triple A at issuance. Almost no ABS joined the eligible assets pool from then onwards and peaks in the number of newly-ineligible ABS dominate, leading to a decrease in the fraction of ABS within the pool. The

Figure 9.4: Asset Types and Quality of Newly-Eligible Assets Denominated in Foreign Currency in November 2008

The figure shows the number of newly-eligible assets in October 2008 according to asset type and credit quality. The collateral policy measure is exemplifying for a classical LOLR measure, as the eligible assets pool is broadened across all asset types without targeting a specific market segment or further lowering the quality level.



Source: author's calculation; ECB, Eligible Assets Database.

peaks in the yellow lines are not clearly connected to policy changes but might rather reflect downgradings of credit ratings.[375] The loosened collateral policy on ABS from December 2011 onwards does not find a visible reaction in terms of increased numbers of newly-eligible ABS. The tightening collateral policy on ABS thus affects the structure of the eligible assets pool much more strongly than the loosening of criteria later on.

In order to identify Eurozone member countries whose economies particularly profited from the qualitative broadening of the eligible assets pool, a series of figures provides information on the quality of assets distinguished by issuer countries. The left panel of Figure 9.6 colors the flow of newly-eligible assets of quality levels within CQS 1/2 according to the issuer country. The right panel of the figure does the same for lower-quality assets. In the left panel, all eligible issuer countries are represented, whereby in particular visible shares fall upon Germany and other (Eurozone and G10) countries. The French share is large, as in the left panel of Figure 9.2. Newly-eligible assets of lower qualities were issued in all countries in October 2008, the month of the introduction of their eligibility. Subsequently, during the period until mid-2010 – marking the intensification of the European sovereign debt crisis – French issuers and issuers from other (Eurozone and G10) countries profited from the lower quality requirement. Since mid-2010, more lower-quality collateral joined the pool, with large shares coming from Greece, as well as France, Spain, Italy, Ireland and Portugal, i.e. all countries relatively strongly troubled by the European sovereign debt crisis. The Eurosystem collateral policy measure of qualitative loosening hence benefited issuers and thus markets in these countries more than e.g. in Germany.

375 E.g. in February 2012, a large amount of ABS issued by Spanish and Italian mortgage-structuring funds became ineligible.

Figure 9.5: Development of the Number of Asset-Backed Securities in the Eligible Assets Pool

The figure shows how the fraction of ABS within the eligible assets pool developed over time. ABS were strongly affected by the Eurosystem's collateral policy measures, as described in Section 4.3.5. However, collateral policy on ABS differed from the general collateral policy stance. The tightening policy on collateral criteria for ABS leaves much more traces in the figure than the loosening from November 2011 onwards.

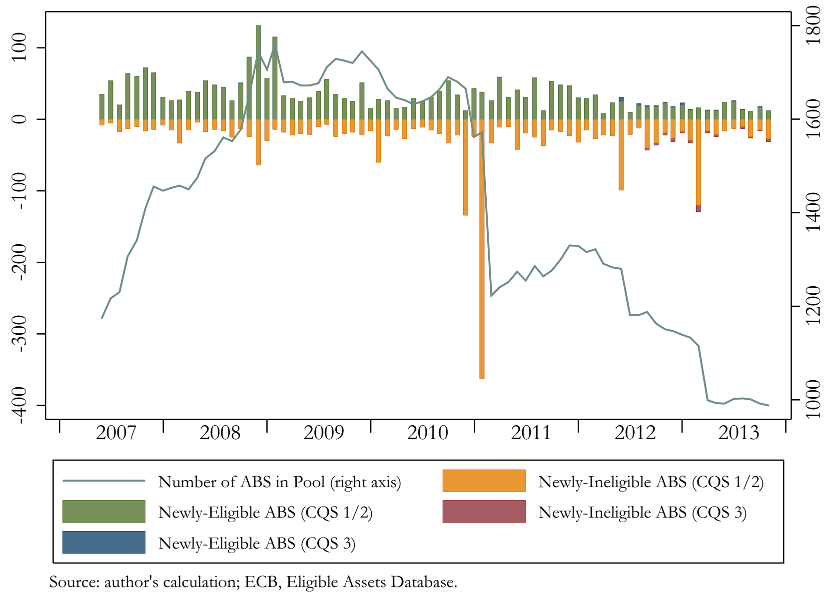
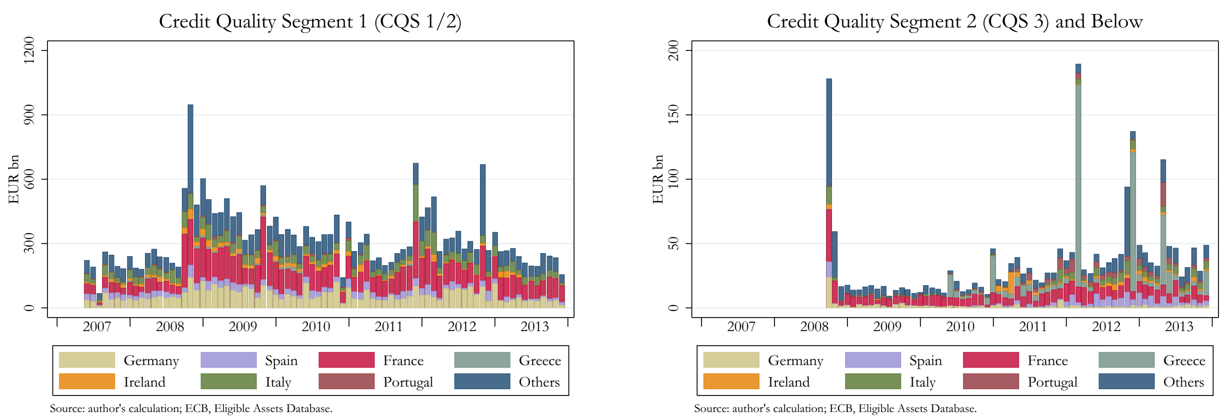


Figure 9.6: Newly-Eligible Marketable Assets by Country and Credit Quality Segment

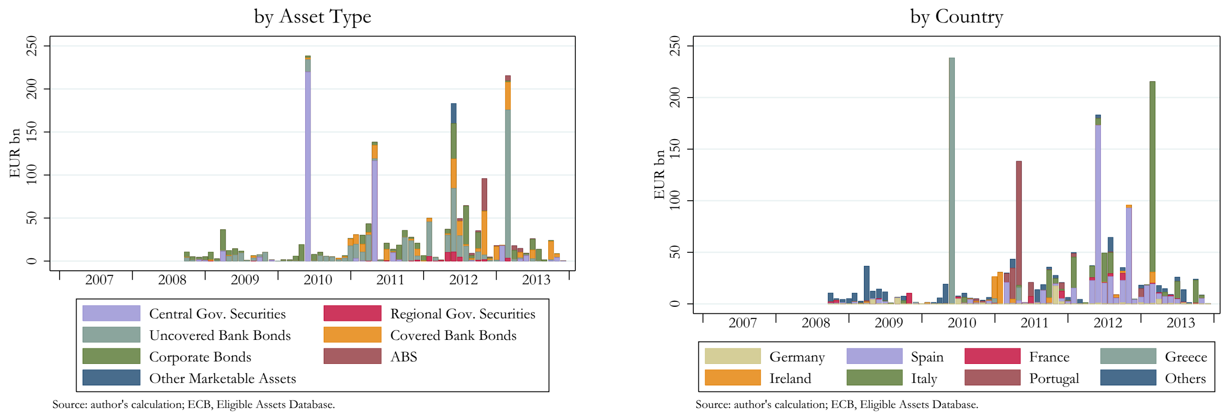
The figure shows how issuers of new assets profited from the lower credit quality requirement over the period from May 2007 to December 2013 by country. In the left panel, high qualities (CQS 1/2) are shown, while in the right panel lower qualities are depicted. Crisis-afflicted countries issued a substantial share of lower-quality assets, profiting from the eligibility of those compared to e.g. Germany.



Not only newly-eligible assets profited from the qualitatively loosened eligibility criteria, but also those that were downgraded from CQS 1/2 into CQS 3. Figure 9.7 provides an overview over time. The right panel shows that up to the intensification of the European sovereign debt crisis in 2010, mostly assets from Eurozone members other than the depicted or G10 countries were downgraded. However, from 2010 onwards, assets issued in crisis countries profited to a great extent, in particular

Figure 9.7: Downgradings into Lower Credit Quality Segment

The figure shows the amount of collateral monthly downgraded from CQS 1/2 into CQS 3, colored according to asset type (left panel) and country (right panel). Most prominently resulting from a view on both panels are the downgradings of Greek and Portuguese government securities, as well as Spanish and Italian non-government assets during the European sovereign debt crisis phase.



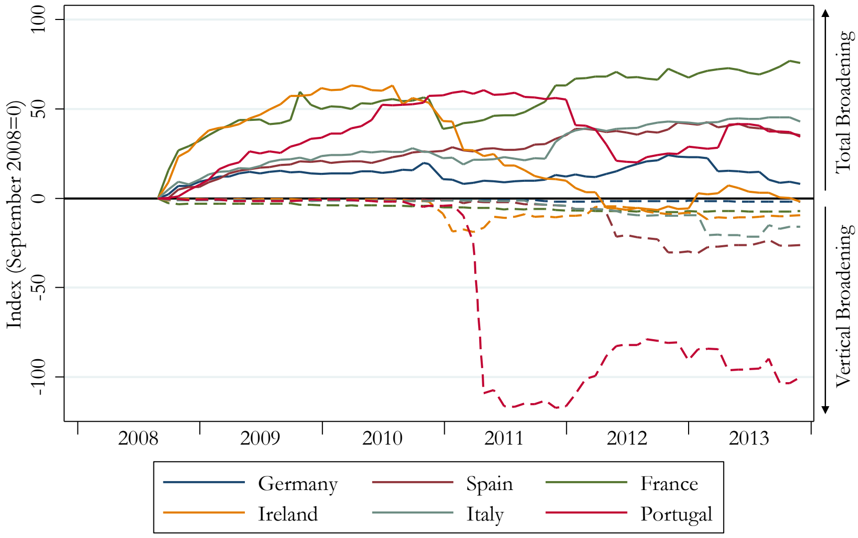
assets from Greece and Portugal, a little later from Spain and Italy, as well as Irish assets at times. Downgradings of German and French assets were a rather rare exception.

Figure 9.8 summarizes the analysis on the basis of Eurozone member countries by deciphering the broadening of national collateral pools into total and vertical broadenings along the lines of Figure 4.20. The national eligible asset pools profited asymmetrically from the collateral policy measures conducted since the fall of 2008 and compared with their respective pre-crisis levels. The German collateral pool only grew due to the quantitative broadening and only very moderately. The Irish pool grew massively quantitatively during the financial crisis phase, although it reduced to its pre-crisis level throughout the European sovereign debt crisis phase. Qualitative broadening is only apparent around the turn of 2010/2011 and only to a minor extent. For the other depicted countries, the quantitative broadening of the national collateral pools was much greater and more or less steadily increased over time. In particular, the French and Italian pools profited from the quantitative extension. Portugal profited most from qualitative broadenings, as well as Italy and Spain to a lesser degree.

Besides the geographical perspective on profiting market sectors, a view on the asset types affected most by the lowering of the minimum credit rating threshold is interesting. As the left panel of Figure 9.9 shows, newly-eligible assets of qualities within CQS 1/2 distribute among all asset types. On the other hand, lower credit qualities (right panel) becoming newly eligible are to an overwhelming extent corporate bonds, at least until the intensification of the European sovereign debt crisis in 2010. The rest falls upon uncovered bank bonds, most significantly in October 2008. From then onwards the picture shifts, as bank bonds and government securities gain importance. Nevertheless, they only add to a strong fraction of low-quality corporate bonds joining the pool every month. The downgraded assets from CQS 1/2 into CQS 3 per month distinguished by asset type are shown in the left panel of Figure 9.7. Until the downgrading of Greek government securities in mid-2010, corporate bonds also dominate the monthly bars here. During the European sovereign debt crisis phase, apart from the downgradings of Greek and Portuguese government bonds downgradings

Figure 9.8: Total and Vertical Broadening of National Collateral Pools

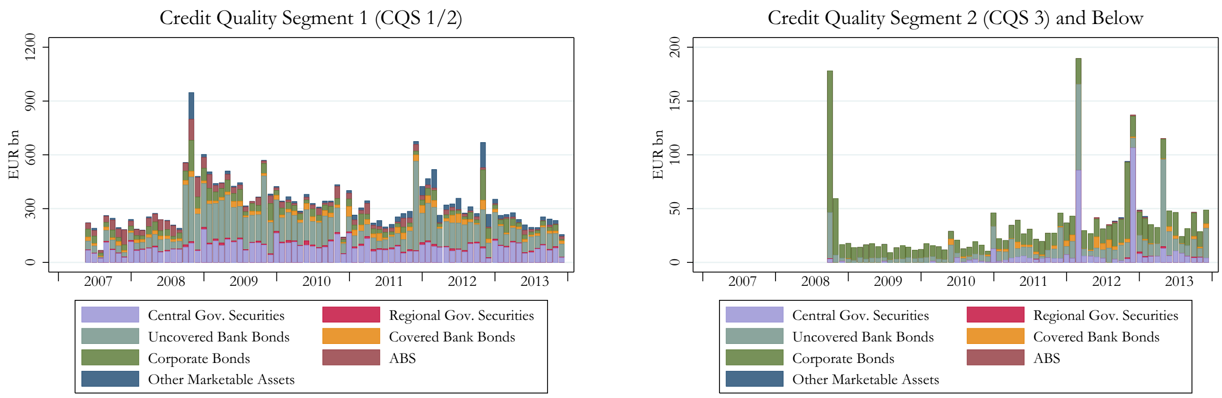
The figure deciphers the broadening of the Eurosystem Collateral Pool into national pools and extracts the respective vertical (qualitative) dimension, i.e. the impact of the lowering of the minimum credit rating threshold. Eurozone member countries profited asymmetrically from both the quantitative and qualitative loosening of collateral policy.



