The Effect of Banking Regulation on Cross-Border Lending

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Abstract

Banking regulations often differ between countries. For instance, some regulators oblige banks to document their evaluation of firms' creditworthiness and thereby determine the banks' lending technology. We study in a theoretical model how differences in regulation influence competition between domestic and foreign banks and the effect of regulatory harmonization on cross-border lending. We predict that lending rates are lower and access to credit is easier for firms located in the border region if regulation differs. We confirm the model's predictions using unique bank- and firm-level data from Germany by employing a difference-in-difference estimation.

JEL Classification: G21, G18, F23.
Keywords: Bank regulations, cross-border lending, SMEs, difference-in-difference estimation.

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1. Introduction

The credit market in the European Union (EU) is one of the EU's least integrated markets.[1] Small and opaque firms still face significant barriers to accessing EU-wide financing opportunities, and problems stemming from information asymmetries are severe. As a result, relationship banking plays an important role, and therefore, the physical distance between banks and firms is an influential variable. Small and opaque firms are also most strongly affected by EU-wide regulatory differences (ECB, 2010). Therefore, policy attempts to harmonize banking regulations. In this paper, we analyze how harmonization affects the credit market and the financing opportunities available to firms. We address this issue both theoretically and empirically using the example of regulatory harmonization between Germany and Austria for our empirical identification strategy.

In the European Union, banks have been allowed to operate abroad for several years, be it by market entry through new branches or acquisitions or through cross-border lending. However, legal provisions and, in particular, banking regulations differ between European countries despite efforts to harmonize them. For example, Germany and Austria both require banks to document how they assess the creditworthiness of firms above a certain threshold for the national supervisory authority. The threshold above which documentation is required was higher in Austria than in Germany (Hahn and Rößler, 2009). Until May 2005, banks had to document their assessment of creditworthiness for loans exceeding EUR 250,000 in Germany and EUR 750,000 in Austria. German (cooperative and savings) banks complained about competition from Austrian banks through cross-border lending, and the threshold value in Germany was subsequently adjusted to the Austrian level (Economist, 2005).[2]

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[1] Several analyses and reports try to quantify the degree of integration by measuring interest rate convergence, cross-border capital flows, or mergers. These surveys include Baele et al. (2004), Barros et al. (2005), Dermine (2006), Kleimeier and Sander (2007), and Heuchemer et al. (2008).

[2] This type of regulation is used only in Germany and Austria, and the difference in thresholds has existed for a long period of time. However, after the introduction of a common currency, banks began to engage in cross-border lending. The adjustment of the threshold value in Germany is in line with the Lamfalussy approach, which aims to reduce the difference in financial regulation and supervision.

Our paper begins with a theoretical analysis of the effect of regulatory differences between states and the effect of regulatory harmonization on cross-border lending. The theoretical model consists of a domestic and foreign bank, both of which choose their lending technologies. Both banks evaluate the creditworthiness of firms by using either 'private' or 'verifiable' information. We define 'private information' as information obtainable only from personal interaction between the bank and the firm. 'Verifiable information' is objective, and it does not depend on personal interaction and is thus independent of the physical distance between the bank and the firm. Most importantly, only verifiable information can be reported to the supervisory authority. In our empirical analysis, we then test the theoretical model using unique firm-level and bank-level data from Germany. We exploit surveys on firms' perceptions of banks' lending behavior, and we apply a difference-in-difference estimator to identify the effect of a regulatory difference on cross-border lending. By conducting a robustness analysis, we discuss the possible impact of cross-border lending on regional banks.

We obtain three main findings. First, the model predicts that for the foreign bank, cross-border lending is especially attractive if the domestic bank is facing stricter regulations; i.e., if it must use verifiable information. Correspondingly, the domestic bank suffers from regulation differences. Indeed, we observed that German banks lobbied for regulatory provisions to match those in Austria.

Secondly, our model shows that the probability of a firm located in the border region receiving loan offers from banks in both states depends on whether the regulation between these states differs. If the domestic bank is subject to stricter regulations than the foreign bank, there is a parameter range in which a firm's proximity to the Austrian bank increases the probability that it will receive loan offers from both banks. A difference-in-difference estimation shows that firms located closer to the Austrian border are more likely to perceive bank access to loans as accommodating as long as regulatory differences exist. This result is consistent with the research of Presbitero and Zazzaro (2011), who find that more competition (in our case, through regulatory differences) increases relationship lending in markets dominated by small local banks.

Finally, we show that the lending rate offered by the domestic bank depends on its proximity to the foreign bank. A German bank located relatively close to an Austrian bank demands lower lending rates when regulation differs; lending rates also increase

with the distance from the Austrian bank. The robustness analysis for an alternative data set of regional banks documents that the lending rates of German banks actually increase with the distance of these banks to Austria.

The paper is organized as follows. The next section presents a review of the related literature. Then, in section 3, we develop a theoretical model that captures the situations with and without regulation between two neighboring countries. Section 4 presents the difference-in-difference estimation for the firms' perception of access to credit, and we present similar results for lending rates taken from bank balance sheets in the robustness analysis. Finally, section 5 presents the conclusion.

2. Literature review

Our paper is related to several lines of research, including the role of financial deregulation, the relationship between distance in lending and foreign bank entry. The effects of regulatory changes are usually studied in the context of branching deregulation in some US states.[3] This literature (as summarized by Strahan, 2003) suggests that deregulation leads to faster growth and reduces volatility in the business cycle by fostering entrepreneurship. However, other authors propose that deregulation may negatively affect entrepreneurship in some regions (Wall, 2004) or that it does not significantly affect growth (Huang, 2008). Rice and Strahan (2011) show that small and medium enterprises (SMEs) in states with intense interstate banking benefit from lower interest rates. They suggest that deregulation causes banks to be more competitive, and this manifests itself in the form of lower interest rates. However, other features of the loan contract and access in general do not change.

Petersen and Rajan (2002) document that the physical distance between borrowers and banks in the U.S. has increased significantly over the last decades; they attribute this development to advances in information technology. Better information processing systems allow banks to access more hard information, and thus the need to collect soft information decreases. Hard information is usually recorded and does not have to be collected in person (Petersen, 2004). By contrast, soft information typically is gathered

[3] Note that in contrast to the US, banks in Europe have been free to operate abroad for several years. However, legal provisions and, in particular, banking regulation differ between European countries despite efforts to harmonize these and thus provide a level playing field.

through personal interaction between a firm and a bank or as a result of geographical proximity to a firm (Stein, 2002).[4] As a result, hard information is more amenable to comparative analyses (Petersen, 2004).

In most theoretical models, differences in lending technology are captured in the cost of acquiring information. In these models, the bank always obtains a perfect signal and therefore will finance only creditworthy firms. Due to the hold-up problem, the interest rate is higher for firms located closer to a bank because they are farther away from the competitor (see, for example, Degryse et al., 2008). Lending technologies may also differ in their assessment of the creditworthiness of firms. In Hauswald and Marquez (2006) the quality of the signal decreases with the distance between a bank and a firm. In such models, banks are not always active on the credit market. However, there is no definitive prediction about the effect of distance on the overall probability of receiving a loan offer. Regarding interest rates, the result is the same as before. The closer a firm is to the informed bank, the higher the interest rate (Hauswald and Marquez, 2006).[5]

This relationship between distance and the availability of soft information explains why price discrimination exists. Empirical studies by Degryse and Ongena (2005) and Agarwal and Hauswald (2010) find that as the distance between a borrower and his bank increases, the interest rate on loans decrease; however, as the distance between the borrower and the competing bank increases, the interest rate also increases. These results are due to the hold-up problem a borrower faces with its incumbent bank as it exploits its proprietary information to extract rents. Agarwal and Hauswald (2010) show that distance influences the loan rate and the availability of loans. The probability that a borrower gets an offer from his bank decreases with the distance from his bank, but the probability of an offer from a competing bank increases with this distance. Therefore, Agarwal and Hauswald (2010) conclude that price discrimination is due to asymmetric information between banks and is not caused by transportation costs (as suggested by

[4] The literature often refers to hard and soft information in similar contexts. However, we focus on whether information can be communicated between the bank and the financial supervisor agency.

[5] Casolaro and Mistrulli (2008) obtain the same result in a model in which they allow banks to choose between granting relational or transactional loans. In their model, functional distance, which depends on the organizational structure of the bank, is the crucial determinant of this choice.

Degryse and Ongena, 2005).[6] All of these papers study distance between a borrower and a bank operating in a single country. By contrast, we investigate the role of distance in cross-border lending.

So far, the empirical evidence on the effects of foreign banks (as a result of entry through either greenfield investment or acquisition) is mixed. Most of the existing research focuses on emerging markets, and – even more importantly – these papers do not discriminate between the modes of foreign bank entry.

To the best of our knowledge, our theoretical and empirical analysis of the effects of regulatory differences on cross-border lending is a novel contribution to the existing literature. Market entry via cross-border lending increases bank competition in the border region and improves its lending conditions. Thus, we provide evidence of distance and border effects in cross-border lending. This set-up differs from most other papers on foreign bank entry (see, for example, Berger et al., 2001; Mian, 2006). Previous approaches assume that the foreign bank has an advantage in dealing with verifiable information because they enter a new market (which is often distant from the bank's home country) through greenfield investment or acquisition. In contrast, we study lending practices to small and opaque firms in a cross-border context.

3. Model of cross-border lending

Our model captures banks and firms in two countries which may have different banking regulations. In the model, there is a continuum of (domestic) firms, the number of which is normalized to 1, and they are distributed uniformly on a Hotelling line of length 1. Firms want to undertake an investment project that has a cost of I. However, they do not have the funds to finance the projects themselves and therefore need to finance the investment with credit. We introduce two types of firms; good firms represent a fraction μ of the population and will be successful with probability p, and bad firms will always fail. If successful, a firm generates a return of X. If it fails, the return is 0. We

[6] Evidence from Italy (Alessandrini et al., 2009) confirms that a borrower's financing constraint increases in functional distance, which is the distance between a borrower's and a bank's location (where decisions about loans are made).

assume that the expected profit of a good project is positive, i.e., $pX - I > 0$, and that the average profitability of all projects is positive, i.e., $\mu pX - I > 0$.