Solid Line: Total Broadening (positive); Dashed Line: Vertical Broadening (negative).
Source: author's calculation; ECB, Eligible Assets Database.

Figure 9.9: Newly-Eligible Marketable Assets by Asset Type and Credit Quality Segment

The figure shows how issuers of new assets profited from the lower credit quality requirement over the period from May 2007 to December 2013 by asset type. In the left panel, high qualities (CQS 1/2) are shown, while in the right panel lower qualities are depicted. While newly-eligible assets of higher qualities distribute among all asset types, the dominance of corporate bonds within the monthly inflows of lower-quality assets into the pool is striking.



Source: author's calculation; ECB, Eligible Assets Database. Source: author's calculation; ECB, Eligible Assets Database.

of covered and uncovered bank bonds and occasionally ABS and other marketable assets from Spain catch the attention.

9.4 Movements in Market Prices and Spreads

It is difficult to disentangle an effect on prices (or bid-ask spreads) of assets due to a Eurosystem collateral policy measure from other influencing factors of market prices as new information on the risk or the quality associated with the asset or a new evaluation of existing information by market participants in this respect influences prices as well as overall up- and downswings in the respective markets or connected markets. The event study character of the following discussion is further complicated because data contained in the Eligible Assets Database is only available in a monthly frequency. Therefore, it is possible that several events aside from the announcement of the collateral policy measure can interfere with the price development triggered by this measure. Furthermore, prices are only available for a fraction of eligible assets. Nyborg (2015) states that for around three-quarters of eligible assets, theoretical valuation measures have been used, which suggests that these assets were not marketed.[376] For the above-named reasons and more – as e.g. discussed in Bank for International Settlements (2015) and Bindseil and Papadia (2006, 2009)– the exact estimation of the premium for central bank eligibility is difficult and evidence of attempts is scarce (see Bank for International Settlements, 2015).

However, the following investigation does not aim at an exact measurement and quantification of a price effect or an eligibility premium. Nonetheless, despite possible interferences, a closer view at price movements around the date of eligibility due to a collateral policy measure holds interest, providing some indication of the direction of the eligibility effect and the fact that collateral policy achieves market impact (at least in times of distress) besides its function of fighting collateral scarcity.[377] Furthermore, a message on the relative market impact achieved can be deduced by the decomposition of affected assets. In other words, the prices of certain asset types, assets from certain countries or certain asset qualities can react relatively more or less than their peers. This yields insights into the relative affection of the respective asset markets. The setup of the following investigation additionally supports the reliability of the results deduced in three ways:

1. Developments of prices and bid-ask spreads in the months before and after the month of eligibility are depicted. Therefore, sustained differences in the price/spread level become visible.
2. The figures show calendar time-independent averages such that developments of market valuations around all eligibility events are evaluated. Different market environments (owing to different calendar dates) are thus included in the same analysis. A prevailing effect of eligibility thereby gains robustness.
3. The average spread of all eligible assets (not only the newly-eligible ones) for the respective month is contrasted. These should similarly be influenced by unobserved factors. Any prevailing difference between bid and ask prices points at an effect of the collateral policy measure.

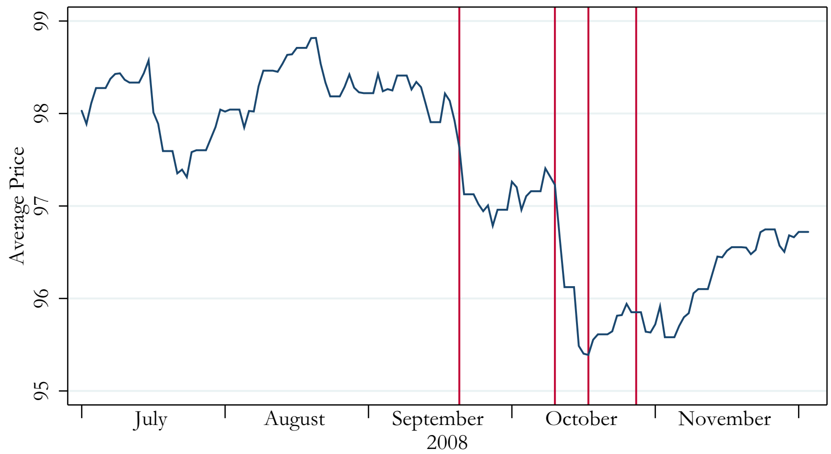
A peculiarity of the first figure discussed in this section (Figure 9.10) is the daily frequency of the analyzed market prices. This high frequency is particularly helpful in this case, as after the collapse of Lehman on 15 September 2008 policy reactions were manifold and happening shortly after another. Moreover, the Eurosystem also took more than one action within weeks. Prices of the assets of lower qualities (within CQS 3) – which became eligible on October 25, 2008 – were going through sharp falls as of mid-September 2008. The internationally-coordinated introduction

376 In the following analyses, only assets are included that could be assigned market prices via Bloomberg.
377 Note that the analysis includes newly-eligible assets in the respective months, albeit conditional upon the fact that they have not been newly issued. Hence, only eligibility due to changes in collateral criteria are taken into account.

of currency swaps on September 18 did not stop the decrease, nor did the reduction of the main refinancing rate by 50 basis points on October 8. However, when the collateral policy measures of the October 2008 package were announced on the 15th – including the full allotment policy and the lowering of the minimum credit rating threshold – the downward trend was broken. Prices of the newly-eligible assets started rising again shortly after October 25 2008, when the collateral policy measures went into effect. From the graph, a contribution of the central bank eligibility to the stabilization of asset prices seems apparent.

Figure 9.10: Development of Prices of Assets in Credit Quality Step 3 Becoming Newly Eligible in October 2008

The figure shows the daily development of the average market price of assets rated within CQS 3 that became newly eligible on October 25, 2008. The downward trend triggered by the Lehman collapse was stopped on the day when the collateral policy measures included in the October 2008 package were announced. A rise in prices started on the day that the measures came into force.



Red Vertical Lines
18 September 2008: Coordinated action of international central banks providing currency swaps.
8 October 2008: Reduction of interest rate by 50 basis points.
15 October 2008: Announcement of collateral policy measures (October 2008-package).
25 October 2008: Reduction of minimum credit rating threshold effective.

Source: author's calculation; Bloomberg; ECB, Eligible Assets Database.

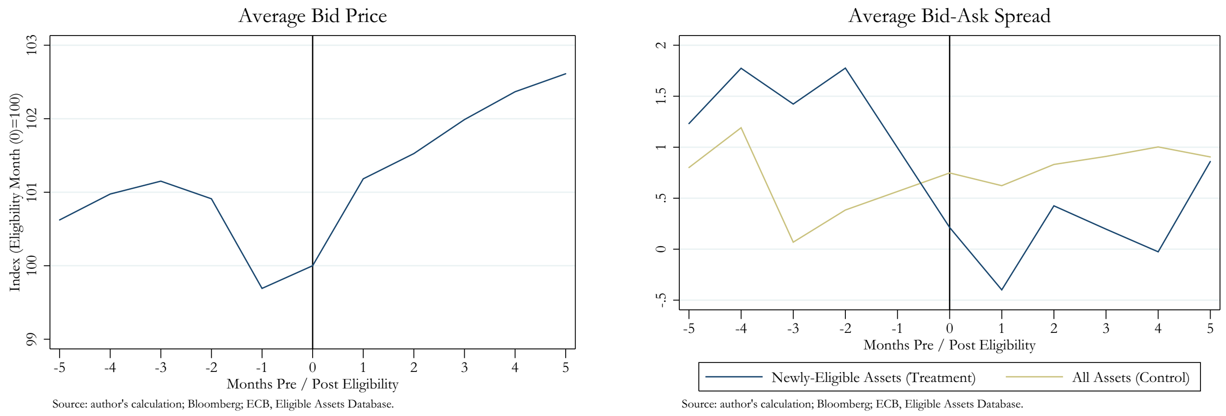
In the left panel of Figure 9.11, the average bid price of all assets that became newly eligible at any point between June 2007 and December 2013 due to changes in collateral criteria (not due to issuance) is shown. On the abscissa, 0 marks the month of new eligibility. The average price is depicted as an index with the price in the eligibility month set to 100. Prices collected at the end of up to five months before (−5) and five months after (+5) this asset-specific event are also depicted, such that the price levels before and after eligibility become apparent.[378] In the months −5 to −2, the average index level is around 101, before dropping towards the eligibility month. However, after eligibility, the price level is clearly above the pre-eligibility level and continues rising. Moreover, the turnaround is already visible one month before eligibility, which points to the existence of announcements or at least rumors among market insiders.

The right panel of Figure 9.11 brings together supply and demand by showing the associated average bid-ask spread. It is assembled analogously to the average bid price in the left panel, albeit not indexed. Note that the bid-ask spreads are calculated as the differences between ask and bid prices,

[378] The included timespan per asset depends on its duration and data availability.

Figure 9.11: Impact of Changing Eligibility Criteria on Prices and Spreads (All Affected Assets)

The figure shows the average indexed bid price (left panel) and average bid-ask spread (right panel) of assets becoming newly eligible due to a collateral policy measure at any point between June 2007 and December 2013. The abscissa marks the (asset-specific) month of new eligibility with 0 **and compasses a range of eleven months. Bid prices reach a higher level after eligibility. Bid-ask spreads are lower after than before eligibility. In particular, they are above the level of spreads of already-eligible assets before eligibility and lower afterwards, with a tendency to align.**



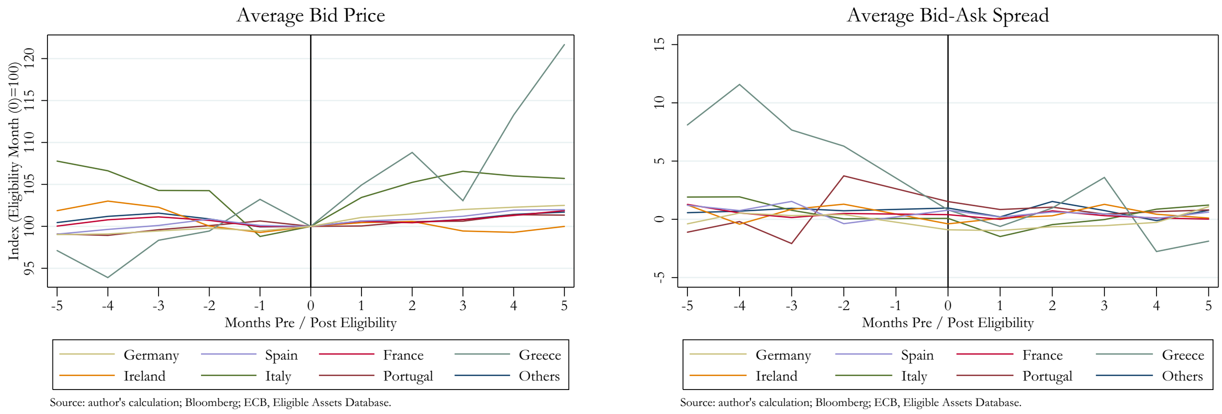
as is the standard in finance literature.[379] The more positive the bid-ask spread, the difference between ask and bid prices is not only larger – pointing to access availability of the respective asset on the market – but also the liquidity of the asset is lower because the trading volume is lower. The pre-eligibility spread level of assets becoming newly eligible by a collateral policy measure at 0 starts at around 1.5. These assets can be thought of as belonging to the treatment group, where the treatment is new eligibility at 0. The pre-eligibility spread level of these assets is above the average spread level of already-eligible assets in the respective month. The latter assets can be thought of as belonging to the control group, although the control group here is not as usually *not* treated, but rather *already* treated. The spread of these assets is low, close to zero but positive, yielding a high liquidity but still some excess availability. The average spread of already-eligible assets does not react to the eligibility of newly-eligible assets. This is as one would expect, at least in times of distress. In normal times, one could also argue that bid prices of already-eligible collateral should fall after broadening of the collateral pool, owing to the subsequently higher supply of collateral.[380] On the other hand, bid-ask spreads of newly-eligible assets fall to a level below the spread level of assets in the control group. This reflects a higher liquidity than previously and a rise in bid prices relative to ask prices. In the first month after eligibility, the spread even becomes negative, reflecting higher bid than ask prices and a scarcity of the assets. Over time, the spread aligns to the spread of assets in control. This is also as expected, because there is no reason for newly-eligible assets being valued differently by the market than other eligible assets in the collateral pool.

The following three figures decompose the assets affected by a policy-induced eligibility according to country of origin, asset type and credit quality and thus help to disentangle drivers of the movements identified in Figure 9.11. In Figure 9.12, country-specific average bid prices and average bid-ask spreads are shown.

[379] E.g. Edwards et al. (2007), Goldstein (2012), and Harris (1994).
[380] See e.g. Bindseil (2014, Ch. 9) for more details on this argument.

Figure 9.12: Impact of Changing Eligibility Criteria on Prices and Spreads by Country

The figure provides the information of Figure 9.11 on a country basis. It suggests the strongest effects of eligibility on market prices for Greece, Portugal and – to a much weaker degree – Italy. For all other countries except Ireland, prices do not follow counter-intuitive paths. The spreads align towards a low level after eligibility.



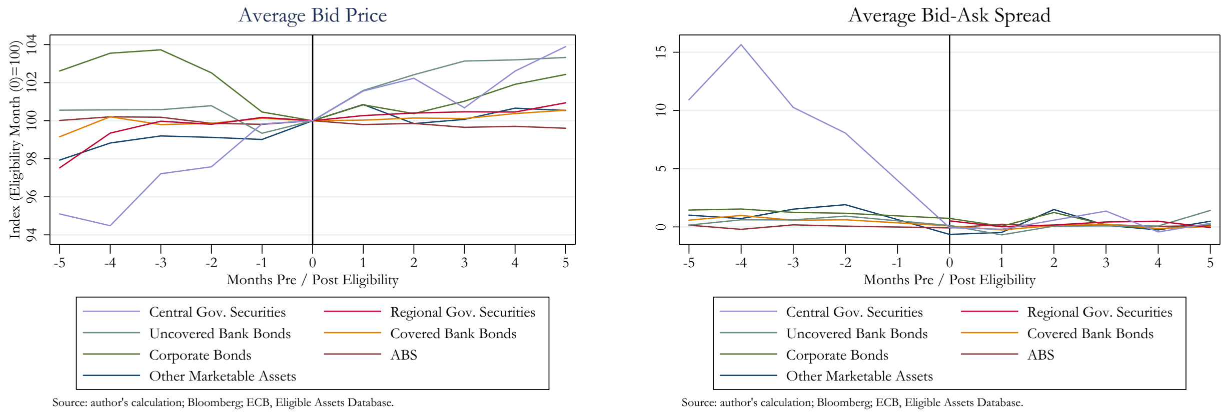
Most pronounced in the left panel is the increase in the average bid price of Greek assets deemed newly eligible, which are thus identifiable as the driving element of the trend seen in the left panel of Figure 9.11. From as low as 95, the index increases by more than 25 points. However, the Greek increase is rather steady, such that an underlying positive trend in market prices is likely to contribute. Of the other depicted country averages, only the Irish one contradicts the expected effect and reaches a lower level after rather than before eligibility. In the Italian case – and to a limited extent the cases of the other countries – prices fall slightly towards eligibility (or a month before, recalling announcement effects or rumors), when the trend is broken and prices tend to increase again. The right panel offers an alignment effect towards low spread levels as in the right panel of Figure 9.11. The reduction of the spread is greatest for the heavily-distressed countries Greece and Portugal, while to a lesser extent it also prevails for Italy. In particular, assets from especially crisis-afflicted countries thus reveal movements in prices and spreads around the respective dates of their eligibility.

Figure 9.13 provides details on an asset type basis. For all asset types but ABS, price levels increase after eligibility in the left panel. For uncovered bank bonds, the level is around 100.5 before and around 103 after eligibility, while for regional governments and covered bank bonds levels are approximately 100 and approximately 100.5, respectively. For other marketable assets, the index is around two points above the pre-eligibility level afterwards. Corporate bonds seem to be rescued out of a downward trend by the eligibility. The strongest and most visible increase is for central government securities, which are mostly from Greece and thus show the above-described steady increase continuing throughout eligibility and hence are likely driven by an overall market development. The right panel again shows an alignment of bid-ask spreads on a very low level after eligibility. The picture is again dominated by the massive lowering of the spread for central government securities from Greece.

Finally, Figure 9.14 shows how quality segments of assets becoming newly eligible develop throughout the eligibility event. In the left panel, an enormous increase of assets rated below investment

Figure 9.13: Impact of Changing Eligibility Criteria on Prices and Spreads by Asset Type

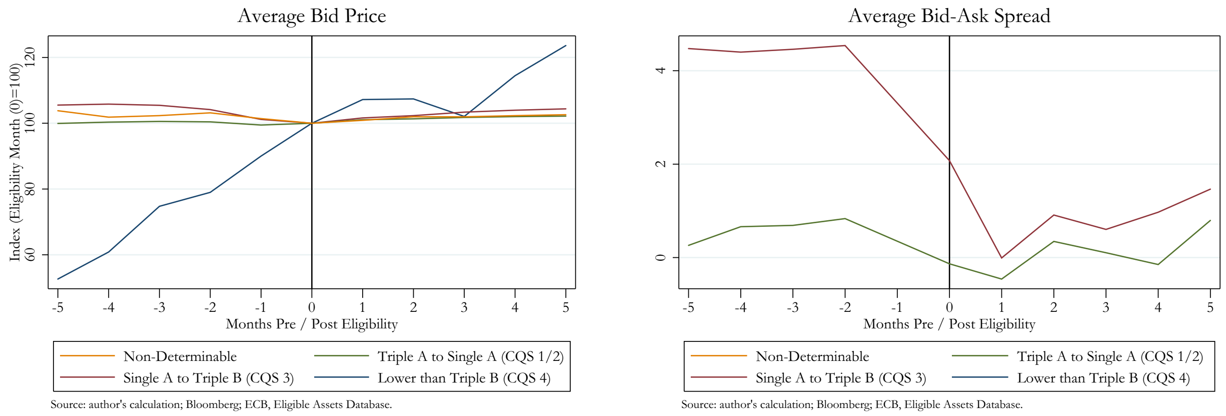
The figure provides the information of Figure 9.11 on an asset type basis. Higher levels of bid prices are visible after rather than before eligibility for all asset types aside from corporate bonds and ABS. While no effect can be identified for the latter, the former recover from a downward trend prior to eligibility. Average spreads of asset types align on a very low level after eligibility.



grade (CQS 4) throughout the eligibility month stands out. The price recovery parallel to eligibility expands over 70 points of the index. However, price improvements after the eligibility month are also visible for the other quality segments. CQS 1/2 assets start on a level slightly below 100 and increase to above 102, whereby eligibility might play a revaluing role even for high-quality assets. CQS 3 assets seem to be stopped from a price deterioration by eligibility. Their prices start above a level of 105 and fall towards the eligibility month, after which they recover to a level of slightly below 105 again. The right panel very vividly illustrates the alignment of spreads of lower and higher qualities because they share the selection into the eligible collateral pool.[381] For both quality segments, spreads decrease towards and after eligibility, more strongly for the lower qualities.

Figure 9.14: Impact of Changing Eligibility Criteria on Prices and Spreads by Credit Quality

The figure provides the information of Figure 9.11 clustering assets into credit quality segments. The left panel shows increasing prices of all quality segments, albeit CQS 4 assets do so by far the most, strongly influencing this impression. In the right panel, it is illustrated how spreads of lower and higher qualities align on a low level because they share the selection into the eligible collateral pool.



381 Non-determinable qualities and qualities below Triple B are omitted owing to a lack of data on ask prices.

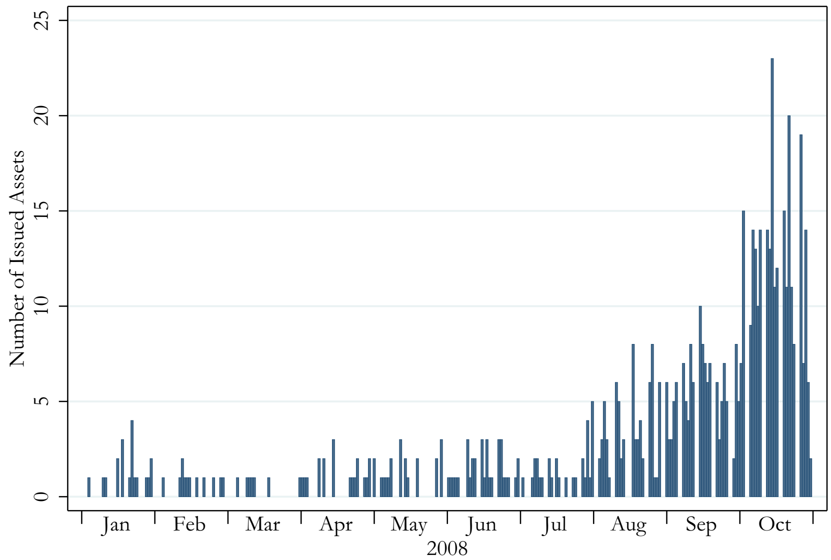
9.5 Changing Issuance Behavior

As the last of the impact-identifying criteria presented in Section 9.2, changes in market behavior – in particular in issuance behavior – reacting to changes in collateral criteria as identifiable from the Eligible Assets Database shall be presented. Any change in these criteria allows analyzing pre- and post-change issuance behavior. Pre-change behavior is only expected to adapt if the policy measure is announced to or expected by market participants and issuers. It is identifiable in the Eligible Assets Database because a loosening of collateral criteria leads to the inclusion of such assets that were issued prior to the respective date into the database in the month of effectiveness of the policy measure. If markets expect the loosening, they will likely intensify the issuance of affected assets to profit from central bank eligibility as early as possible.

Figure 9.15 shows at what time assets that became newly eligible in October 2008 due to the lowering of the minimum credit rating threshold were issued. Almost all of them were issued in 2008 and hence only this year is depicted. Obviously, the distribution intensified with the eligibility decision approaching and the majority of the assets were issued within the month in which they became eligible.[382] More precisely, most assets were issued on the very day when the lowering of the minimum credit rating threshold was officially announced by the ECB, namely October 15, 2008. The second peak of the bars in Figure 9.15 in October 2008 is on the 22nd, one day before the legal document (the guideline) putting the collateral policy measure into force was published. The third peak on October 27 marks the first working day after effective eligibility (October 25, 2008).

Figure 9.15: Issuance Dates of Credit Quality Step 3 Assets Becoming Newly Eligible in October 2008

The figure shows the number of issued CQS 3 assets during each day in 2008 until the eligibility month of October. The overwhelming majority of the assets affected by the policy measure were issued in the month of eligibility, with peaks on the days of announcement of the policy measure and the first working day after effectiveness.



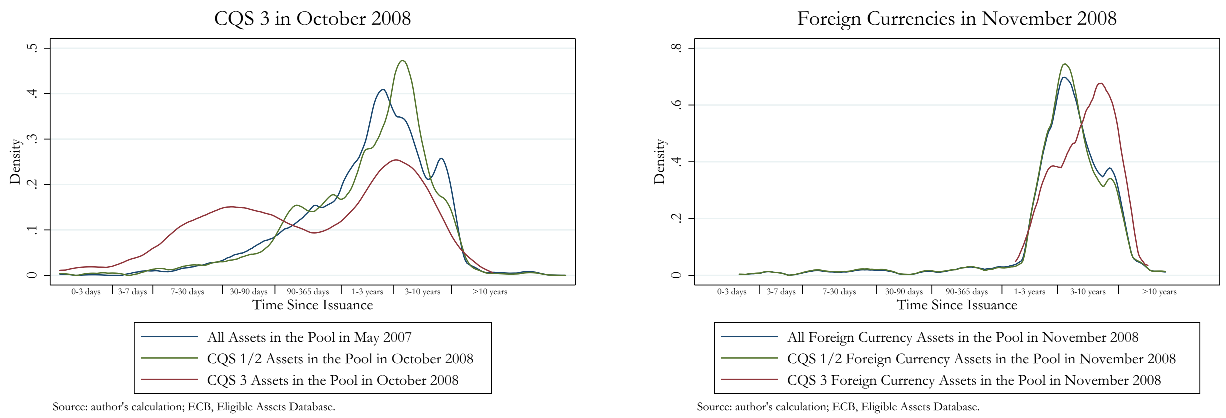
Source: author's calculation; ECB, Eligible Assets Database.