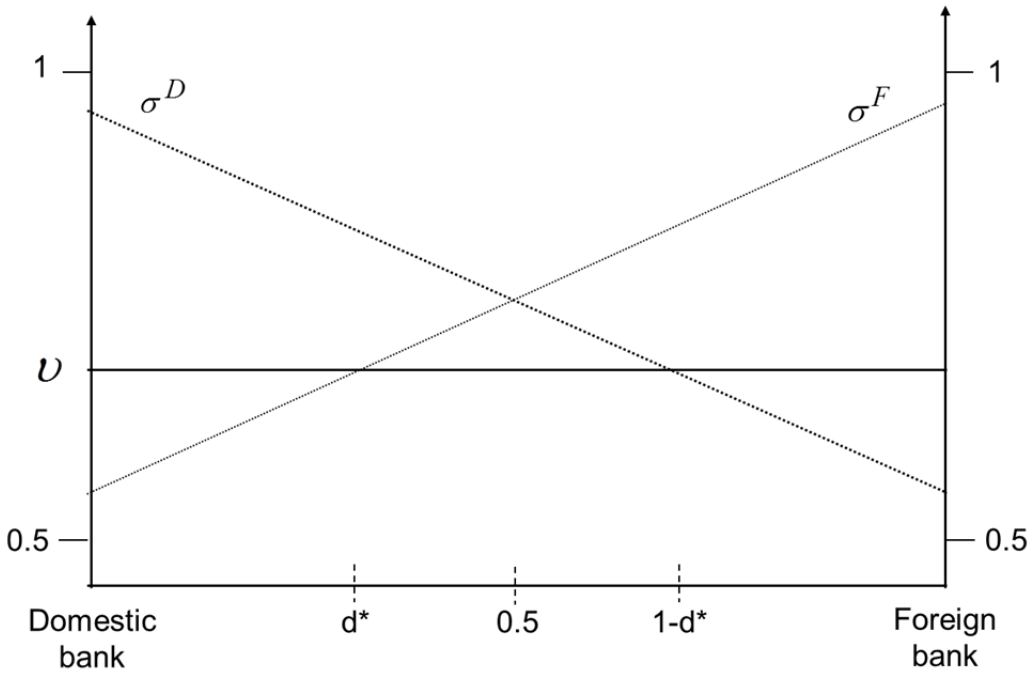
The firm can demand a loan from either a domestic bank or a foreign bank; these banks are located at opposite ends of the Hotelling line. Banks cannot observe a firm's creditworthiness, but they can observe its location and make their offers contingent on the firm's location; i.e., they price discriminate. Banks demand loan repayment rates of R if a firm is successful, where R^D denotes loan repayment to a domestic bank and R^F repayment to a foreign bank. The two banks have the same costs of refinancing, which we normalize to zero.

Banks can gather private or verifiable information. They can obtain verifiable information, for instance, from the firm's balance sheet by conducting a creditworthiness test. This verifiable information can be easily communicated, particularly to the supervisory authority. We capture the underlying screening as a procedure that gives the bank an imperfect signal about the type of the firm, which is correct with a probability of $\upsilon,\ 0.5 < \upsilon < 1$. The quality of the signal is independent of the distance between the firm and the bank because verifiable information can be communicated easily. Alternatively, the bank can rely on private information, which consists of insights gained during personal interaction between the loan officer and the firm's manager, for instance. However, this private information cannot easily be communicated to the supervisory authority. The bank obtains private information through a signal that reveals the firm's type correctly with a probability of $\sigma,\ 0.5 < \sigma < 1$.

As distance increases, it is more difficult to acquire and address private information. The quality of the signal σ deteriorates with the distance between the firm and the bank, and the parameter *d* denotes the distance between the foreign bank and the firm. We assume that both the domestic and the foreign bank use the same technology to process private information. Therefore, if both banks use private information, they obtain the correct signal with the same probability as firms that are located equidistant from the two banks, i.e., at *d=0.5* (see Figure 1 for an illustration). Beyond a certain threshold, the verifiable information will be more precise. Thus, we denote the distance to the foreign bank at which verifiable and private information are equally precise as d^*.

We focus on the case in which it is a disadvantage for the domestic bank to use verifiable information, and we assume that at d=0.5, the quality of private information is higher than that of verifiable information, $\sigma > \upsilon$.[7]

Figure 1: Probability that a Bank Receives a Correct Signal



For each location, the banks decide which lending technology to adopt and are not required to use one technology for all of their lending decisions. This set-up implies that the banks' costs for acquiring information consist of the expected losses arising from a wrong signal. There are no variable costs involved.[8] We assume that a bank (denoted by subscript 2) makes an expected loss if it finances a firm for which it obtains a positive

[7] Thus, when the domestic bank obtains a more precise signal from verifiable (rather than private) information, firms are relatively close to the foreign bank. This is the case for firms at a distance of $d<1-d^*<0.5$.

[8] In many models, the costs to acquire different types of information vary, but the signals obtained are perfect. However, in our model, the costs are captured by the expected losses. We could add costs to the evaluation of creditworthiness. Nevertheless, this would not qualitatively change our results and would render the exposition of the results less clear.

signal but the competing bank has rejected that firm, i.e., for all possible combinations of lending technologies,

$$\left((1-\mu)(1-s_1)s_2\left(pR^D-I\right)-(1-\mu)s_1(1-s_2)I\right)<0 \text{ for } s_1=\sigma \text{ or } \upsilon, s_2=\sigma \text{ or } \upsilon .$$

The foreign bank would have fixed costs of *k* to serve the (domestic) market, and the domestic bank has invested the fixed costs to implement the technology needed to acquire verifiable information. Thus, for the domestic bank, these fixed costs are sunk. The foreign bank can decide whether to incur the fixed costs *k* or not. We assume that if the bank is indifferent between the two technologies, it adopts the one in which the signal precision is higher.

The timing of events in the model is as follows. In the first stage, the foreign bank decides whether to serve the market or not. Then, the banks select a lending technology if they are free to make this choice, or they adopt the lending technology imposed on them by regulation. In the third stage, banks simultaneously announce the loan repayments that they require from the applicant, and in the fourth stage, firms simultaneously submit credit proposals to both banks. Banks then receive signals about the firms' creditworthiness and select a firm to receive a loan. Firms then decide from which bank they will borrow. Finally, payoffs are realized and, if successful, firms repay the bank loan.

We solve the game through backward induction and start by analyzing the banks' decision to grant a loan. Banks will only finance firms with a positive signal because financing bad firms yields a loss. Next, we study the banks' decision on lending rates. This decision depends on the lending technology chosen in the first step. There are three different possible scenarios, which we will study separately. When deriving the lending rates, we obtain the banks' profits, and we use bank profits to investigate the banks' decision related to lending technology.

3.1. Private and verifiable information

Suppose first that the foreign bank uses private information and the domestic bank uses verifiable information. The profit of both banks depends on the quality of its own signal and the quality of the competitor's signal. Banks offer loans to firms with a positive signal, and these firms consist of two groups. First, there are firms for which both banks obtain a positive signal. Second, there are firms for which the foreign bank receives a positive signal even though these firms were rejected by the competing bank. As we

assumed before, financing this latter type of firm yields a loss for this bank. The first group of firms will accept the offer if the repayment rate offered is lower than that of the competitor. The second group of firms will always accept the offer. The cumulative distribution function of the loan repayments to the foreign bank is denoted by F^F. Then, the profit function of the domestic bank Π^D can be written as follows:

$$\begin{aligned}\Pi^D\left(R^D\right) = \left(1 - F^F\left(R^D\right)\right)\left(\mu\sigma\upsilon\left(pR^D - I\right) - \left(1-\mu\right)\left(1-\sigma\right)\left(1-\upsilon\right)I\right) \\ + \left(\left(1-\mu\right)\left(1-\sigma\right)\upsilon\left(pR^D - I\right) - \left(1-\mu\right)\sigma\left(1-\upsilon\right)I\right)\end{aligned} \tag{1}$$

The quality of the foreign bank's signal depends on the firm's location, i.e., on the distance between the bank and the firm. For firms close to the foreign bank ($d < d^*$), the foreign bank is better informed about the firms' creditworthiness than its competitor and thus possesses an information advantage. This implies that the domestic bank requires a higher repayment rate on the loan to break even (denoted by $\underline{R}^D$) than the foreign bank. Consequently, the foreign bank can marginally undercut the domestic bank and make a positive profit from all customers of

$$\overline{\Pi}^F = I\left(1-\mu\right)\frac{\sigma - \upsilon}{\upsilon}. \tag{2}$$

In this type of model, there is no equilibrium in pure strategies. We can use the equations derived so far to characterize the equilibrium in mixed strategies. For firms located farther away from the foreign bank ($d \geq d^*$), the same logic applies but the domestic bank is now the better-informed bank. The results are summarized in the following lemma.

Lemma 1 [Foreign (domestic) bank uses private (verifiable) information]:

(1) For firms at a distance of $d < d^*$, the foreign bank offers loan repayment rates of R^F according to

$$F^F\left(R^F\right) = \frac{\mu\upsilon\left(pR^F - I\right) - \left(1-\mu\right)\left(1-\upsilon\right)I}{\mu\sigma\left(\upsilon pR^F - I\right) - \left(1-\mu-\sigma\right)\left(1-\upsilon\right)I} \qquad \forall\, R^F \in \left[\underline{R}^D, X\right).$$

The domestic bank offers loan repayment rates of R^D according to

$$F^D\left(R^D\right) = \frac{\sigma}{\upsilon}\frac{\mu\upsilon\left(pR^D - I\right) - \left(1-\mu\right)\left(1-\upsilon\right)I}{\mu\sigma\left(\upsilon pR^D - I\right) - \left(1-\mu-\sigma\right)\left(1-\upsilon\right)I} \qquad \forall\, R^D \in \left[\underline{R}^F, X\right)$$

and does not make an offer with a probability of $1-F^D(X)$. The foreign bank makes expected profits of $\overline{\Pi}^F_{d<d^*} = I(1-\mu)\frac{\sigma-\upsilon}{\upsilon}$ and the domestic bank of $\overline{\Pi}^D_{d<d^*} = 0$.

(2) For firms at a distance of $d \geq d^*$, the foreign bank offers loan repayment rates of R^F according to

$$F^F(R^F) = \frac{\upsilon}{\sigma}\frac{\mu\sigma(pR^F - I) - (1-\mu)(1-\sigma)I}{\mu\sigma(\upsilon pR^F - I) - (1-\mu-\sigma)(1-\upsilon)I} \qquad \forall R^F \in [\underline{R}^D, X)$$

and does not make an offer with a probability of $1-F^F(X)$. The domestic bank offers loan repayment rates of R^D according to

$$F^D(R^D) = \frac{\mu\sigma(pR^D - I) - (1-\mu)(1-\sigma)I}{\sigma\mu(\upsilon pR^D - I) - (1-\mu-\sigma)(1-\upsilon)I} \qquad \forall R^D \in [\underline{R}^F, X).$$

The foreign bank makes expected profits of $\overline{\Pi}^F_{d\geq d^*} = 0$ and the domestic bank of $\overline{\Pi}^D_{d\geq d^*} = I(1-\mu)\frac{\upsilon-\sigma}{\sigma}$.

Proof: See Appendix.