[382] Note that the data for October 2008 is based on the Eligible Assets List of October 30, 2008.

The bias in the issuance distribution towards the eligibility date is striking because in principle an asset becoming newly eligible due to a change in collateral criteria could have been issued at any point in time before the eligibility date, in contrast to an asset becoming eligible due to being issued. In Figure 9.15, STEPs – which naturally only have a short lifetime and would have further drawn the issuance distribution towards the eligibility date – have explicitly been excluded. In order to rule out the notion that the observed issuance distribution is ordinary and similar to that of assets already in the pool, the left panel of Figure 9.16 contrasts the distribution of the age of the newly-eligible CQS 3 assets in October 2008 with the age of all assets in the pool in May 2007 (a pre-crisis month and the first available month in the dataset), as well as the already-eligible CQS 1/2 assets of October 2008.[383] The abscissa is in log-scale and marks different age clusters. Most assets eligible in May 2007 were between one and ten years old. The market behavior did not significantly change until October 2008, as the distribution of eligible CQS 1/2 assets in that month looks very similar. Therefore, one would also expect the distribution of policy-induced newly-eligible assets to be of a comparable shape. However, as already suggested by Figure 9.15, the newly-eligible CQS 3 assets in October 2008 are significantly younger, with many only being between 7 and 90 days of age on October 30, 2008. By contrast, another part follows the ordinary pattern accumulating around ages of one to ten years.

Figure 9.16: Distribution of Age of Assets

The figure shows the distribution of asset ages for the package of CQS 3 assets becoming newly eligible in October 2008 (left panel) and the package of foreign currency-denominated assets becoming newly eligible in November 2008 (right panel) on a logarithmic scale. While an extraordinary close issuance to the time of eligibility can be identified for the first-named, the last-named follow the ordinary age distribution. A changing market behavior (more issuances) can thus be concluded for CQS 3 assets shortly before they effectively became eligible collateral.



The right panel of Figure 9.16 shows the same analysis for the foreign currency assets being added to the eligible assets pool in November 2008.[384] Here, the distribution of newly-eligible assets much more closely follows the course of distributions of already-eligible assets. A change in issuance behavior cannot be identified. To summarize, while the overall market behavior regarding issuances had not changed from May 2007 to the fall of 2008, newly-eligible CQS 3 assets were to a large extent only issued rather shortly before the eligibility date, suggesting an attempt by markets to create more central bank-eligible collateral.

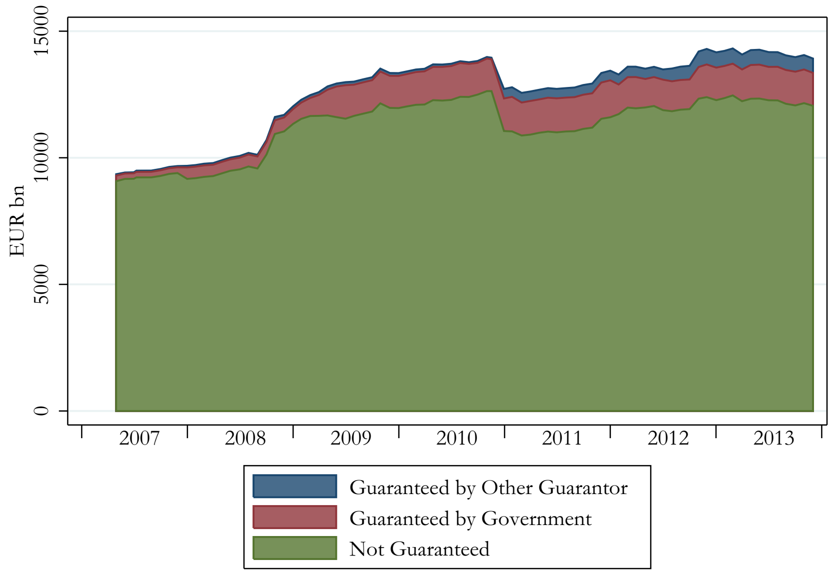
[383] STEPs are excluded again, see above.

[384] Foreign currency-denominated assets were not eligible until November 2008 and thus rather than all eligible assets in May 2007, all eligible foreign currency-denominated assets in November 2008 are shown.

Next, traces of collateral policy in the pattern of eligible guaranteed assets shall be discussed. Over time, government guarantees grew in importance, cf. Figure 9.17. In May 2007, only assets to the amount of EUR 22 billion of the eligible collateral pool were guaranteed by a government, whereas the figure grew to 1,293 billion in December 2013. Government guarantees not only gained importance compared to the overall pool but governments are also the predominant guarantor group. The following series of graphs examines the connection between the rise of government guarantees and collateral policy measures by the Eurosystem that affect government-guaranteed assets, which have been described in Section 4.3.2.

Figure 9.17: (Government) Guarantees in the Eligible Collateral Pool

The figure shows the guaranteed fraction of assets within the Eurosystem eligible assets pool. The importance of guarantees grew over time, with governments being the predominant guarantor group.



Source: author's calculation; ECB, Eligible Assets Database.

Guaranteed assets could have already been issued with a guarantee or receive one at some point in time. The motivation for governments to provide a guarantee can be manifold.[385] Nevertheless, in principle a guarantee to an *already*-eligible asset is often provided to safeguard the liquidity of the issuer and foster trust among market participants holding the assets. Translated into the central bank objectives defined in Chapter 1, guarantees to already-eligible assets support financial stability. The reason is that they do not result in new liquidity for the issuer, which could subsequently be used to finance new projects. Allowing the pledge of guarantees to already-eligible assets is thus in line with the financial stability objective of a central bank. Of course, the provision of a guarantee to a *newly*-eligible asset can stem from similar motivations. However, such a guarantee also has a subsidizing character as it makes fresh liquidity for the issuer cheaper or possible at all. Thereby, it obviously helps to finance new investment projects and makes those of lower productivity profitable. A central bank supporting the issuance of government guarantees to newly-eligible assets thus pursues its fiscal and economic stability objective. The stabilization of the fiscal budget in particular is fostered by such a measure in the presence of a consensual nexus between the government and financial sector (see Allen et al., 2015; Erce, 2015; Farhi and Tirole, 2016; Nyborg, 2015; Sinn,

[385] See Eberl (2016, Ch. 8) for a detailed discussion of motivations for governments to guarantee assets.

2014b).[386] This could be expressed in the provision of guarantees by governments in return for the purchase of government bonds by banks profiting from the guarantee. Central banks accepting guarantees on newly-eligible assets hence also accept or even actively foster this fiscal and economic strengthening.

The Eurosystem does not explicitly differentiate the eligibility of guarantees between newly- and already-eligible assets. Guaranteed assets – in particular those guaranteed by governments – had already been eligible before the crisis of 2007/2008. However, the Eurosystem conducted a policy measure in February 2009 explicitly deeming eligible own-use uncovered assets. These assets can be pledged without ever being marketed. The financial stability-driven motivation fostering the trust of a third party holding an already-eligible asset is thus not applicable. By contrast, as assets can be bundled into a security for the sole purpose of pledging it to the central bank for fresh liquidity – which can consequently be used to finance own investment or the government budget (via government bond purchases) – they will mostly be newly issued for this purpose. In addition, they only become eligible due to the guarantee. This particular broadening of collateral criteria for guaranteed assets can thus be counted as being driven by the objective of strengthening fiscal and economic stability.

From Figure 9.18, a changing pattern in the provision of government guarantees is clearly visible. While many already-eligible assets received government guarantees during the peak months of the financial crisis – i.e. the predominant motive during that time was to sustain financial stability – this subsequently changed and the change intensified during the European sovereign debt crisis. Around the second peak of new government guarantees provided, the vast majority was given to newly-eligible assets, i.e. assets that had either just been issued or only became eligible due to the guarantee. It is striking from the figure that the highest amount of collateral was guaranteed in March 2012, the month of the second LTRO during the "big bazooka" period.

The sub-division of data presented in Figure 9.18 is given in Figure 9.19 and provides an explanation. First of all, the left panel shows that almost all new government guarantees during the depicted period were given to uncovered bank bonds. This did not change between the two peak periods, which are attributable to financial crisis and European debt crisis. On the other hand, the right panel reveals another changing pattern: while most guarantees during the financial crisis were given by the German government and governments not explicitly depicted ("Other"), the aftermath of the financial crisis and especially the European debt crisis saw a shift towards governments of crisis-stricken countries to provide most of the government guarantees. The outstanding amount of March 2012 was to a large extent guaranteed by the governments of Italy, Ireland, Greece, France and Spain. In fact, the governments of Italy and Spain even institutionalized guarantee schemes during the "big bazooka" period.[387][388]

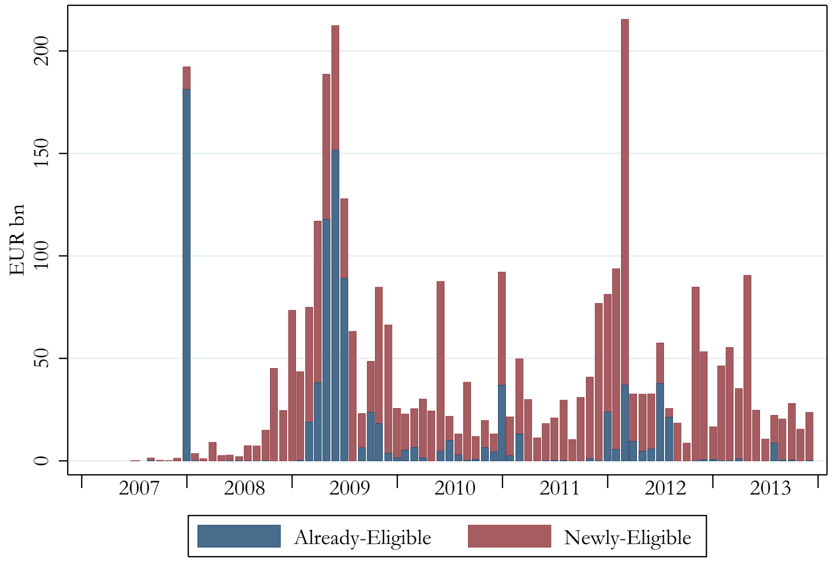
386 A model incorporating this calculus of governments in their decision to provide guarantees is presented in Eberl (2016, Ch. 8).

387 See Eberl (2016, Ch. 8), who also compares collateral amounts guaranteed by governments before, during and after the "big bazooka" period and finds that governments of crisis countries massively extended their guarantees during that period, unlike Germany and other governments.

388 For the Spanish guarantee scheme, see European Commission, "State Aid SA. 34224 (2012/N) – Spain. Reintroduction of the Spanish Guarantee Scheme in H1 2012," *C(2012) 786 final*, 9 February 2012, `http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=3_SA_34224`. For the Italian guarantee scheme, see Clifford Chance, "Italian Government Guarantees. Easing the Pressure on Italian Banks," *Client Briefing*, December 23, 2011.

Figure 9.18: New Government Guarantees to Already- versus Newly-Eligible Assets

The figure shows newly-granted government guarantees to already-eligible versus newly-eligible assets. Two peak times over guarantee provision stand out: while during the financial crisis many already-eligible assets received guarantees, guarantees to newly-eligible assets dominate thereafter.



Source: author's calculation; ECB, Eligible Assets Database.

The extended provision of government guarantees to newly-issued uncovered bank bonds – coinciding with the implementation of the fully-allotted LTROs of three-year maturities – and the surging use of central bank refinancing credit by crisis countries during that time – as visible from Figure 8.9 – strongly suggests a connection to the collateral policy measures by the Eurosystem. The bonds are likely to have been pledged by the issuing bank itself (own-use) at the respective NCB for fresh liquidity, which could subsequently be used to finance government bond purchases or loans to investment projects, which would otherwise not have been made.[389] The collateral policy on guaranteed assets hence resulted in a market-making aimed at fostering fiscal and economic stability.

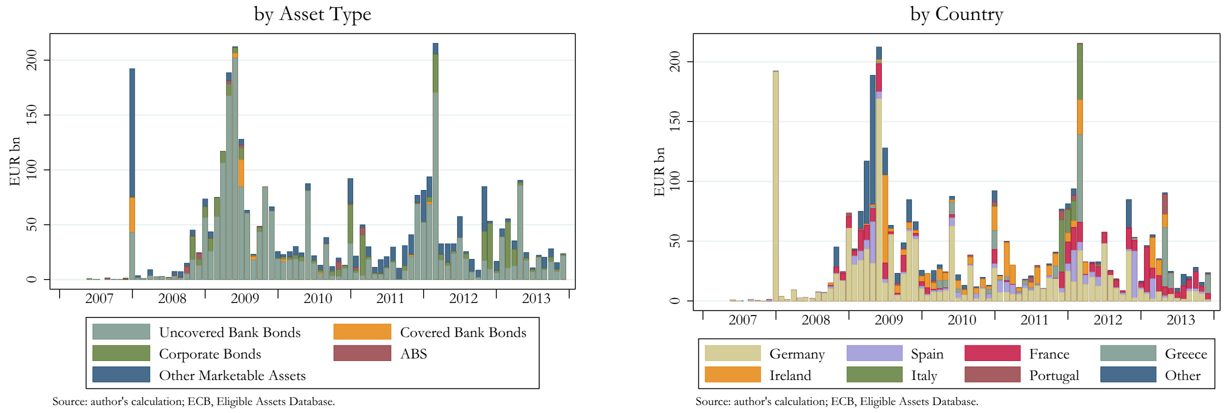
The impact on issuance behavior following the eligibility decision for own-use government-guaranteed bank bonds is further illustrated by Figure 9.20, showing that the implementation date of the guideline laying down the eligibility of own-use government-guaranteed debt instruments was accompanied by a rocketing of the issuances of government-guaranteed bonds. The above analysis based on the Eligible Assets Database suggests that a substantial fraction of these increasingly issued bonds found their way into reverse transactions for refinancing credits with the Eurosystem.

The decision to accept STEPs issued by banks had a significant impact on the collateral pool, as has been described in Section 9.3. Figure 9.21 also shows that the issuance behavior on the STEP

389 According to news coverage, Italian banks were said to have pledged EUR 40 billion worth of own-use bonds as collateral in 2011, while Irish banks were reported to have done so to the amount of EUR 18 billion in 2011 and another EUR 8 billion in March 2013, see S. Sirletti and E. Martinuzzi, "Italy Banks Said to Use State-Backed Bonds for ECB Loans," *Bloomberg*, December 21, 2011, `http://www.bloomberg.com/news/2011-12-20/italian-banks-are-said-to-use-stateguaranteed-bonds-to-receive-ECB-loans.html`, and J. Brennan, "Irish Banks Aid Funding With Own-Use Bonds Amid Cyprus Woes" *Bloomberg*, March 28, 2013, `http://www.bloomberg.com/news/2013-03-28/irish-banksaid-funding-with-own-use-bonds-amid-cyprus-woes-1-.html`.

Figure 9.19: New Government Guarantees by Asset Type and Country

The figure shows new government guarantees distinguished by asset type (left panel) and country (right panel). Mainly uncovered bank bonds were guaranteed at all times as well as during both peak periods. However, while most guarantees were given by the German government and governments not explicitly depicted ("Other") during the financial crisis, during the European debt crisis governments of the strongly crisis-afflicted countries also provided most of the guarantees.



market changed around the times when collateral policy decisions of the Eurosystem affected this market. It is obvious from the figure that the announcement of the acceptance of the STEP market as a non-regulated market in September 2006 was accompanied by a trebling of market volume. Another smaller increase of around 20% can be observed when STEPs issued by banks became eligible as of October 2008. Subsequently, the amount of STEPs outstanding persisted at a high level.

Figure 9.20: Barclay's Euro Aggregate Index for Government-Guaranteed Bonds

This figure shows the development of the European government-guaranteed bond market in terms of issuances between 2006 and 2013. The index for the number of issuances strongly increased after the outbreak of the crisis, almost doubling between October 2008 and October 2010. This development is connected to the guarantees for bank bonds by some European countries after the outbreak of the crisis. The figure illustrates that the market development yields a strong dynamic around the time of the introduction of eligibility for own-use government-guaranteed bonds.

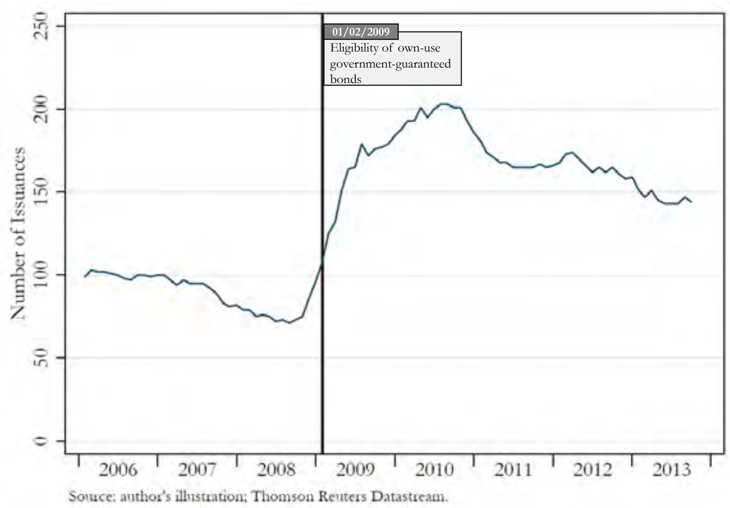
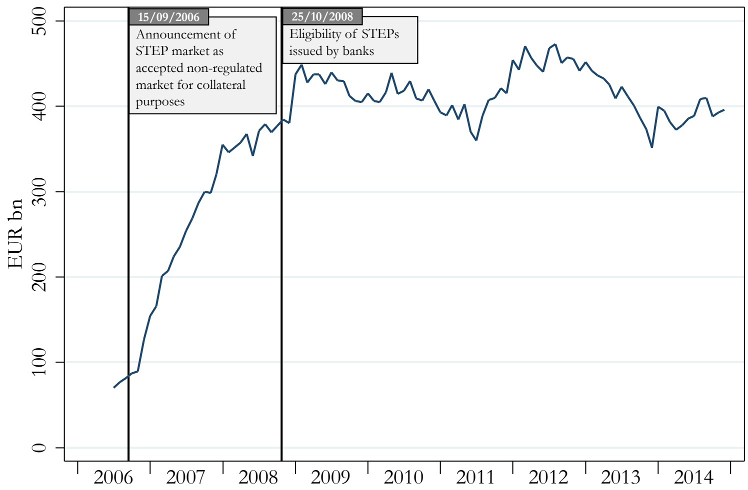


Figure 9.21: Development of the Short-Term European Paper Market

This figure depicts the development of the STEP market in terms of market volume. It can be observed that both the general acceptance of the STEP market for collateral purposes and the eligibility of STEPs issued by banks were accompanied by increases in market volume.



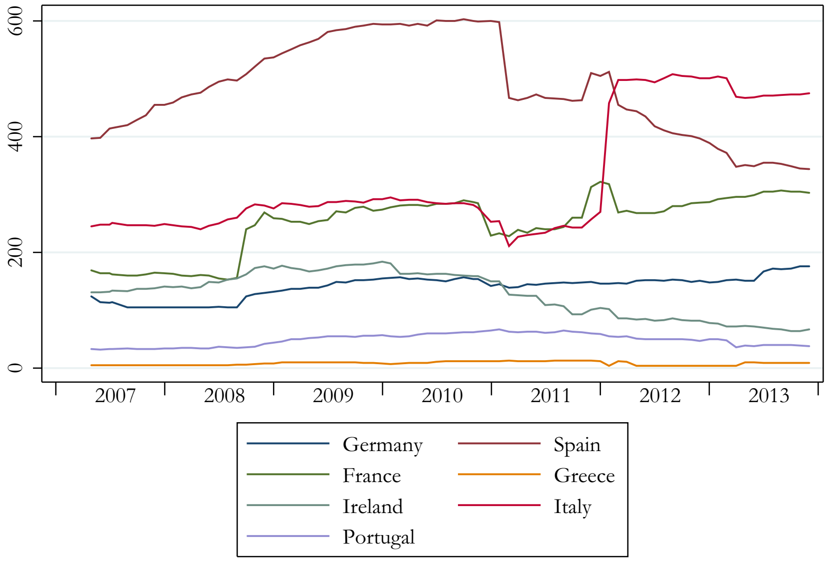
Source: author's illustration; ECB.

It has been argued in the previous Chapters 6, 7 and 8 that the Eurosystem's approach of segmentally pooling refinancing conditions led to an asymmetric impact on national asset markets. The results of the models presented suggest that central bank refinancing became relatively more attractive compared to market refinancing for lower-quality collateral and in countries of lower productivities. As a final analysis of the data of the Eligible Assets Database, it shall thus be examined whether there is evidence of a growing strive among issuers from the respective national markets to benefit from central bank refinancing.

As a start, Figure 9.22 thus shows the number of issuers of eligible assets by country over time. In Germany, the number of issuers is at 105 at the beginning of the depicted period and rests there until October 2008, when it jumps to 125. This represents a policy-inherent increase owing to the broadening of the eligible asset pool. Until December 2013, a further increase to 176 is visible. Compared to other depicted countries, the number is small and the increase is moderate; for example, the number of Spanish issuers starts at the highest level of 400 and then constantly increases to around 600 in the second half of 2011. As no jumps and steps are visible from the Spanish plot until early 2011, the development suggests a run of market participants towards central bank eligibility rather than a policy-inherent trigger. The consolidation in early 2011 is likely to be due to downgradings of ABS issuers, as already visible from Figure 9.5. During the large-scale and long maturity refinancing offers of the "big bazooka", more issuers stream towards the eligible assets pool again, before a decrease of issuers towards the initial level sets in. The French increase from around 156 in September 2008 to 322 in October 2008 is again driven by the collateral policy package of the Eurosystem. Nevertheless, the three-year LTRO triggers a hill in the line, which is not explainable by a broadening of the collateral pool. Overall, the French number of issuers increases from around 170 to around 300. In Greece, the respective number more than doubles in a slow development from initially 5 to 13 in the second half of 2011, before slightly declining again to 9. Ireland is the only country where significantly fewer issuers find their way to central bank eligibility in 2013 compared with 2007. The number goes down from 180 around the turn of the

Figure 9.22: Number of Issuers per Country

The figure shows the development of the number of issuers of eligible collateral for selected countries over time. In several crisis countries, more issuers tend to demand access to the eligible assets pool. The relative increases of the number of issuers are larger for those countries than e.g. for Germany and are mostly not triggered by policies broadening the collateral criteria (as e.g. in October 2008).



Source: author's calculation; ECB, Eligible Assets Database.

2009/2010 to 70 in December 2013. In 2007, it is at 130. The development mirrors the Irish crisis experience, which started earlier than 2008.[390] It is thus likely that Irish issuers already wanted to access central bank refinancing to a greater extent in the years before 2008. In Italy, demand for "big bazooka" credit seems most pronounced. From January 2012 to February 2012, the flow of issuers into the eligible assets pool results in an increase in the number of issuers from 270 to 458. Over the entire period, the vast increase is marked by an initial level of 245 in May 2007 to 475 in December 2013, with an intermediate high of more than 500 during the second half of 2012. Portuguese issuers strive for central bank eligibility earlier: from 2007 to early 2011, the number of issuers there doubles from 33 to 67, before subsequently declining to 38 in 2013 again. Indeed, it can be concluded that in crisis countries more issuers tend to demand access to the eligible assets pool. The relative increases of the number of issuers are larger for those countries than e.g. for Germany and are mostly not triggered by policies broadening the collateral criteria.

Next, it shall be evaluated whether the average issuer per country also tries to make higher fractions of his balance sheet eligible for central bank collateralization. Figure 9.23 shows the average number of eligible assets (left panels) and the average amount of eligible collateral (right panels) for this purpose. Only private sector asset types are depicted, whereas government and other public and semi-public issuers have been excluded. In Germany, the average number of eligible assets per issuer only very slightly increases over time and the amount of eligible collateral that a representative issuer possesses even decreases. Bank bonds are the predominant asset type. By contrast, in Spain the average number of eligible marketable assets sharply increases from between 30 and 40 to over 90 during the European sovereign debt crisis. This also results in an increase in the average amount

[390] See e.g. Sinn (2012b) for a description of the Irish crisis experience.