When firms are close to the foreign bank, the foreign bank has an information advantage and can undercut the domestic bank. If the domestic bank's offer is indeed undercut, the domestic bank will finance only those firms that were rejected by the foreign bank but nevertheless generate a positive, verifiable signal. Their average quality does not produce positive profits. Thus, the domestic bank is better off staying out of the credit market with a positive probability. As a result, it will make zero expected profits from all loan repayments. Both banks continuously mix their loan repayment rates in the ranges specified in Lemma 1. The foreign bank can exploit its private information by demanding X with a probability of $1-F^F(X)$. For firms located farther away, the precision of the domestic bank's signal is higher. Accordingly, the foreign bank then stays out of the market with a positive probability (part 2 of Lemma

1). The same argument put forth in Lemma 1 can be applied if the foreign bank uses verifiable information and the domestic bank uses private information.[9]

3.2. Verifiable information

Suppose next that both banks use verifiable information. Given that signals are independent, the profits are equivalent to the one in equation (1). The next lemma describes the resulting equilibrium.

Lemma 2 [Both banks use verifiable information]:

In this case, the banks are symmetric and each offers loan repayment rates of R according to

$$F(R) = \frac{\mu\upsilon(pR - I) - (1-\mu)(1-\upsilon)I}{\left(\mu\upsilon^2(pR - I) - (1-\mu)(1-\upsilon)^2 I\right)} \qquad \forall\, R \in [\underline{R}, X)$$

and does not make an offer with a probability of $1 - F(X)$. Both banks make zero expected profits.

Proof: See Appendix.

If both banks use verifiable information, they are symmetric. They both stay out of the credit market with positive probability, as this protects them against losses. Otherwise, the results in Lemma 2 are equivalent to those in Lemma 1.[10]

[9] Like the foreign bank, the domestic bank could be in a position to obtain private information in addition to verifiable information. However, due to regulations, the domestic bank is obliged to collect verifiable information. Given that it must be able to prove the creditworthiness of the firm to its supervisory authority, it cannot grant a loan to a firm with a bad (verifiable) signal although it knows (from private information) that the firm is good. Conversely, if a firm has a positive, verifiable signal and the bank has private information that the firm is bad, it will not grant a loan. Due to this first effect, the qualitative results of our analysis will hold.

[10] The seminal research of Broecker (1990) introduces the model for competition between banks with imperfect information and symmetric banks.

3.3. Private information

Suppose that both banks use private information. We denote the probability that they receive the correct signal as σ^F for the foreign bank and as σ^D for the domestic bank.

Lemma 3 [Both banks use private information]:

(1) For firms at a distance $d < 0.5$, the foreign bank offers loan repayment rates of R^F according to

$$F^F\left(R^F\right)=\frac{\mu\sigma^D\left(pR^F-I\right)-\left(1-\mu\right)\left(1-\sigma^D\right)I}{\mu\sigma^F\left(\sigma^D pR^F-I\right)-\left(1-\mu-\sigma^F\right)\left(1-\sigma^D\right)I} \qquad \forall\, R^F \in \left[\underline{R}^D, X\right).$$

The domestic bank offers loan repayment rates R^D according to

$$F^D\left(R^D\right)=\frac{\sigma^F}{\sigma^D}\frac{\mu\sigma^D\left(pR^D-I\right)-\left(1-\mu\right)\left(1-\sigma^D\right)I}{\mu\sigma^F\left(\sigma^D pR^D-I\right)-\left(1-\mu-\sigma^F\right)\left(1-\sigma^D\right)I} \qquad \forall\, R^D \in \left[\underline{R}^F, X\right)$$

and does not make an offer with a probability of $1-F^D(X)$. The foreign bank makes expected profits of $\overline{\Pi}^F_{d<0.5}=I(1-\mu)\frac{\sigma^F-\sigma^D}{\sigma^D}$ and the domestic bank of $\overline{\Pi}^D_{d<0.5}=0$.

(2) For firms at a distance of $d \geq 0.5$, the foreign bank offers loan repayment rates of R^F according to

$$F^F\left(R^F\right)=\frac{\sigma^D}{\sigma^F}\frac{\mu\sigma^F\left(pR^F-I\right)-\left(1-\mu\right)\left(1-\sigma^F\right)I}{\mu\sigma^F\left(\sigma^D pR^F-I\right)-\left(1-\mu-\sigma^F\right)\left(1-\sigma^D\right)I} \qquad \forall\, R^F \in \left[\underline{R}^D, X\right)$$

and does not make an offer with a probability of $1-F^F(X)$. The domestic bank offers loan repayment rates of R^D according to

$$F^D\left(R^D\right)=\frac{\mu\sigma^F\left(pR^D-I\right)-\left(1-\mu\right)\left(1-\sigma^F\right)I}{\mu\sigma^F\left(\sigma^D pR^D-I\right)-\left(1-\mu-\sigma^F\right)\left(1-\sigma^D\right)I} \qquad \forall\, R^D \in \left[\underline{R}^F, X\right).$$

The foreign bank makes expected profits of $\overline{\Pi}^F_{d\geq 0.5}=0$ and the domestic bank of $\overline{\Pi}^D_{d\geq 0.5}=I(1-\mu)\frac{\sigma^D-\sigma^F}{\sigma^F}$.

Proof: See Appendix.

3.4. Choice of lending technology

In the next step of the backward induction, we derive the banks' choice of the lending technology. Lemmas 1 to 3 imply that profit depends on the distance between the bank and the firm. Consequently, the choice of the lending technology also depends on distance. We can describe the banks' choice in the following proposition:

Proposition 1:

- In the presence of regulatory provisions, the domestic bank has to use verifiable information, whereas the foreign bank can choose its information source and uses private information.
- In the absence of regulatory provisions, for distance $d \in [0;1-d^*)$, the foreign bank uses private information, and the domestic bank uses verifiable information, and for distance $d \in [1-d^*;1]$, both banks use private information.

Proof: See Appendix.

When selecting their lending technology, banks compare their profits. If the domestic bank must use verifiable information, the foreign bank's best choice is to employ private information. If the foreign bank also uses verifiable information, competition would drive down profits to zero. Moreover, in a wide parameter range, private information yields a more reliable signal than verifiable information, and this gives the foreign bank an information advantage.

If the domestic bank is free to choose its lending technology, distance becomes a key variable. For firms close to the foreign bank, i.e., $d \in [0;1-d^*)$, the dominant strategy of the foreign bank is to use private information, as it yields a more precise signal. For the domestic bank, it is then optimal to use verifiable information to best protect itself against financing bad firms. For firms closer to the domestic bank, i.e., $d \in [1-d^*;1]$, both banks use private information.

In the last step of the backward induction, we study the foreign bank's choice to serve the market under consideration. The foreign bank will enter the market if the expected profits in that market exceed the fixed costs of serving the market k. When

comparing the profits of the foreign bank with and without regulation of the domestic bank, we obtain the following result:

Proposition 2: When regulatory provisions force the domestic bank to use verifiable information, the domestic bank offers lower loan repayment rates to firms at a distance of $d \in [1\text{-}d^*;1]$ than in the absence of these regulatory provisions. Thus, the foreign bank's profit is higher, and market entry is more attractive.

Proof: See Appendix.

Both in the presence and absence of regulation, the contracts are the same for firms at a distance of $d \in [0;1\text{-}d^*)$. However, firms outside of this interval are offered a lower repayment rate by the domestic bank if regulation is in place. This occurs because regulation forces the domestic bank to use verifiable information, even though it provides a less precise signal than private information. Therefore, the informational advantage that the domestic bank can exploit is smaller. Moreover, the expected profits of the foreign bank are higher because profits are higher for firms at a distance of $d \in [1\text{-}d^*;0.5]$ and because they are positive for firms at a distance of $d \in [0.5;d^*]$.

Ultimately, we are interested in the effect of distance on the credit market. Comparative statics provide the following results:

Proposition 3:

(1) If regulatory provisions are applied, a lower distance between the firm and the foreign bank implies that
   - the probability that a good firm receives an offer from both banks
     - is affected ambiguously by a distance $d \in [0;d^*)$, depending on the impact of distance on the underlying technology.
     - is higher for firms at a distance of $d \in [d^*;1]$.
   - the loan repayment rates offered by the domestic bank are higher for firms within a distance interval of $d \in [0;d^*)$ and lower for an interval of $d \in [d^*;1]$.

(2) If no regulatory provisions are applied, a lower distance between the firm and the foreign bank implies that

- the probability that a good firm receives an offer from both banks is ambiguously affected by distance depending on the impact of distance on the underlying technology.
- the loan repayment rates offered by the domestic bank are higher for firms at a distance of $d \in [0;0.5)$ and lower for $d \in [0.5;1]$.

Proof: See Appendix.

When the domestic bank is obliged to use verifiable information, we find that for firms close to the foreign bank, the foreign bank has an information advantage relative to the domestic bank. Banks will always offer loans to firms with a positive private signal. However, the domestic bank does not always offer loans. The probability that it offers a loan (i.e., is active on the credit market) is lower for firms close to the foreign bank. Thus, there are two countervailing effects that cause an undetermined sign and one of these effects will dominate depending on how strongly the informational content of the private signal deteriorates with distance and how important these information losses are at different locations. This effect will also influence the probability with which the domestic bank is active on the credit market. Nevertheless, we know that the information advantage of the foreign bank is highest for the closest firms, meaning that the domestic bank faces a stronger adverse selection problem. Thus, the domestic bank has to require higher loan repayment rates. Therefore, within this distance, firms located closer to the foreign bank are offered higher loan repayment rates by the domestic bank.

Secondly, we compare firms that are located farther away from the foreign bank. Within this group, firms that are closer to the foreign bank have a higher probability of receiving offers from both banks. The domestic bank always makes an offer to firms with a positive signal. However, the foreign bank stays out of the credit market with positive probability. This probability is lower if the firm is closer to the foreign bank, as the information disadvantage of the foreign bank is smaller in this instance. Moreover, the quality of the signal increases with greater proximity. Thus, it is even more likely that the foreign bank obtains a positive signal for a good firm. Accordingly, the probability that the good firm receives two offers increases the closer it is to the foreign bank. Moreover, as the quality of the foreign bank's signal improves, the foreign bank

can make more aggressive bids to nearby firms. This drives down the loan repayment rates offered by the domestic bank for firms that are closer to the foreign bank.

When the domestic bank is not subject to regulatory provisions, we again find that there are countervailing effects on the probability that a good firm is offered a loan (following from the same arguments as presented above). However, unlike when there are differences in regulation between states, this dynamic applies to all firms. Moreover, the loan repayment rates offered by the domestic bank increase for firms located closer to the foreign bank within a distance interval of [0;0.5). This occurs because the domestic bank faces a stronger adverse selection effect for firms located closer to the foreign bank, and it therefore demands higher loan repayment rates. For firms in the other parameter range, i.e., those that are closer to the domestic bank, a greater distance between the domestic bank and the firm means that the informational advantage available to the domestic bank – which it can use to demand higher loan repayment rates – is lower. Moreover, the private signals obtained by the foreign bank for these firms improve in quality such that the foreign bank exerts more competitive pressure. As a result, the loan repayment rates offered decrease for firms closer to the foreign bank.