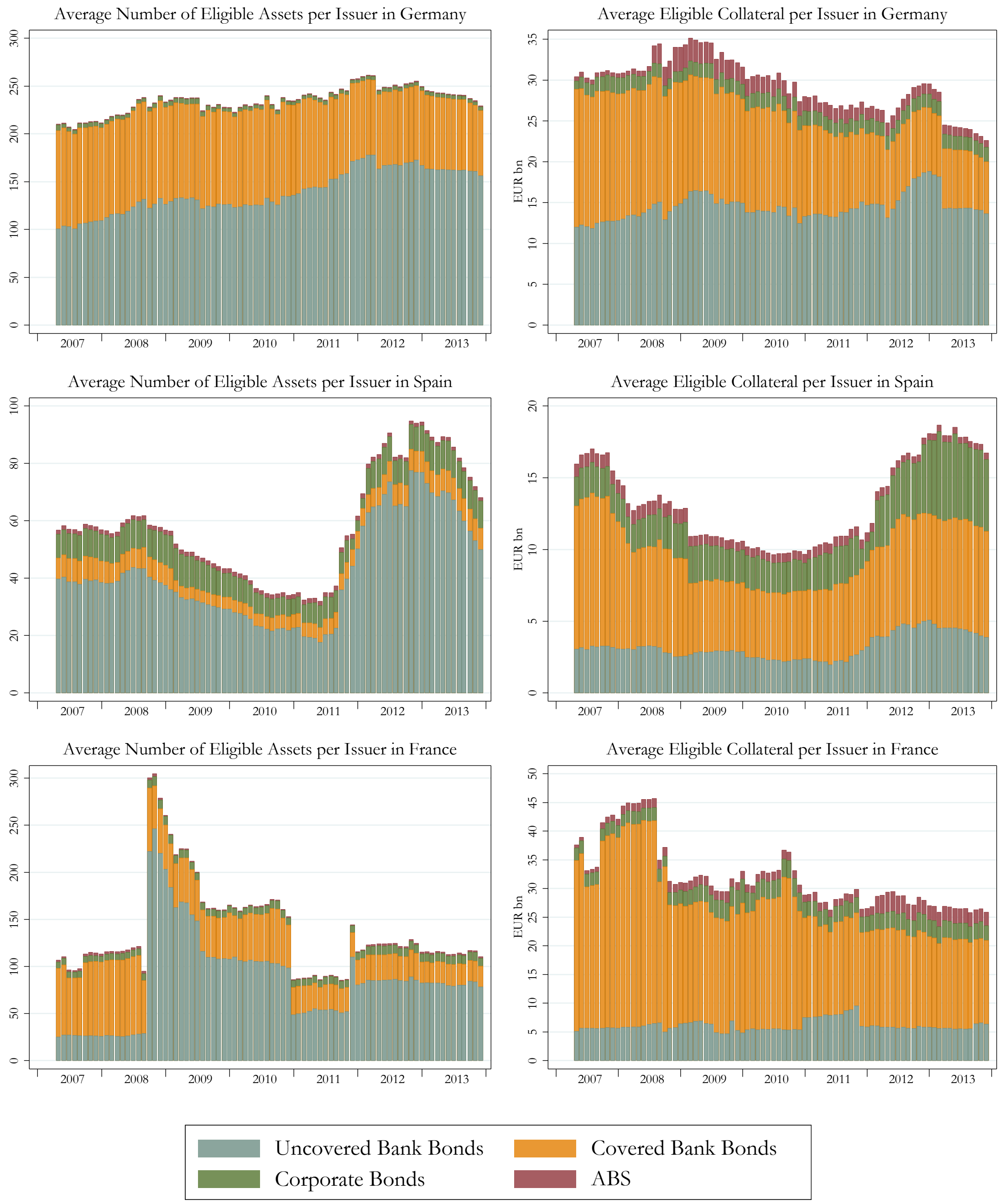
in the right panel from just over EUR 10 billion to around EUR 18 billion. This excludes the possibility of a division of a constant amount into simply a higher number of assets. Corporate bonds grow to approximately one-third of the average amount per issuer, which aside from this are mostly bank bonds. Participants of the real economy thus seem to have striven to benefit from the eligibility to collateralize central bank liquidity. Note that the increase in the number of issuers in Spain – visible from Figure 9.22 – further boosts the stronger reliance on access to central bank refinancing in Spain, which consequently also results in the growing national pool, cf. Figure 8.6. In France, a repackaging and shifting of eligible collateral seems to take place in the fall of 2008, when the average number of eligible assets per issuer sharply increases while the average amount of eligible collateral per issuer declines. At the same time, the number of issuers jumps (see Figure 9.22). Hence, a distribution of eligible collateral on more assets per issuer combined with a growing number of issuers stands behind the increase in the national eligible collateral pool (see Figure 8.6). Until the Greek debt restructuring in 2012, both the average number of eligible assets and the average amount of eligible collateral increase for Greek issuers. ABS and corporate bonds lose importance, while banks overcompensate the national production of central bank-eligible collateral. In Ireland, not only the number of issuers declines (see Figure 9.22), but also the average number of assets per issuer and – to a lesser degree – the average amount of collateral per issuer. For Italian issuers, there is an asymmetric course of the bars in the two panels: while the average number of assets per issuer declines step-wise, the average amount of collateral per issuer increases, i.e. larger assets emerge. Uncovered bank bonds lose shares and are replaced by more assets backed by real economic investments. However, as known from Figure 9.22, the number of issuers also jumps at the end of 2011 and thus the national pool increases (see Figure 8.6). Moreover, at the end of 2011, issuers produce both an outstanding average number of assets and the highest average amount of collateral to make extensive use of the "big bazooka". Finally, in Portugal an overall slightly increasing tendency of both the average number and the average amount of collateral can be identified, which is especially unclouded during the years of emergence of the European sovereign debt crisis, placing Portugal under pressure from early onwards. To summarize, Figure 9.23 shows an intensified reliance on the issuance of central bank-eligible collateral in most crisis countries – especially in Spain, Italy and Greece – while the average number of issuers and the average amount of collateral rather decreased in Germany and France during the European sovereign debt crisis.

As a final indication of the increased efforts of issuers to comply with the eligibility criteria of the Eurosystem presented here, Figure 9.24 relates eligible collateral issued by banks and SPVs in selected countries to the aggregate bank balance sheet total in the respective country.[391] Consequently, the figure only shows data for the banking sector, while the previous figure also took the issuance behavior of participants of the real economy into account. Nevertheless, banks are the market participants ultimately using the central bank lending facilities and under some conditions even able to pledge self-issued collateral. Changes in their issuance behavior in terms of making greater amounts of their balance sheets central bank-eligible thus holds particular importance. It becomes clear from the figure that the broadening of the collateral pool in the fall of 2008 resulted

[391] SPVs are used by banks to issue ABS. SPVs have only been distinguished as a separate issuer group ("Financial corporations other than credit institutions") since November 2010, whereas previously they were identifiable as issuers of ABS within the issuer group called "Corporate and other issuers". Lenza et al. (2010, p. 21) describe the phenomenon of "retained securitization, whereby banks transformed loans on their own balance sheet into ABS via related SPVs and then held the resulting security to use as collateral in the Eurosystem operations. For example, mortgage loans could thus be refinanced at the ECB."

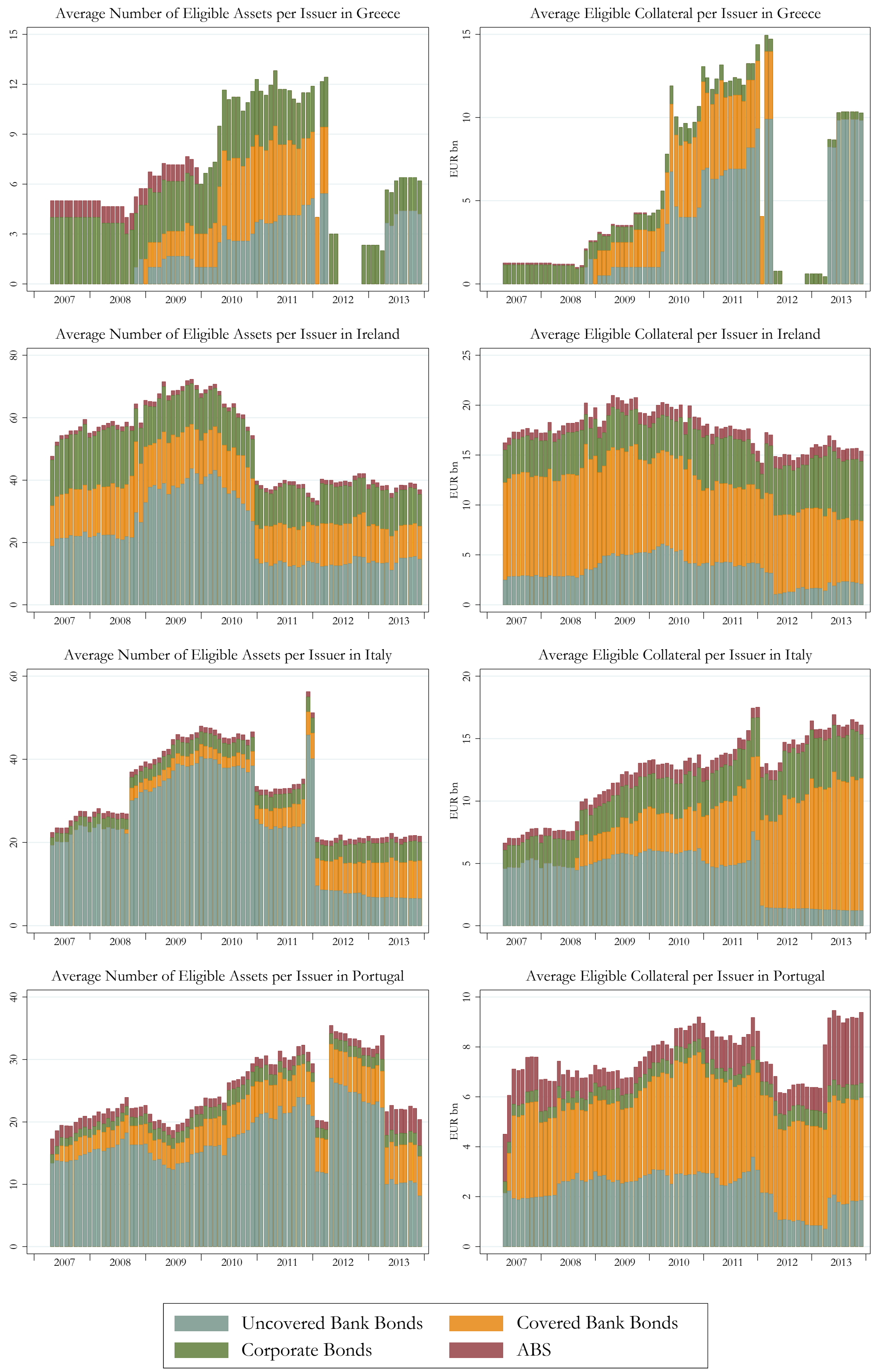
Figure 9.23: Average Eligible Collateral per Issuer by Country and Asset Type

The figure shows the average number of eligible assets per issuer (left panels) and the average amount of eligible collateral (right panels) distinguished by selected countries and asset types. It thus reveals intensified efforts to produce central bank-eligible collateral on an issuer basis. In Spain, Greece, Italy and Portugal, such behavior can be identified, while in Germany and France the average eligible collateral per issuer decreases.



Source: author's calculation; ECB, Eligible Assets Database.

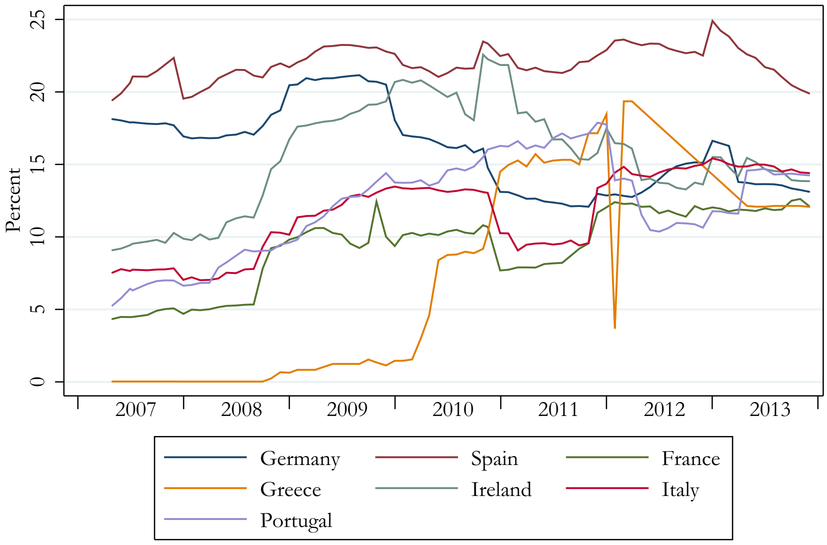
Figure 9.23: Average Eligible Collateral per Issuer by Country and Asset Type (Continued)



Source: author's calculation; ECB, Eligible Assets Database.

Figure 9.24: Eligible Collateral Issued by Banks and Special Purpose Vehicles Relative to Total Bank Assets

The figure shows the ratio of eligible collateral issued by banks and SPVs to banks' aggregate balance sheet total on a national basis for selected countries. From an aggregate perspective, an increase in the fractions of banks' assets that are eligible is visible. While in 2007 five of the seven countries had ratios below 10%, no country maintained a ratio below this level in 2013. The increase is not only due to collateral policy measures of the Eurosystem – e.g. in October 2008 – but also mirrors increased efforts of banks to produce central bank-eligible collateral.



Source: author's calculation; ECB, Monetary and Financial Statistics, MFI Balance Sheets; ECB, Eligible Assets Database.

in a jump in the ratio of eligible collateral to total assets in almost all depicted countries. Indeed, this observation only fails to hold in the case of Greece and Spain. However, the development during the European sovereign debt crisis is more interesting: from 2010 to 2012, the depicted ratio declines in Ireland (where it had increased a lot during 2008 and 2009) and Germany but increases in Portugal (until early 2012), Greece (where the data for 2012 is not very reliable due to the debt restructuring), Italy (with a temporary dip in 2011) and – to a lesser degree – in Spain and France. The developments in the named crisis countries drive the development emerging from an aggregate perspective, whereby larger shares of banks' balance sheets have become eligible over time. While in 2007 five of the seven countries had ratios below 10%, no country maintained a ratio below this level in 2013. The increase is not only due to collateral policy measures of the Eurosystem, but also mirrors increased efforts of banks to produce central bank-eligible collateral and be able to swap larger amounts of their assets into fresh liquidity using the reverse transactions with the Eurosystem.

Conclusion

This dissertation has elaborated upon the role of collateral for central banks in great detail.[392] It arrives at the conclusion that the configuration of the collateral framework is an instrument of central bank policy. Within a central bank refinancing loan contract, collateral is just as defining as other elements such as the amount, the maturity or the interest rate. Therefore, collateral policy should be regarded as equally important in terms of achieving central bank objectives.

In particular, the multifaceted nature of collateral policy induces its relevance for the entire range of central bank objectives spanning from monetary stability to financial stability as well as fiscal and economic stability. The various layers of the configuration of collateral policy are subsumed into six dimensions: the horizontal dimension of the quantitative range of eligible asset types, the vertical dimension of the eligible asset quality, the time dimension of the eligible asset ages, the value-level dimension shaped by operational conditions, the flow-back dimension defining eligible counter-assets in the collateralized lending operation and the access window dimension scaled by the range of eligible counterparties.

It was explained in Part I that the definition of eligible asset types and quality along the horizontal dimension of collateral policy plays a stressed role for monetary stability. This is true regardless of whether monetary stability is defined in terms of a stable relative value of the currency to a precious metal, another currency or the development of economic output. From a COMPR's perspective, for one collateral criteria securing a connection between the value of the currency that it issues and the value of the reference asset holds importance, for another the safety of the currency-backing assets that it takes onto its balance sheet. Historically, the link of having eligible collateral expand and contract with the needs of the real economy was implemented very directly in eligibility criteria, especially during the times of the gold standard through the Real Bills Doctrine and the idea of an elastic currency. This eventually shifted when government securities became the predominant collateralizing assets, as has been illustrated within Part II. However, as government securities inter alia receive their value from taxing power, economic activity is still mirrored indirectly. Additionally, the sustainability of public finances holds importance and can be captured along the vertical dimension of collateral quality. By contrast, from the perspective of financial stability, the collateral framework should both offer a wide range of eligible assets along the horizontal dimension and access to a wide set of solvent banks along the access window dimension. In effect, it should be possible to quickly liquidize large parts of banks' assets (of appropriate quality) at the central bank if necessary. Moreover, a LOLR places emphasis on

[392] The main findings, implications and contributions have already been overviewed at large within the introduction.

already-issued assets along the time dimension of asset ages and possibly sterilizes liquidity along the flow-back dimension. Most importantly, the value-level dimension requires relatively tight operational conditions above the (normal) market level to preserve the last resort character. Not only do requirements posed by the financial stability objective differ from those described for monetary stability, but also prescriptions for collateral policy towards fiscal and economic stability are different anon. Accordingly, a MMOLR has to offer operational conditions below the (normal) market level to encourage new issuances and loans at the time dimension. To trigger the realization of additional investment projects – which subsequently must be of lower productivity – a market-maker also has to accept the refinancing of the same, i.e. collateral of lower quality at the vertical dimension of its eligible collateral pool.

In light of the diverging configurations of collateral policy demanded by the various central bank objectives, the optimal use of collateral policy has been deduced from a theoretical analysis of the resulting trade-offs in central bank decision-making. It has been shown that through classical interest rate policy, a COMPR can control the level of investment and still leave the allocation of liquidity to market forces. Nevertheless, collateral policy is helpful to prevent losses to the central bank's balance sheet and facilitate the implementation of price stability through the appropriate delimitation of the eligible collateral pool. On the other hand, to sustain financial stability, collateral policy at the quantitative margin of the eligible collateral pool should be the means of choice. Freeing up large parts of banks' balance sheets in case of illiquid markets while maintaining a last-resort character permits a central bank to fulfill the LOLR role while minimizing trade-offs to other objectives. Haircut policy is helpful towards the fiscal and economic stability objective in two ways: for one, it allows targeted policy-making that affects market segments asymmetrically; and for another, it offers additional possibilities to ease central bank policy at the ZLB. From the extensive analyses of practical collateral policy actions of central banks in Part II, it is confirmed that major central banks have made use of collateral policy as an instrument towards their objectives at all times, namely both prior to and throughout the recent financial turmoils. Central banks in many of the discussed historical examples – as well as the Fed, BoE and BoJ in their recent collateral policies – paid tribute to the above-explained circumstance, namely that different objectives require different configurations of collateral policy by differentiating their collateral policy to varying degrees and subsequently being able to align it better to the respective configuration required by the targeted objective.

The lack of such a differentiation within the collateral framework of the Eurosystem constitutes the first of four critical remarks regarding the Eurosystem's collateral policy that evolve from the analyses and will complete this dissertation in the following. Before the crisis breakout, the collateral policy of the Eurosystem had already been uniform along five of six dimensions. Collateralized lending operations only differed to some extent along the value-level dimension, more precisely with respect to loan duration and the interest rate, which was also determined in auctions by variable-rate tenders. From the beginning of the crisis, it changed into an entirely uniform collateral policy because from then onwards liquidity has been fully allotted at the main refinancing rate (without a premium applied) and for all kinds of durations. Consequently, the Eurosystem takes a role (COMPR, LOLR or MMOLR, respectively) in all of its operations without exception and due to the full allotment leaves the determination of the scale to its counterparties.

The second critical remark is more fundamental and refers to the roles assigned to the Eurosystem based on the comprehensive analysis of its collateral framework in every detail and including all amendments from 2001 to 2014. It was concluded that the collateral policy by far exceeded the role of a COMPR, as elements of LOLR policy and even more pronounced of MMOLR policy have been identified. The latter in particular manifested in changes to the collateral criteria benefiting specific asset types and the deterioration of the quality structure of the eligible collateral pool, which has been identified through an innovative outside-in analysis. Moreover, traces of several collateral policy actions in asset markets and thus a market-making effect have been revealed. However, the Eurosystem has only been legally assigned a single mandate on price stability and hence monetary stability. Although this dissertation must leave an examination of their legal admissibility to further research, these collateral policy actions exceeding this mandate are remarkable, in a critical way.

Aside from the legal perspective, a third critical remark refers to the distribution effects that evolve because market segments targeted by asymmetrical collateral policy may to different degrees represent national economies in a monetary but not fiscal union like the EMU. By revealing information on the geographical structure of the Eurosystem's eligible assets pool, it has been shown that national collateral pools within the EMU differ and have been affected by collateral policy measures to varying extents. Some member countries have thus profited from collateral policy measures more than others, while resulting risks to monetary stability are shared by all member countries. Moreover, the ECB has granted some power to idiosyncratically decide upon eligibility and haircut determination to NCBs, hence setting the stage of a common pool problem. Anecdotal evidence of resulting free-riding behavior has been provided. Indeed, an estimate of the fractions of national collateral pools used in refinancing operations with the Eurosystem confirms that some member countries made more recourse of central bank refinancing than others.

Fourth, the segmental pooling of refinancing conditions by the Eurosystem can be criticized. It results from a clustering approach along three of four haircut-determining dimensions of asset characteristics, namely liquidity, residual maturity and credit quality, such that simplified haircuts are applied. In addition, the application of supplementary haircuts irrespective of credit quality, the theoretical valuation of assets as well as the application of a first-best rule to determine pivotal credit ratings contribute to an alignment of refinancing conditions for assets of different quality. An implementation of such conditions into a model of the European repo market has shown that the Eurosystem thereby subsidizes lower-quality assets and discriminates those of higher qualities, fostering an adverse selection of lower-quality collateral into its refinancing operations. Moreover, implementing segmentally-pooled refinancing conditions into the schematic analysis of distribution effects within a heterogeneous monetary union yields an additional quality dimension of the above-described distribution effects. More precisely, a redistribution from more productive to less productive countries – or, applied to the Eurozone, from non-crisis to crisis countries – is inferred from the model. An indication for the existence of such redistributive effects is given by the development of the TARGET balances.

While this dissertation has elaborated upon the possibilities of collateral policy for central bankers and revealed both positive and negative effects of its application, a critical assessment persists regarding the Eurosystem's collateral policy. The foundation for the critique essentially boils down to two points: first, the configuration of the policy such that it has – from the perspective of this dissertation – to be classified as exceeding the monetary stability objective assigned by legal mandate; and second, the facilitation of cross-border distributive effects within a monetary but not fiscal union by an independent institution that has been founded to conduct monetary policy but lacks the democratic basis for distribution policy. I conclude with a comment looking over the rim of an economist's tea cup: in light of current streams and developments within the society in Europe, both issues should be solved to re-strengthen European coherence and trust in common institutions.

Appendix to Chapter 7

Derivation of Equation (7.1)

Let the binary variable $I(\theta_j)$ be either 1 if bond j is traded on the market or 0 otherwise. Rent of borrowers R^B is given by the area underneath the price curve in Figure 7.4. As all bonds are traded at the distinct price $\rho(\theta_j) = \theta_j$, R^B reads as

$$R^B = \int_{\underline{\theta}}^{\bar{\theta}} I(\theta)\rho(\theta)\ d\theta = \int_{\underline{\theta}}^{\bar{\theta}} I(\theta)\theta\ d\theta = \int_{\underline{\theta}}^{\bar{\theta}} \theta\ d\theta = \left[\frac{1}{2}\theta^2\right]_{\underline{\theta}}^{\bar{\theta}} = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2}.$$

Derivation of Equation (7.3)

Analogous to the derivation of Equation (7.1) and with the uniform price $\rho = \frac{\bar{\theta}+\underline{\theta}}{2}$, R^B and R, respectively, are given by

$$R^B = R = \int_{\underline{\theta}}^{\bar{\theta}} I(\theta)\rho\ d\theta = \int_{\underline{\theta}}^{\bar{\theta}} \frac{\bar{\theta}+\underline{\theta}}{2}\ d\theta = \left[\frac{(\bar{\theta}+\underline{\theta})\theta}{2}\right]_{\underline{\theta}}^{\bar{\theta}} = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2}.$$

Derivation of Equation (7.4)

With a positively distorted signal and all bonds being traded with $\rho(\theta_j) = \max\Big(\theta_j + \epsilon, \bar{\theta}\Big)$, lenders suffer a loss in the amount of

$$\begin{aligned} R^L &= \int_{\underline{\theta}}^{\bar{\theta}} I(\theta)\Big(\theta - \rho(\theta)\Big)\ d\theta = \int_{\underline{\theta}}^{\bar{\theta}-\epsilon} I(\theta)\Big(\theta - (\theta+\epsilon)\Big)d\theta + \int_{\bar{\theta}-\epsilon}^{\bar{\theta}} I(\theta)(\theta - \bar{\theta})d\theta \\ &= [-\epsilon\theta]_{\underline{\theta}}^{\bar{\theta}-\epsilon} + \left[\frac{1}{2}\theta^2 - \bar{\theta}\theta\right]_{\bar{\theta}-\epsilon}^{\bar{\theta}} = -(\bar{\theta} - \underline{\theta} - \frac{1}{2}\epsilon)\epsilon < 0. \end{aligned}$$

Derivation of Equation (7.5)

Analogous to Equation (7.4), borrowers receive rent in case of a positively distorted signal given by

$$\begin{aligned} R^B &= \int_{\underline{\theta}}^{\bar{\theta}} I(\theta)\rho(\theta)\ d\theta = \int_{\underline{\theta}}^{\bar{\theta}-\epsilon} I(\theta)(\theta+\epsilon)d\theta + \int_{\bar{\theta}-\epsilon}^{\bar{\theta}} I(\theta)\bar{\theta}d\theta \\ &= \left[\frac{1}{2}\theta^2 + \theta\epsilon\right]_{\underline{\theta}}^{\bar{\theta}-\epsilon} + \Big[\bar{\theta}\theta\Big]_{\bar{\theta}-\epsilon}^{\bar{\theta}} = \frac{\bar{\theta}^2 - \underline{\theta}^2}{2} - \Big(\underbrace{-(\bar{\theta} - \underline{\theta} - \frac{1}{2}\epsilon)\epsilon}_{R^L}\Big). \end{aligned}$$