3.5. Testable hypotheses

Based on our theoretical model, we derive testable hypotheses for the lending rates offered by domestic banks and the banks' lending attitudes and determine how these variables are affected by distance. Given that the empirical analysis in the present study focuses on regulatory differences between Germany and Austria, we consider the German firms and banks as domestic agents and the Austrian banks as the foreign bank.

From our geographical data (which is described below), we can determine the proximity of the German firms and banks to the Austrian banks. Therefore, provided that the Austrian bank serves the market in question, the conditions observed in border regions are best captured by the results for firms located at $d \in [0.5;1]$. Proposition 3 implies hypothesis 1 concerning the banks' readiness to lend. Proposition 2 implies hypothesis 2 regarding the lending rates required by the domestic bank. Thus, in the next section we test the following two hypotheses.

Hypothesis 1: Firms located closer to the border are more likely to perceive banks' lending behavior as accommodating if regulatory differences between the two countries exist.[11]

Hypothesis 2: Banks located closer to the border have lower lending rates if regulatory differences between the two countries exist.

When regulation is harmonized across the two countries, the financing conditions become less favorable for firms in the border region. However, the lending rates will still be influenced by the distance to the border because – provided the foreign banks engage in cross-border lending – banks exert a stronger influence on closer firms. Moreover, Proposition 2 suggests that for the Austrian bank, market entry via cross-border lending is a more attractive prospect if German regulations are stricter than those in Austria.

4. Estimation results

In this section, we use unique firm-level and bank-level data from Germany (see Table 1 for variable definitions) to test the hypotheses derived in the previous section. In the first part, we use firm surveys on their perception of the lending behavior of banks. Then, as robustness analysis, we discuss the impact of cross-border lending on regional banks. Our identification strategy relies on the difference-in-difference approach which accounts for variation in time and space and is commonly used for analyses of policy impact (Gruber and Poterba, 1994, Buettner and Rincke, 2007). The time variation is derived from the harmonization of regulations in May 2005. The spatial variation arises because only borrowers in the border region have access to cross-border credits.

[11] The existing literature gives largely different predictions. Applying the results of Degryse et al. (2008) and Hauswald and Marquez (2006) to cross-border lending, we would expect that firms in border regions pay higher interest rates, which decrease with distance to the foreign bank. Thus, their prediction is antithetical to ours. Degryse et al. (2008) predict that the probability of a loan being offered to good firms is equal to one because banks obtain a perfect signal. Thus, the distance between a bank and a firm should not matter for the perception of the bank's lending behavior. Although Hauswald and Marquez (2006) propose that distance is a significant variable, they do not predict the effect of distance on the perception of the foreign bank's lending behavior.

Table 1: Definition of Variables.

A: Ifo Business Climate Survey

Table label	Symbol	Definition
Access to credit	*c*	Dummy variable which is coded as 1 for firms perceiving the lending policy of banks as accommodating and 0 otherwise.
Business situation	*b*	Variable which is coded as 1 for firms perceiving the business situation as bad, 2 for usual and 3 for good.
New orders	element of **Z**	Variable which is coded as 1 for firms perceiving the status of new orders as bad 2 for usual and 3 for good.
Exporter	element of **Z**	Dummy variable which is coded as 1 if firms report exports and 0 otherwise.
Distance	*distance*	Minimum distance of analyzed firms to selected communities in Austria which have at least one bank office. This variable is used only for the definition of $border^{pre}$ and $border^{post}$.
$Border^{pre}$	$border^{pre}$	Dummy variable which is coded as 1 for firms located in the cross-border region (distance less than 150 km) before the regulatory harmonization in May 2005 and zero otherwise.
$Border^{post}$	$border^{post}$	Dummy variable which is coded as 1 for firms located in the cross-border region (distance less than 150 km) after the regulatory harmonization in May 2005 and zero otherwise.
Size (1-49 employees)	element of **Z**	Set of dummy variables which are coded as 1 for firms with 1-49, 50-499, 500-999, and 1000 employees and more, respectively, and 0 otherwise.
Year dummies	element of **Z**	Set of dummy variables for business surveys (performed in March and August) between 2003 and 2007. The dummies are coded as 1 for the indicated period and 0 otherwise.

B: Bavarian Cooperative Banks

Table label	Symbol	Definition
Lending rate	*LR*	Lending rate computed as the ratio of interest income to interest yielding assets according to equation (3).
Assets	*assets*	Total assets in Euro (in logs).
Equity	*equity*	Ratio of equity capital to total assets.
Distance	*distance*	Minimum distance of analyzed banks to selected communities in Austria with at least one bank office.
Border	*border*	Dummy variable which is coded as 1 for banks located in the border region (distance less than 150 km) and zero otherwise.
$Border^{pre}$	$border^{pre}$	Dummy variable which is coded as 1 for banks located in the border region (distance less than 150 km) before the regulatory harmonization in May 2005 and zero otherwise.
Year dummies	element of **Z**	Set of dummy variables which are coded as 1 for years 2003 to 2007 and 0 otherwise.

Table 2: Descriptive Statistics

A: ifo Business Climate Survey

Variable	no. of obs	Mean	std. dev.	min	max
Access to credit	2312	0.082	0.274	0	1
Business situation	2311	1.957	0.673	1	3
New orders	2309	1.766	0.647	1	3
Exporter	2312	0.739	0.439	0	1
Distance	2312	1.499	0.803	0.053	2.991
$Border^{pre}$	2312	0.283	0.451	0	1
$Border^{post}$	2312	0.278	0.448	0	1
Size (1-49 employees)	2312	0.230	0.421	0	1
Size (50-199 employees)	2312	0.417	0.493	0	1
Size (200-499 employees)	2312	0.171	0.376	0	1
Size (500-999 employees)	2312	0.072	0.258	0	1
Year 2003:06	2312	0.097	0.296	0	1
Year 2003:08	2312	0.096	0.295	0	1
Year 2004:03	2312	0.109	0.312	0	1
Year 2004:08	2312	0.095	0.293	0	1
Year 2005:03	2312	0.106	0.308	0	1
Year 2005:08	2312	0.095	0.293	0	1
Year 2006:03	2312	0.111	0.314	0	1
Year 2006:08	2312	0.101	0.301	0	1
Year 2007:03	2312	0.100	0.300	0	1
Year 2007:08	2312	0.090	0.286	0	1

B: Bavarian Cooperative Banks

Variable	no. of obs	mean	std. dev.	min	max
Lending rate	1747	5.363	0.474	3.663	7.213
Assets	1766	0.287	0.318	0.012	4.077
Equity	1766	0.059	0.013	0.028	0.172
Distance	1675	1.438	0.838	0.144	3.320
Border	1783	0.566	0.496	0	1
$Border^{pre}$	1783	0.225	0.418	0	1
Year 2003	1783	0.216	0.412	0	1
Year 2004	1783	0.204	0.403	0	1
Year 2005	1783	0.199	0.399	0	1
Year 2006	1783	0.188	0.391	0	1
Year 2007	1783	0.183	0.387	0	1

Note: The definition of variables can be found in Table 1.

4.1. Data description

In the empirical analysis, we use the regulatory differences between Germany and Austria to explain the behavior of the credit market in the federal state of Bavaria, which is the only federal state in Germany to border Austria. This border is 816 km in length, and Bavaria has approximately 12.5 million inhabitants. Bavaria is thus slightly larger than Austria, which has approximately 8.4 million inhabitants. Moreover, it represents approximately 15 percent of Germany's total population and nearly 18 percent of the German GDP. Regulatory differences existed between these countries until 2005, and this context provides a unique natural experiment that we exploit for our empirical analysis.

The German banking system is a three-pillar system, consisting of private commercial banks, cooperative banks, and public banks. If all market segments are considered, each of these 'pillars' has about the same market share (Brunner et al., 2004; Krahnen und Schmidt, 2004). However, large commercial banks play a limited role in financing SMEs, whereas savings banks and cooperative banks approach the financing of SMEs in a similar fashion (Prantl et al., 2009). Due to their regional principle, cooperative and savings banks both finance firms in their own 'district' but rarely finance firms located elsewhere. Our analysis is especially salient to SMEs, but no individual loan data are available for them. However, we have two data sets covering either firms or banks that we use to conduct a comprehensive empirical analysis.

4.1.1. Ifo business climate survey

Our first data set originates from the Ifo Business Climate Survey and provides a unique source of information on the perception of banks' lending behavior by German manufacturing firms.[12] This data set is composed of 339 firms and about 2,300 observations (see Table 2, Panel A). The data set became available for research only recently. The surveys are available on a semiannual basis from June 2003 to August 2007. On average, the number of periods per firm is 6.8 (ranging from 1 to 10). For

[12] Unfortunately, we do not have information about which banks a firm has a business relationship with because this goes beyond the scope of the Ifo Business Climate Survey. With only a few exceptions, all firms have the possibility of contacting at least one bank that is located directly in their municipality. The majority of firms are located in municipalities with two or more financial institutions.

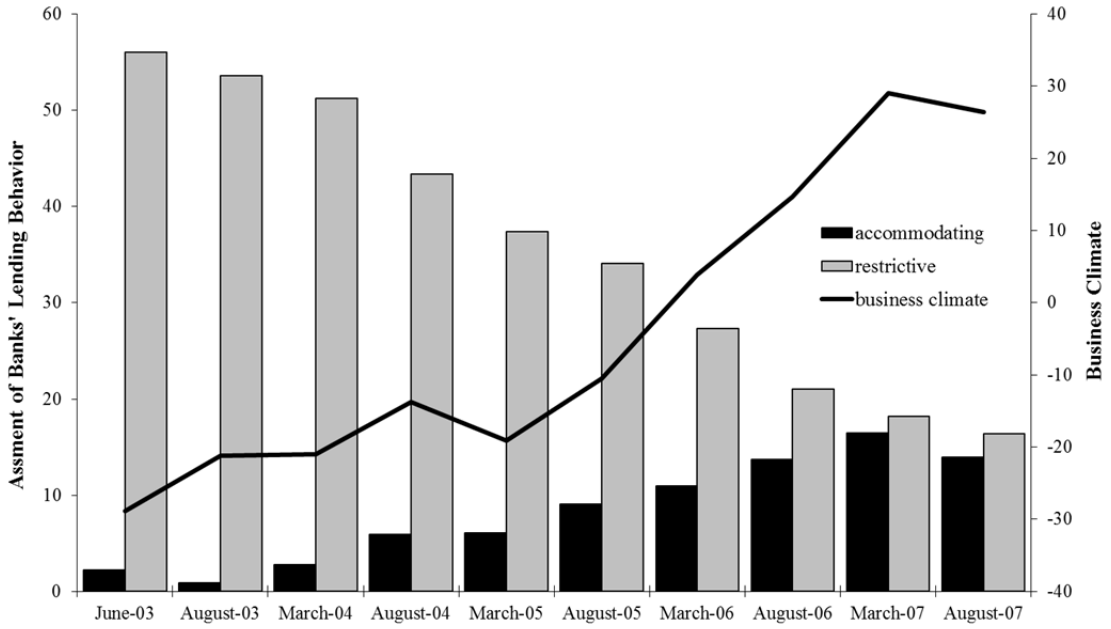
slightly more than a half, 141 firms, data is available for the whole period.[13] The majority of firms participated in several surveys before and after the regulatory changes in May 2005. Only 82 firms did not participate in the surveys performed after May 2005. Similarly, only 32 firms joined the Ifo Business Climate Survey after May 2005.