Derivation of Equation (7.6)

Considering $\alpha(\theta) = \theta - \underline{\theta}$ and that a fraction of bonds is traded in the market while the remainder is used with the outside option, rent of borrowers corresponding to aggregate surplus in the market is given by

$$\begin{aligned} R^B = R &= \int_{\underline{\theta}}^{\bar{\theta}} I(\theta)\rho \; d\theta + \int_{\underline{\theta}}^{\bar{\theta}} \Big(1 - I(\theta)\Big)\alpha(\theta) \; d\theta = \int_{\underline{\theta}}^{\theta_\alpha} \frac{\underline{\theta} + \theta_\alpha}{2} \; d\theta + \int_{\theta_\alpha}^{\bar{\theta}} (\theta - \underline{\theta}) \; d\theta \\ &= \left[\frac{(\underline{\theta} + \theta_\alpha)\theta}{2}\right]_{\underline{\theta}}^{\theta_\alpha} + \left[\frac{1}{2}\theta^2 - \theta\underline{\theta}\right]_{\theta_\alpha}^{\bar{\theta}} = \frac{\theta^2 - \underline{\theta}^2}{2} - \underline{\theta}(\bar{\theta} - \theta_\alpha). \end{aligned}$$

Derivation of Equation (7.19)

Rent of borrowers with segmentally-pooled public repo conditions and correct ratings is given by

$$\begin{aligned} R^B &= \int_{\underline{\theta}}^{\bar{\theta}} I(\theta)\rho(\theta) \; d\theta + \int_{\underline{\theta}}^{\bar{\theta}} \Big(1 - I(\theta)\Big)\alpha(\theta) \; d\theta \\ &= \int_{\underline{\theta}}^{\hat{\theta}_3} s(\theta) \; d\theta + \int_{\hat{\theta}_3}^{\theta_{\alpha_3}} \alpha(\theta) \; d\theta + \int_{\theta_{\alpha_3}}^{\hat{\theta}_1} s(\theta) \; d\theta + \int_{\hat{\theta}_1}^{\theta_{\alpha_1}} \alpha(\theta) \; d\theta + \int_{\theta_{\alpha_1}}^{\bar{\theta}} s(\theta) \; d\theta \\ &= \int_{\underline{\theta}}^{\hat{\theta}_3} \theta \; d\theta + \int_{\hat{\theta}_3}^{\theta_{\alpha_3}} \frac{\hat{\theta}_1 + \hat{\theta}_3}{b_3} \; d\theta + \int_{\theta_{\alpha_3}}^{\hat{\theta}_1} \theta \; d\theta + \int_{\hat{\theta}_1}^{\theta_{\alpha_1}} \frac{\bar{\theta} + \hat{\theta}_1}{b_1} \; d\theta + \int_{\theta_{\alpha_1}}^{\bar{\theta}} \theta \; d\theta \\ &= \left[\frac{1}{2}\theta^2\right]_{\underline{\theta}}^{\hat{\theta}_3} + \left[\frac{(\hat{\theta}_1 + \hat{\theta}_3)\theta}{b_3}\right]_{\hat{\theta}_3}^{\theta_{\alpha_3}} + \left[\frac{1}{2}\theta^2\right]_{\theta_{\alpha_3}}^{\hat{\theta}_1} + \left[\frac{(\bar{\theta} + \hat{\theta}_1)\theta}{b_1}\right]_{\hat{\theta}_1}^{\theta_{\alpha_1}} + \left[\frac{1}{2}\theta^2\right]_{\theta_{\alpha_1}}^{\bar{\theta}} \\ &= \frac{\bar{\theta}^2 - \underline{\theta}^2}{2} + \underbrace{\frac{\hat{\theta}_1^2 + \hat{\theta}_3^2}{2} + \frac{1}{2}\left(\frac{\hat{\theta}_1 + \hat{\theta}_3}{b_3}\right)^2 + \frac{1}{2}\left(\frac{\bar{\theta} + \hat{\theta}_1}{b_1}\right)^2 - \frac{\hat{\theta}_3(\hat{\theta}_1 + \hat{\theta}_3)}{b_3} - \frac{\hat{\theta}_1(\bar{\theta} + \hat{\theta}_1)}{b_1}}_{\text{additional rent from segmentally-pooled public repo conditions}}. \end{aligned}$$

Derivation of Equation (7.21)

Lenders sustain a loss with perfectly-pooled repo conditions and positively distorted ratings in the amount of

$$\begin{aligned} R^L &= \int_{\underline{\theta}}^{\bar{\theta}} I(\theta)\Big(\theta - \rho(\theta)\Big) \; d\theta = \int_{\underline{\theta}}^{\hat{\theta}_3 - \epsilon} \Big(\theta - s(\theta)\Big) \; d\theta + \int_{\theta_{\alpha_3} - \epsilon}^{\hat{\theta}_1 - \epsilon} \Big(\theta - s(\theta)\Big) \; d\theta + \int_{\theta_{\alpha_1} - \epsilon}^{\bar{\theta}} \Big(\theta - s(\theta)\Big) \; d\theta \\ &= \int_{\underline{\theta}}^{\hat{\theta}_3 - \epsilon} \Big(\theta - (\theta + \epsilon)\Big) \; d\theta + \int_{\theta_{\alpha_3} - \epsilon}^{\hat{\theta}_1 - \epsilon} \Big(\theta - (\theta + \epsilon)\Big) \; d\theta + \int_{\theta_{\alpha_1} - \epsilon}^{\bar{\theta} - \epsilon} \Big(\theta - (\theta + \epsilon)\Big) \; d\theta + \int_{\bar{\theta} - \epsilon}^{\bar{\theta}} (\theta - \bar{\theta}) \; d\theta \\ &= \Big[-\theta\epsilon\Big]_{\underline{\theta}}^{\hat{\theta}_3 - \epsilon} + \Big[-\theta\epsilon\Big]_{\theta_{\alpha_3} - \epsilon}^{\hat{\theta}_1 - \epsilon} + \Big[-\theta\epsilon\Big]_{\hat{\theta}_1 - \epsilon}^{\theta_{\alpha_1} - \epsilon} + \Big[-\theta\epsilon\Big]_{\theta_{\alpha_1} - \epsilon}^{\bar{\theta} - \epsilon} + \left[\frac{1}{2}\theta^2 - \bar{\theta}\theta\right]_{\bar{\theta} - \epsilon}^{\bar{\theta}} \\ &= -\left(\bar{\theta} - \underline{\theta} - \frac{1}{2}\epsilon + \hat{\theta}_1 + \hat{\theta}_3 - \frac{\hat{\theta}_1 + \hat{\theta}_3}{b_3} - \frac{\bar{\theta} + \hat{\theta}_1}{b_1}\right)\epsilon < 0. \end{aligned}$$

Derivation of Equation (7.22)

By contrast, borrowers benefit from positively distorted ratings and realize rent given by

$$
\begin{aligned}
R^B =& \int_{\underline{\theta}}^{\bar{\theta}} I(\theta)\rho(\theta)\ d\theta + \int_{\underline{\theta}}^{\bar{\theta}} \Big(1 - I(\theta)\Big)\alpha(\theta)\ d\theta \\
=& \int_{\underline{\theta}}^{\hat{\theta}_3-\epsilon} s(\theta)\ d\theta + \int_{\hat{\theta}_3-\epsilon}^{\theta_{\alpha_3}-\epsilon} \alpha(\theta)\ d\theta + \int_{\theta_{\alpha_3}-\epsilon}^{\hat{\theta}_1-\epsilon} s(\theta)\ d\theta + \int_{\hat{\theta}_1-\epsilon}^{\theta_{\alpha_1}-\epsilon} \alpha(\theta)\ d\theta + \int_{\theta_{\alpha_1}-\epsilon}^{\bar{\theta}} s(\theta)\ d\theta \\
=& \int_{\underline{\theta}}^{\hat{\theta}_3-\epsilon} (\theta+\epsilon)\ d\theta + \int_{\hat{\theta}_3-\epsilon}^{\theta_{\alpha_3}-\epsilon} \frac{\hat{\theta}_1+\hat{\theta}_3}{b_3}\ d\theta + \int_{\theta_{\alpha_3}-\epsilon}^{\hat{\theta}_1-\epsilon} (\theta+\epsilon)\ d\theta + \int_{\hat{\theta}_1-\epsilon}^{\theta_{\alpha_1}-\epsilon} \frac{\bar{\theta}+\hat{\theta}_1}{b_1}\ d\theta \\
&+ \int_{\theta_{\alpha_1}-\epsilon}^{\bar{\theta}-\epsilon} (\theta+\epsilon)\ d\theta + \int_{\bar{\theta}-\epsilon}^{\bar{\theta}} \bar{\theta}\ d\theta \\
=& \left[\frac{1}{2}\theta^2 + \theta\epsilon\right]_{\underline{\theta}}^{\hat{\theta}_3-\epsilon} + \left[\frac{(\hat{\theta}_1+\hat{\theta}_3)\theta}{b_3}\right]_{\hat{\theta}_3-\epsilon}^{\theta_{\alpha_3}-\epsilon} + \left[\frac{1}{2}\theta^2 + \theta\epsilon\right]_{\theta_{\alpha_3}-\epsilon}^{\hat{\theta}_1-\epsilon} + \left[\frac{(\bar{\theta}+\hat{\theta}_1)\theta}{b_1}\right]_{\hat{\theta}_1-\epsilon}^{\theta_{\alpha_1}-\epsilon} \\
&+ \left[\frac{1}{2}\theta^2 + \theta\epsilon\right]_{\theta_{\alpha_1}-\epsilon}^{\bar{\theta}-\epsilon} + \Big[\bar{\theta}\theta\Big]_{\bar{\theta}-\epsilon}^{\bar{\theta}} \\
=& \frac{\bar{\theta}^2 - \underline{\theta}^2}{2} + \underbrace{\frac{\hat{\theta}_1^2+\hat{\theta}_3^2}{2} + \frac{1}{2}\left(\frac{\hat{\theta}_1+\hat{\theta}_3}{b_3}\right)^2 + \frac{1}{2}\left(\frac{\bar{\theta}+\hat{\theta}_1}{b_1}\right)^2 - \frac{\hat{\theta}_3(\hat{\theta}_1+\hat{\theta}_3)}{b_3} - \frac{\hat{\theta}_1(\bar{\theta}+\hat{\theta}_1)}{b_1}}_{\text{additional rent from segmentally-pooled public repo conditions}} \\
&+ \underbrace{\left(\bar{\theta} - \underline{\theta} - \frac{1}{2}\epsilon\right)\epsilon}_{\text{additional rent from rating distortion}}.
\end{aligned}
$$

Derivation of Equation (7.24)

Risk to the central bank from offering perfectly-pooled public repo conditions when ratings are positively distorted corresponds to

$$
\begin{aligned}
R^{CB} =& \int_{\underline{\theta}}^{\bar{\theta}} (1 - I(\theta)\Big(\theta - \alpha(\theta)\Big) = \int_{\hat{\theta}_3}^{\theta_{\alpha_3}} \Big(\theta - \alpha(\theta)\Big)\ d\theta + \int_{\hat{\theta}_1}^{\theta_{\alpha_1}} \Big(\theta - \alpha(\theta)\Big)\ d\theta \\
=& \left[\frac{1}{2}\theta^2 - \frac{(\hat{\theta}_1+\hat{\theta}_3)\theta}{b_3}\right]_{\hat{\theta}_3-\epsilon}^{\theta_{\alpha_3}-\epsilon} + \left[\frac{1}{2}\theta^2 - \frac{(\bar{\theta}+\hat{\theta}_1)\theta}{b_1}\right]_{\theta_{\alpha_1}-\epsilon}^{\hat{\theta}_1-\epsilon} \\
=& -\left(\frac{\hat{\theta}_1^2+\hat{\theta}_3^2}{2} + \frac{1}{2}\left(\frac{\hat{\theta}_1+\hat{\theta}_3}{b_3}\right)^2 + \frac{1}{2}\left(\frac{\bar{\theta}+\hat{\theta}_1}{b_1}\right)^2 - \frac{\hat{\theta}_3(\hat{\theta}_1+\hat{\theta}_3)}{b_3} - \frac{\hat{\theta}_1(\bar{\theta}+\hat{\theta}_1)}{b_1}\right) \\
&- \epsilon\left(\frac{\hat{\theta}_1+\hat{\theta}_3}{b_3} + \frac{\bar{\theta}+\hat{\theta}_1}{b_1} - \hat{\theta}_3 - \hat{\theta}_1\right).
\end{aligned}
$$

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