With regard to the lending policy of banks, firms are asked: *"How do you assess the readiness of banks to provide loans to firms?"*, with 'restrictive', 'normal', and 'accommodating' being the possible responses. Importantly, the first two choices are not necessarily mutually exclusive; in particular, responses of 'restrictive' and 'normal' are likely to represent a joint category. This could be especially important in the German context because of its long tradition of conservative lending policy, which is positively perceived by the population. Therefore, we group the answers into two categories, namely 'accommodating' versus 'non-accommodating' (which is normal and restrictive). The test of the parallel regression assumption confirms that this approach is appropriate, and the test results are available upon request.

The business situation of the individual firms should play an important role in the banks' decision to lend. If banks obtain informative signals about a firm's creditworthiness, the correlation between the perception of the banks' lending behavior and the firm's business situation is expected to be positive. Figure 2 shows a strong correlation between the assessment of the lending behavior and the overall business situation. Therefore, we include the firms' assessment of their business as a control variable. Similar to the previous case, the answers include 'bad' (coded as 1 in the data set), 'satisfying' (coded as 2), and 'good' (coded as 3). Moreover, we compare business evaluations against information on new orders. Similarly to the business assessments, firms are asked to evaluate their orders as bad (coded as 1), usual (coded as 2) and good (coded as 3). Not surprisingly, both variables are highly correlated and yield similar results. Furthermore, we include the export status of the analyzed firms, which is defined as a dummy variable which equals to one for exporting firms and zero otherwise. The response rates to all questions are generally very high.

[13] Von Kalckreuth (2008) and Büttner and Fuest (2010) show that credit conditions are a significant determinant of investment and business cycles in Germany.

Figure 2: Access to Credit and Business Climate, in Percent



Note: Business climate is defined as the share of firms assessing their business situation as good minus the share assessing it as bad.

Source: EBDC Data Center of the University of Munich and ifo Institute Munich, own calculations.

4.1.2. Bank balance sheet data

Our second data set covers the annual balance sheets of more than 330 Bavarian cooperative banks (mainly the so-called "Raiffeisenbanken") between 2003 and 2007 and includes all of their balance sheet and profit-and-loss account data. These data provide us with more than 1,600 observations on cooperative banks (see Table 2, Panel B). The cooperative banks provide household loans but focus on financing SMEs (Prantl et al., 2009). Thus, they are of particular interest to us because regulatory changes should have the greatest effect on medium-sized firms. Moreover, the cooperative banks operate regionally and largely finance firms in their specific 'district'. Therefore, if distance is a significant variable (as our theoretical model suggests), distance-dependent effects should be clearly visible in the data for these banks. The distance effects could hardly be identified on the balance sheets of large commercial banks because these banks are active throughout Germany.

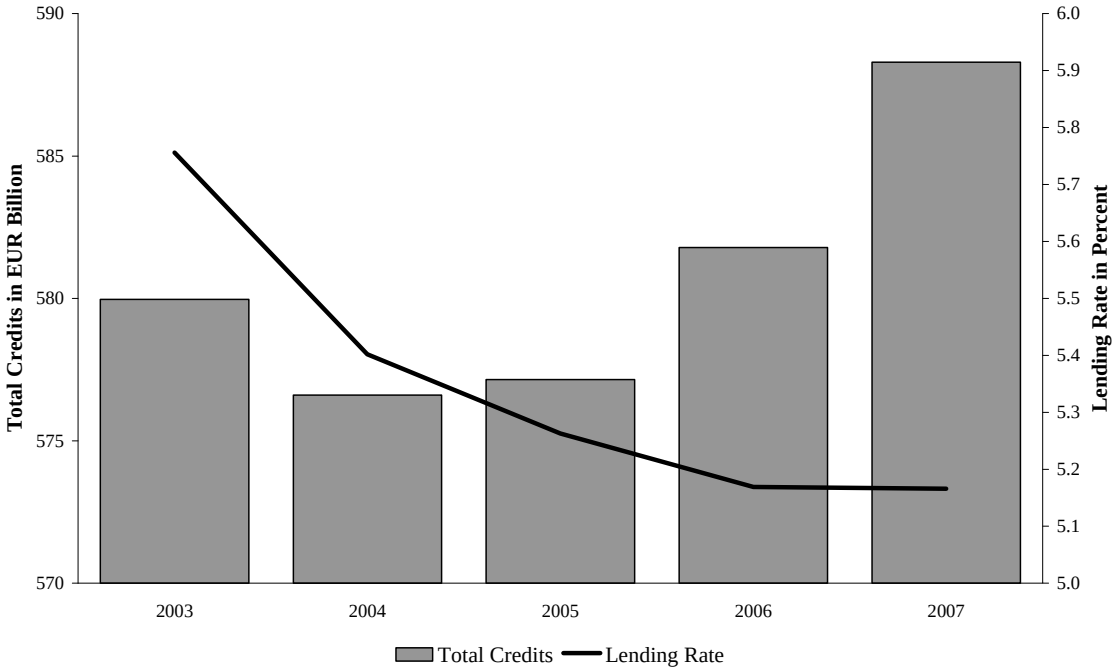
From the balance sheets, we can compute lending rates, *LR*, as the ratio of interest income to interest-yielding assets,

$$LR_{it} = 100 \frac{IP_{it}}{C_{it}^{P} + C_{it}^{G} + C_{it}^{F}}, \tag{3}$$

where *IP* is total interest income, and C^P, C^G and C^F are credits to private firms, the public sector, and financial institutions, respectively.

Figure 3 illustrates the development of lending conditions from the perspective of the cooperative banks. Loans to the private sector provided by cooperative banks remained constant at approximately EUR 570 to 580 billion between 2003 and 2005. After this period, loan growth remained very moderate, at less than 1 percent. By contrast, the average lending rate declined by approximately 0.6 percent over the same period (from 5.8 percent in 2003 to 5.2 percent in 2007).[14]

Figure 3: Loans and Retail Lending Rates of Cooperative Banks



Source: Union of Bavarian Cooperative Banks, own calculations.

[14] Over the same period, both Germany as a whole and Bavaria in particular reported slight credit declines. In turn, the ECB's repo rate increased from 2 percent in several steps (concentrated especially from 2006 to 2007) to more than 4 percent.

4.1.3. Geographical data

Both data sets are merged with geographical data. We include data for the distance from firms and cooperative banks to selected communities in Austria which have at least one bank office. We use this as a proxy for the firm's opportunity to obtain a loan from abroad. In the empirical analysis, we take the shortest great circle distance between the German firms and bank and an Austrian bank. Thus, we identify 14 communities in Austria that are closest to the German respondents in this study. The distance between these firms and banks ranges between 14 km and approximately 300 km.

4.2. Cross-border lending and firms' perceptions of banks' lending behavior

According to hypothesis 1, German firms located in the border region are more likely to perceive the banks' lending behavior as accommodating if regulation differs between the two countries. Therefore, we begin the empirical analysis by determining the access to credit for firms in the border region of Germany between June 2003 and August 2007 using the Ifo Business Climate Survey.

To estimate the impact of regulatory differences on lending conditions, we exploit the reduction of the threshold level in Germany to the values already applied in Austria in May 2005. This policy change was not expected at that time, and we treat regulatory differences as a policy mechanism that only affected firms located in Bavaria. The untreated group includes firms located more than 150 km from the Austrian border, as well as firms located in the border region after May 2005. We only consider firms from Bavaria, which ensures that the whole sample is relatively homogenous. Thus, the difference between treated and untreated groups is largely due to the different access to cross-border lending before 2005 in the border region. Although the firms are not fully randomly assigned to treatment and non-treatment groups, we are not aware of any major economic developments that had a different effect on both groups.[15] Moreover, if any other changes did occur, they would be related to the regulatory harmonization implemented in May 2005.

[15] The Economist (2005) reports that the harmonization of reporting thresholds in Austria and Germany was the most significant event affecting credit conditions in the border region in 2005.

Table 3: Mean and Mean Equality Test for Selected Periods

	Total period 2003-2007	Before May 2005	After May 2005	Mean equality *t*-test
Access to credit	0.082	0.036	0.128	8.182***
	(0.274)	(0.187)	(0.334)	[0.000]
Business situation	1.957	1.792	2.125	12.265***
	(0.673)	(0.653)	(0.651)	[0.000]
New orders	1.766	1.608	1.925	12.121***
	(0.647)	(0.603)	(0.651)	[0.000]
Exporter	0.739	0.723	0.755	1.745*
	(0.439)	(0.448)	(0.430)	[0.081]
Distance	1.499	1.502	1.497	-0.163
	(0.803)	(0.808)	(0.799)	[0.871]
Size (1-49 employees)	0.230	0.232	0.227	-0.263
	(0.421)	(0.422)	(0.419)	[0.792]
Size (50-199 employees)	0.417	0.412	0.421	0.408
	(0.493)	(0.492)	(0.494)	[0.684]
Size (200-499 employees)	0.171	0.175	0.166	-0.567
	(0.376)	(0.380)	(0.373)	[0.571]
Size (500-999 employees)	0.072	0.075	0.069	-0.552
	(0.258)	(0.263)	(0.253)	[0.581]

Note: The definition of variables can be found in Table 1, bloc A. Standard deviations are in parentheses below mean values, *p*-values are in brackets. ***, **, and * denote significance at 1 percent, 5 percent, and 10 percent, respectively.

When evaluating whether the difference-in-difference approach is appropriate, we should note that, in general, the German economy was improving after 2005. The data in Figure 2 indicate that credit conditions and the business climate were improving between 2003 and 2007. Moreover, Table 3 shows that, after 2005, the business situation, new orders, and access to credit experienced significant improvements in Bavaria, whereas all other variables for the analyzed firms remained similar in both periods. Thus, we found that the general conditions were opposite of those expected in the difference-in-difference estimations.

Using probit and logit models, we estimate the relationship between firms' perceptions of lending policy, distance from a foreign bank and the business situation of the respondent. The estimation equation can be stated as follows:

$$P(c_{it} = 1) = \lambda_1 border_{it}^{pre} + \lambda_2 border_{it}^{post} + \beta_1 + \beta_2 b_{it} + \mathbf{Z}_{it}\gamma + \varepsilon_{it}\,. \quad (4)$$

Our dependent variable is the conditional probability c that a firm i at time t perceives banks' lending behavior to be accommodating. We focus on the variable $border^{pre}$, which measures differences in bank regulation. It equals one for German firms located in the cross-border region before the regulatory harmonization in May 2005 and zero otherwise. A second dummy variable for the border effect after May 2005 ($border^{post}$) equals one for firms in the border region after the regulatory harmonization in May 2005 and zero otherwise. For both variables, the border region is defined by the location within 150 km of the German-Austrian border.[16] This threshold distance of 150 km corresponds to the maximum distance at which direct communication is plausible, given that a meeting can be organized as a half-day trip.

Moreover, b denotes firm i's assessment of its business situation, **Z** is a vector of additional control variables, including dummies for the size of the firms and time effects (that is, the period of the semiannual surveys) with the corresponding coefficient vector γ. Finally, ε is the error term with the standard statistical properties (i.i.d.). The time effects reflect all time-specific factors, including, for example, business cycles as discussed by Blum and Hellwig (1995).

Table 4 reports the results of the difference-in-difference estimation. Prior to May 2005, the border effects to Austria are, as expected, positive and statistically significant. There is a relatively high marginal effect from a firm's location in the border region on the probability that a firm views the credit supply as accommodating (4.9 percentage points on average). Moreover, we can see that the location in the border region has low and insignificant effects after May 2005. Thus, our results confirm that the location in the border region alone does not have a significant effect on lending behavior. The regulatory difference improved access to loans in the border region prior to 2005.

[16] Moreover, we performed a version of the Chow structural break tests looking at selected distance intervals (75, 100, 125, 150, 175, 200, and 250 km). The distance of 150 km was characterized by the highest *z*-statistics. This value splits the sample about equally. The results are available upon request from the authors.

Table 4: Difference-in-Difference Estimation of the Effects of Regulatory Harmonization on Financial Access (Marginal Probability Effects)

	(1)		(2)		(3)		(4)		(5)		(6)	
Estimation Method	logit		probit		logit		probit		logit		probit	
$Border^{pre}$	0.049	**	0.049	**	0.049	**	0.049	**	0.050	**	0.049	**
	(2.284)		(2.427)		(2.286)		(2.428)		(2.224)		(2.402)	
$Border^{post}$					0.003		0.002		-0.000		-0.001	
					(0.283)		(0.218)		(-0.020)		(-0.072)	
Business situation	0.037	***	0.043	***	0.037	***	0.043	***				
	(6.322)		(6.372)		(6.339)		(6.388)					
New orders									0.024	***	0.028	***
									(3.718)		(3.845)	
Exporter									0.011		0.009	
									(1.003)		(0.766)	
Year 2003:06	-0.055	***	-0.061	***	-0.055	***	-0.060	***	-0.060	***	-0.066	***
	(-4.103)		(-4.359)		(-3.989)		(-4.209)		(-4.208)		(-4.529)	
Year 2003:08	-0.066	***	-0.069	***	-0.065	***	-0.069	***	-0.070	***	-0.074	***
	(-4.134)		(-4.605)		(-4.068)		(-4.506)		(-4.177)		(-4.778)	
Year 2004:03	-0.054	***	-0.060	***	-0.054	***	-0.060	***	-0.059	***	-0.065	***
	(-3.615)		(-3.919)		(-3.515)		(-3.788)		(-3.711)		(-3.997)	
Year 2004:08	-0.040	***	-0.045	***	-0.040	***	-0.044	***	-0.045	***	-0.051	***
	(-2.919)		(-2.906)		(-2.774)		(-2.758)		(-3.079)		(-3.187)	
Year 2005:03	-0.039	**	-0.043	**	-0.038	**	-0.042	**	-0.043	***	-0.048	***
	(-2.498)		(-2.512)		(-2.391)		(-2.392)		(-2.641)		(-2.759)	
Year 2005:08	-0.009		-0.011		-0.009		-0.011		-0.014		-0.018	
	(-0.638)		(-0.653)		(-0.636)		(-0.649)		(-0.923)		(-1.016)	
Year 2006:03	-0.006		-0.007		-0.006		-0.007		-0.009		-0.011	
	(-0.430)		(-0.403)		(-0.436)		(-0.405)		(-0.663)		(-0.670)	
Year 2006:08	0.004		0.005		0.004		0.005		0.002		0.002	
	(0.286)		(0.275)		(0.280)		(0.271)		(0.129)		(0.086)	
Year 2007:03	0.010		0.012		0.010		0.012		0.012		0.013	
	(0.678)		(0.662)		(0.674)		(0.659)		(0.783)		(0.718)	
Size (1-49 emp.)	-0.027	**	-0.032	**	-0.027	**	-0.032	**	-0.030	**	-0.035	**
	(-2.022)		(-2.119)		(-2.013)		(-2.112)		(-2.028)		(-2.192)	
Size (50-199 emp.)	0.004		0.004		0.004		0.004		0.002		0.001	
	(0.298)		(0.282)		(0.304)		(0.287)		(0.172)		(0.092)	
Size (200-499 emp.)	0.007		0.007		0.007		0.007		0.004		0.003	
	(0.459)		(0.400)		(0.478)		(0.413)		(0.258)		(0.148)	
Size (500-999 emp.)	0.003		0.003		0.003		0.003		0.001		0.000	
	(0.194)		(0.162)		(0.179)		(0.149)		(0.048)		(-0.004)	
No. of obs.	2311		2311		2311		2311		2309		2309	
Pseudo R^2	0.112		0.113		0.112		0.113		0.0984		0.0987	

Note: The definition of variables can be found in Table 1, bloc A. Coefficients report marginal probability effects and are evaluated at the means of independent variables (changes in the probability for an infinitesimal change in continuous explanatory variables and a discrete change in the probability for dummy variables). Robust *z*-statistics are in parentheses below the coefficient estimates. ***, **, and * denote significance at 1 percent, 5 percent, and 10 percent, respectively.

Table 5: Panel Models, Difference-in-Difference Estimation of the Effects of Regulatory Harmonization on Financial Access (Marginal Probability Effects)

	(1)		(2)		(3)		(4)		(5)		(6)	
Estimation Method	REP		REL		REP		REL		REP		REL	
$Border^{pre}$	0.024	**	0.020	**	0.027	**	0.023	**	0.028	**	0.024	**
	(2.207)		(2.085)		(2.250)		(2.150)		(2.227)		(2.182)	
$Border^{post}$					0.004		0.003		0.002		0.002	
					(0.582)		(0.602)		(0.361)		(0.392)	
Business situation	0.015	***	0.013	***	0.015	***	0.013	***				
	(4.240)		(4.107)		(4.260)		(4.126)					
New orders									0.002	**	0.002	**
									(2.488)		(2.341)	
Exporter									0.009		0.007	
									(0.047)		(0.072)	
Year 2003:06	-0.019	***	-0.020	***	-0.018	***	-0.020	***	-0.020	***	-0.021	***
	(-4.056)		(-3.973)		(-3.934)		(-3.867)		(-4.248)		(-4.183)	
Year 2003:08	-0.021	***	-0.023	***	-0.021	***	-0.023	***	-0.022	***	-0.024	***
	(-4.551)		(-4.256)		(-4.455)		(-4.180)		(-4.672)		(-4.395)	
Year 2004:03	-0.019	***	-0.020	***	-0.019	***	-0.020	***	-0.020	***	-0.021	***
	(-4.399)		(-4.165)		(-4.254)		(-4.042)		(-4.539)		(-4.384)	
Year 2004:08	-0.015	***	-0.015	***	-0.015	***	-0.015	***	-0.016	***	-0.016	***
	(-3.032)		(-2.982)		(-2.892)		(-2.854)		(-3.203)		(-3.183)	
Year 2005:03	-0.016	***	-0.016	***	-0.015	***	-0.015	***	-0.017	***	-0.017	***
	(-3.159)		(-3.095)		(-3.003)		(-2.957)		(-3.364)		(-3.332)	
Year 2005:08	-0.006		-0.005		-0.006		-0.005		-0.008		-0.007	
	(-0.953)		(-0.898)		(-0.942)		(-0.891)		(-1.343)		(-1.286)	
Year 2006:03	-0.005		-0.004		-0.005		-0.004		-0.007		-0.005	
	(-0.917)		(-0.780)		(-0.918)		(-0.785)		(-1.161)		(-1.043)	
Year 2006:08	-0.002		-0.001		-0.002		-0.001		-0.003		-0.002	
	(-0.270)		(-0.189)		(-0.278)		(-0.198)		(-0.457)		(-0.369)	
Year 2007:03	0.006		0.006		0.006		0.005		0.006		0.006	
	(0.818)		(0.903)		(0.815)		(0.898)		(0.870)		(0.934)	
Size (1-49 emp.)	-0.010		-0.009		-0.010		-0.009		-0.012		-0.011	
	(-1.179)		(-1.172)		(-1.143)		(-1.134)		(-1.374)		(-1.386)	
Size (50-199 emp.)	0.002		0.002		0.003		0.002		0.001	***	0.000	***
	(0.274)		(0.232)		(0.303)		(0.262)		(0.060)		(0.026)	
Size (200-499 emp.)	0.005	***	0.005	***	0.005	***	0.006	***	0.003	***	0.003	***
	(0.432)		(0.542)		(0.484)		(0.595)		(0.237)		(0.343)	
Size (500-999 emp.)	0.002	***	0.002	***	0.002	***	0.002	***	0.000	***	0.000	***
	(0.146)		(0.213)		(0.140)		(0.206)		(-0.019)		(0.045)	
No. of obs.	2311		2311		2311		2311		2309		2309	
No. of firms	339		339		339		339		339		339	
Periods per firm	6.8		6.8		6.8		6.8		6.8		6.8	
Log likelihood	-512.70		-511.03		-512.53		-510.85		-518.75		-516.88	

Note: REP- random effects probit, REL – random effects logit. The definition of variables can be found in Table 1, bloc A. Coefficients report marginal probability effects and are computed under the assumption that random effects are zero. Robust *z*-statistics are in parentheses below the coefficient estimates. ***, **, and * denote significance at 1 percent, 5 percent, and 10 percent, respectively.

A firm's evaluation of its own business situation is positively correlated with its perception of the banks' lending behavior. Thus, firms with a good business situation also seem to have better access to loans. This suggests that the banks efficiently select firms with positive qualities and that they provide them with the necessary financial means.[17]

Furthermore, the regression largely confirms the stylized facts regarding the loan supply during the study period. The coefficients of time dummies (which are common to the border as well as to the non-border regions) in both specifications show that the perception of the banks' lending behavior continuously improved over this time. Small firms (i.e., fewer than 50 employees) assess the credit supply as more restrictive than medium and large firms.

Finally, the results remain largely unchanged if we use alternative explanatory variables. We replace the firms' evaluation of their business situations with new orders in the last two columns of Table 4 and add a dummy to identify whether the firm engages in exporting. New orders are positive and significant, similar to the indicator of the business situation. By contrast, our results indicate that exporting firms do not have easier access to credit than non-exporting firms. Distance to Austria remains unaffected by the inclusion of export status. Thus, the results confirm the overall stability of the difference-in-difference specification.

As a further robustness check, we include random effects which cover all unobservable firm-specific characteristics in Table 5.[18] The panel specifications indicate that regulatory differences have a positive effect on loan availability, although the marginal effects (computed under the assumption that firm random effects are zero) are slightly lower than the previous estimations. Similarly to the previous results, the border

[17] However, there is a possible endogeneity problem, as firms with loans may also have better economic prospects. Nevertheless, the bias should not be important because respondents are asked to comment on the access – and not on the actual use – of credits.

[18] However, we have to keep in mind that a fixed-effects model, which cannot be estimated consistently in panel probit and logit models, could be more appropriate for an analysis of the geographical position of the firms. Nevertheless, random effect probit and logit model provide an interesting comparison to the previous cross-section results. Conditional logit is also not appropriate because it drops firms reporting time-invariant access to loans during the whole analyzed period.

effects after 2005 are no longer significant. State of business and new orders are also highly significant, while export status remains insignificant. Thus, our previous results are confirmed.

4.3. Robustness analysis: Lending rates of cooperative banks

According to hypothesis 2, we expect that there will be lower lending rates in the border region if regulation differs between the two countries. Therefore, in our robustness analysis, we test how the lending rates, *LR*, of cooperative banks indexed by *j* in Bavaria are affected by regulation. Although we have only two years available after the regulatory change in May 2005, we start with a difference-in-difference approach similar to that applied in the previous section. Thus, we estimate whether the regulatory change in 2005 influenced the lending rates in the border region of Germany, which is defined by a 150 km interval to the next Austrian community with a bank. As in section 4.2, we define a bank-related dummy variable $border^{pre}$, which is equal to one for banks in the border region before 2005 and zero otherwise. To control for heterogeneity in our sample of banks we control for selected determinants of lending rates. First, large banks (measured by logarithm of total assets, which is denoted by *assets*) have a stronger position, which they can use to increase lending rates. Second, capitalization (i.e., share of equity capital to total liabilities), denoted by *equity*, ensures better access to refinancing opportunities. Thus, the bank can offer lower lending rates. The estimation equation can be stated as follows:

$$LR_{jt} = \lambda border_{jt}^{pre} + \beta_1 + \beta_2 assets_{jt} + \beta_3 equity_{jt} + \mathbf{Z}_{jt}\gamma + \varepsilon_{jt}. \qquad (5)$$

The matrix **Z** includes time effects estimated in the coefficient vector γ. This covers all general macroeconomic and refinancing factors that were identified in the literature on bank lending channels (Bernanke and Gertler, 2004). Finally, ε is an i.i.d. error term, and *t* stands for time (i.e., the years from 2003 to 2007).

Table 6 shows the results for the difference-in-difference estimation for the effect of regulatory harmonization, $border^{pre}$, in 2005. We include the control variables individually when estimating the determinants of lending rates to deduce whether the results are influenced by possible multicollinearity (see Table 6). Bank size and equity have expected signs but are insignificant. With regard to financial regulations, the coefficient of $border^{pre}$ is negative in all specifications but is never significant. This may

occur because it takes longer for regulatory changes to have an effect on actual lending rates, and bank loans are specified for several years. Hence, lending rates in 2006 and 2007 may be determined by the legal context of the preceding years. Therefore, we cannot compare the effects before and after the regulatory harmonization. Instead of this, we change specification (5) and replace the dummy for legal unification in 2005 with a more general dummy for the border region, *border*, which is equal to one if a bank is located within the 150 km distance to Austria and is set at zero otherwise. The resulting equation is as follows:

Table 6: Effects of Regulatory Harmonization and Retail Lending Interest Rates, Difference-in-Difference Estimation

	(1)	**(2)**	**(3)**
$Border^{pre}$	-0.020	-0.021	-0.020
	(-0.606)	(-0.632)	(-0.591)
Assets		0.022	
		(0.450)	
Equity			-1.023
			(-1.093)
Year 2003	0.600***	0.603***	0.595***
	(16.660)	(16.702)	(16.305)
Year 2004	0.247***	0.249***	0.243***
	(6.904)	(6.950)	(6.737)
Year 2005	0.097***	0.098***	0.095***
	(3.184)	(3.222)	(3.119)
Year 2006	0.003	0.003	0.003
	(0.094)	(0.109)	(0.092)
Constant	5.166***	5.159***	5.229***
	(258.653)	(205.398)	(86.495)
No. of observations	1747	1747	1747
R^2	0.224	0.225	0.225

Note: The definition of variables can be found in Table 1, bloc B. Robust *t*-statistics are in parentheses below the coefficient estimates. ***, **, and * denote significance at 1 percent, 5 percent, and 10 percent, respectively.

$$LR_{jt} = \delta\ border_{jt} + \beta_1 + \beta_2 assets_{jt} + \beta_3 equity_{jt} + \mathbf{Z}_{jt}\gamma + \varepsilon_{jt}. \qquad (6)$$

Indeed, Table 7 shows that the border effect is negative and at least marginally significant. On average, lending rates in the border regions are 0.04 percentage points lower than the lending rates in the rest of Bavaria. The economic significance of this effect appears to be small. However, we compute lending rates from the bank balance sheet data, which means that we compute the average interest rate of all loans. Given

that the regulatory change only affected part of the banks' lending business, the effect on firms that took loans in the amounts for which regulation differed would have been much higher.

Table 7: Effect of Border on Retail Lending Interest Rates

	(1)	(2)	(3)
Border	-0.041**	-0.042**	-0.040*
	(-1.977)	(-2.032)	(-1.929)
Assets		0.026	
		(0.519)	
Equity			-0.975
			(-1.036)
Year 2003	0.587***	0.589***	0.582***
	(18.803)	(18.838)	(18.498)
Year 2004	0.234***	0.235***	0.231***
	(7.806)	(7.845)	(7.647)
Year 2005	0.096***	0.097***	0.094***
	(3.150)	(3.192)	(3.089)
Year 2006	0.003	0.003	0.003
	(0.098)	(0.115)	(0.096)
Constant	5.190***	5.183***	5.249***
	(218.531)	(185.700)	(87.518)
No. of observations	1747	1747	1747
R^2	0.226	0.226	0.227

Note: The definition of variables can be found in Table 1, bloc B. Robust *t*-statistics are in parentheses below the coefficient estimates. ***, **, and * denote significance at 1 percent, 5 percent, and 10 percent, respectively.

In the next step, we replace the border dummy with *distance,* the actual distance of bank *i* to Austria, to further analyze the border effects. Thus, the estimation equation is formulated as

$$LR_{jt} = \theta\ distance_j + \beta_1 + \beta_2 assets_{jt} + \beta_3 equity_{jt} + \mathbf{Z}_{jt}\gamma + \varepsilon_{jt}, \qquad (7)$$

Our results show that distance to Austria has a positive effect on retail lending rates (see Table 8). This implies that banks located 100 km from the Austrian border can charge lending rates that are three basis points higher than those located directly at the border. Thus, the cooperative banks with the greatest distance to Austria (i.e., 300 km) have lending rates approximately nine basis points higher in total. These two results are in line with Proposition 3, which suggests that distance to the border negatively influences lending rates.

Thus, the regulatory differences gave the Austrian banks a competitive advantage in cross-border lending activities. After regulatory harmonization, these banks can still profit from the lending relationships that they had established. For example, the Austrian bank Oberbank has founded several new subsidiaries in Bavaria since 2005.

Table 8: Effect of Distance and Retail Lending Interest Rates

	(1)	(2)	(3)
Distance	0.031**	0.032**	0.031**
	(2.482)	(2.490)	(2.433)
Assets		0.011	
		(0.232)	
Equity			-0.266
			(-0.280)
Year 2003	0.604***	0.605***	0.603***
	(18.559)	(18.572)	(18.399)
Year 2004	0.248***	0.248***	0.247***
	(8.141)	(8.154)	(8.083)
Year 2005	0.107***	0.107***	0.106***
	(3.494)	(3.515)	(3.479)
Year 2006	-0.004	-0.004	-0.004
	(-0.155)	(-0.147)	(-0.155)
Constant	5.122***	5.118***	5.139***
	(192.581)	(162.711)	(76.598)
No. of observations	1646	1646	1646
R^2	0.236	0.236	0.236

Note: The definition of variables can be found in Table 1, bloc B. Distance is measured in 100 km. Robust *t*-statistics are in parentheses below the coefficient estimates. ***, **, and * denote significance at 1 percent, 5 percent, and 10 percent, respectively.

5. Conclusions

Problems of information asymmetry are magnified by differences in regulatory provisions and have made the credit market one of the least integrated markets in the EU, which is of particular concern for SMEs. Consequently, the process of regulatory harmonization is generally expected to reduce the institutional differences between countries and thereby contribute to financial integration.

Our results do not fully confirm this expectation. We find that small differences in financial regulation may actually lead to one-way flows of cross-border lending. In particular, we demonstrate in a theoretical model that cross-border lending increases if one country has stricter banking regulations than its neighbor; in our example, this forces the domestic banks to use verifiable information. As a consequence, a foreign bank finds it profitable to expand across the border to the neighboring market. The

domestic bank thus faces increased competition and earns lower profits in this region. This result is in line with the hypothesis that differences in regulation may provide a competitive advantage to one bank; in our example, the foreign bank.

We subject this question to an empirical analysis of the German and Austrian context using a unique new data set of firm business surveys. Analysis of these two countries allows us to investigate the effect of the harmonization of financial regulations and abstract from other factors because there are few institutional differences between these two countries and language barriers do not exist. Moreover, currency transaction costs have been abolished due to the introduction of the euro. In the theoretical model, we show that proximity to Austria improves the access to loans for German firms when regulation differs, and we document empirical support for this prediction. These effects are confirmed by our robustness analysis, which uses balance sheet data from regional cooperative banks. We show that lending rates are lower in the border region, which is in line with our model.

During the recent financial crisis, despite a general trend towards regulatory harmonization, national interventions increased in the form of national policies that augment internationally accepted regulations. Our research suggests that regulatory differences may have longer term effects that can lead to increased integration even when they exist for a relatively short period of time. We observed that Austrian banks have founded subsidiaries in the border region of Germany after 2005. By lending across the border, Austrian banks have established business relationships with German firms, and this reduces the barrier for entry because the adverse selection problem they face has been reduced. This case shows that cross-border lending may function as one step towards a deeper integration between these two countries. Generally, integration is taking place in several ways, both through cross-border mergers and cross-border lending. This latter form of integration has gone largely unnoticed. Numerous border regions in Europe are – as Austria and Germany are in our example – similar in language, culture and institutions, and cross-border lending has significant potential within this context.

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Appendix

1. Proof of Lemma 1

Step 1: We show that no equilibrium in pure strategies exists.

$\underline{R}^D$ denotes the repayment that the domestic bank needs for making zero expected profit.

Suppose there exists a symmetric equilibrium with $R^D = R^F > \underline{R}^D$. The foreign bank has an incentive to marginally undercut R^D and still make a positive expected profit. Suppose that $R^D = R^F = \underline{R}^D$. The foreign bank has an incentive to undercut the domestic bank and still make positive expected profit. In this case, the domestic bank would make an expected loss and, thus, it would be better to make no offer at all. Then, the foreign bank would act like a monopolist and demand $R^F = X$. The optimal reaction of the domestic bank would be to marginally undercut the foreign bank and make positive expected profits. As a result, no symmetric equilibrium in pure strategies exists.

Suppose there exists an asymmetric equilibrium in pure strategies. Suppose that $R^D > R^F > \underline{R}^D$. The foreign bank has an incentive to marginally undercut the domestic bank and make positive expected profit. Suppose that $R^F > R^D > \underline{R}^D$. The foreign bank has an incentive to undercut the domestic bank and still make positive expected profit. In this case, the domestic bank would make an expected loss and, thus, it would be better to make no offer at all. Suppose that $R^D > R^F \geq \underline{R}^D$. The domestic bank has an incentive to demand a marginally lower repayment than the foreign bank and make a non-negative profit. Thus, we do not find an asymmetric equilibrium in pure strategies.

Step 2: We show that $F^F(R)$ and $F^D(R)$ are continuous and strictly monotonously increasing on an interval $\left(\underline{R}^D, X\right)$.

Suppose that F^D is discontinuous at R^*, i.e., there exists an atom in F^D, then the foreign bank's action of playing $R^* - \epsilon$ strictly dominates playing $R^* + \epsilon, \epsilon > 0$. Therefore, the foreign bank will not bid a free-market repayment $[R^*, R^* + \epsilon)$. But then bank j can raise its repayment without losing customers, so R^* cannot be an optimal action for the domestic bank. Hence, F^D must be continuous. (The same argument can be made for F^F).

Suppose that F^D is non-increasing over some interval, i.e., there exists an interval $(R_a, R_b) \subseteq (\underline{R}, X)$ for which $f^F(R) = 0 \; \forall \; R \epsilon (R_a, R_b)$. But then

$prob\left(R^F < R^D \mid R_1 = R_a\right) =$

$prob\left(R^F < R^D \mid R_i \epsilon (R_a, R_b)\right)$, but profits are strictly higher for $R^F > R_a$ (conditional on winning), so that foreign bank maximizes its payoff by playing $R^F = R_b$ and hence would never offer a repayment in the interval. But then the domestic bank can increase its profits by playing $R^D = R_b - \epsilon$ with positive probability, where $\epsilon < R_b - R_a$, since this will lead to strictly higher profits than any interest rate offer in a neighborhood of R_a. However, this contradicts the assumption that $f^F(R) = 0 \; \forall \; R \epsilon (R_a, R_b)$. (The same argument can be made for F^F).

$d < d^*$

Step 3: We determine the equilibrium in mixed strategies as described in the proposition.

Consider the profit function of the foreign bank conditional on the domestic bank's offer.

$$\begin{aligned}\Pi^F(R^F) &= \left(1-F^D(R)\right)\left(\mu\sigma\upsilon\left(pR^F-I\right)-(1-\mu)(1-\upsilon)(1-\sigma)I\right)\\ &\quad+\left(\mu(1-\upsilon)\sigma\left(pR^F-I\right)-(1-\mu)\upsilon(1-\sigma)I\right)\end{aligned}$$

The foreign bank will participate only if $\Pi^F(R^F) \geq 0$ or

$$\lim_{R\to X}\left(1-F^D(R)\right) \geq \frac{-\left(\mu(1-\upsilon)\sigma\left(pR^F-I\right)-(1-\mu)\upsilon(1-\sigma)I\right)}{\left(\mu\sigma\upsilon\left(pR^F-I\right)-(1-\mu)(1-\upsilon)(1-\sigma)I\right)}$$

There are two ways for getting $\lim_{R\to X}\left(1-F^D(R)\right) > 0$:

- There is an atom at X in F^D. However, an atom cannot exist in both F^F and F^D since then neither $R^F = X$ nor $R^D = X$ would be optimal.
- Either the foreign bank or the domestic bank does not always bid on the free market. As shown below, this has to be the bank with the less precise signal. This implies that its expected profit is zero because each offer generates the same profit.

(The same argument can be made for the domestic bank).

Step 4: We determine the minimum repayment $\underline{R}^D$. $\underline{R}^D$ is determined by the condition that domestic bank wins the free market with certainty:

$$\begin{aligned}\Pi^D(\underline{R}^D) &= \left(\mu\sigma\upsilon\left(p\underline{R}^D-I\right)-(1-\mu)(1-\sigma)(1-\upsilon)I\right)\\ &\quad+\left(\mu(1-\sigma)\upsilon\left(p\underline{R}^D-I\right)-(1-\mu)\sigma\left((1-\upsilon)I\right)\right)\\ &= 0\\ &\qquad \underline{R}^D = \frac{(1-\upsilon)(1-\mu)+\mu\upsilon}{\mu\upsilon p}I\end{aligned}$$

Step 5: We determine the foreign bank's expected profit.

The foreign bank's return for $\underline{R}^D$ is:

$$\begin{aligned}\Pi^F(\underline{R}^D) &= \left(\mu\sigma\upsilon\left(p\left(\frac{(1-\upsilon)(1-\mu)+\mu\upsilon}{\mu\upsilon p}I\right)-I\right)-(1-\mu)(1-\upsilon)(1-\sigma)I\right)\\ &\quad+\left(\mu(1-\upsilon)\sigma\left(p\left(\frac{(1-\upsilon)(1-\mu)+\mu\upsilon}{\mu\upsilon p}I\right)-I\right)-(1-\mu)\upsilon(1-\sigma)I\right)\\ &= I(1-\mu)\frac{(\sigma-\upsilon)}{\upsilon} = \overline{\Pi}^F\end{aligned}$$

Thus, it is shown that the domestic bank does not always bid on the free market and, therefore, makes zero expected profit.

Step 6: We determine the mixing probabilities.

Let us use the fact that $\Pi^F(R^F) = \overline{\Pi}^F$ and $\Pi^D(R^D) = 0$ for each repayment.

- For the foreign bank we determine $F^F(R)$ by setting

$$\begin{aligned}\Pi^D(R^D) &= \left(1 - F^F(R^D)\right)\left(\mu\sigma\upsilon\left(p(R^D) - I\right) - (1-\mu)(1-\sigma)(1-\upsilon)I\right) \\ &\quad + \left(\mu(1-\sigma)\upsilon\left(p(R^D) - I\right) - (1-\mu)\sigma\left((1-\upsilon)I\right)\right) \\ &= 0\end{aligned}$$

Accordingly, $F^F(R^F) = \frac{\mu\upsilon\left(pR^F - I\right) - (1-\mu)(1-\upsilon)I}{\mu\sigma(\upsilon pR^F - I) - (1-\mu-\sigma)(1-\upsilon)I}$ $\forall R^F \epsilon \left[\frac{(1-\upsilon)(1-\mu)+\mu\upsilon}{\mu\upsilon p}I, X\right)$ and $prob\left(R^F = X\right) = 1 - \frac{\mu\upsilon(pX-I) - (1-\mu)(1-\upsilon)I}{\mu\sigma(\upsilon pX - I) - (1-\mu-\sigma)(1-\upsilon)I}$.

- For the domestic bank we determine $F^D(R^D)$ by setting

$$\begin{aligned}\Pi^F(R^F) &= \left(1 - F^D(R^F)\right)\left(\mu\sigma\upsilon\left(pR^F - I\right) - (1-\mu)(1-\upsilon)(1-\sigma)I\right) \\ &\quad + \left(\mu(1-\upsilon)\sigma\left(pR^F - I\right) - (1-\mu)\upsilon(1-\sigma)I\right) \\ &= \overline{\Pi}^F\end{aligned}$$

The domestic bank does not make an offer with probability $prob(D) = 1 - \frac{\sigma}{\upsilon}\frac{\mu\upsilon(pX-I) - (1-\mu)(1-\upsilon)I}{(\sigma\mu(\upsilon pX - I) - I(1-\upsilon)(1-\mu-\sigma))}$. With probability $1 - prob(D)$ it chooses repayments according to $F^D\left(R^D\right) = \frac{\sigma}{\upsilon}\frac{\mu\upsilon\left(pR^F - I\right) - (1-\mu)(1-\upsilon)I}{(\sigma\mu(\upsilon pR^F - I) - I(1-\upsilon)(1-\mu-\sigma))}I$ $\forall R^D \epsilon \left[\frac{(1-\upsilon)(1-\mu)+\mu\upsilon}{\mu\upsilon p}I, X\right)$. Provided that the domestic bank offers a loan it chooses repayments according to the following cumulative distribution function $G^D\left(R^D\right) = \frac{\frac{\sigma}{\upsilon}\frac{\mu\upsilon\left(pR^F - I\right) - (1-\mu)(1-\upsilon)I}{(\sigma\mu(\upsilon pR^F - I) - I(1-\upsilon)(1-\mu-\sigma))}}{\frac{\sigma}{\upsilon}\frac{\mu\upsilon(pX-I) - (1-\mu)(1-\upsilon)I}{(\sigma\mu(\upsilon pX - I) - I(1-\upsilon)(1-\mu-\sigma))}} = \frac{\left(\mu\upsilon\left(pR^F - I\right) - (1-\mu)(1-\upsilon)I\right)(\sigma\mu(\upsilon pX - I) - (1-\mu-\sigma)(1-\upsilon)I)}{(\mu\sigma(\upsilon pR^F - I) - (1-\mu-\sigma)(1-\upsilon)I)(\mu\upsilon(pX-I) - (1-\mu)(1-\upsilon)I)}$ $\forall R^D \epsilon \left[\frac{(1-\upsilon)(1-\mu)+\mu\upsilon}{\mu\upsilon p}I, X\right)$ where $G^D\left(R^D\right) = \frac{F^D\left(R^D\right)}{1 - prob(D)}$. Note that $G^D\left(\frac{(1-\upsilon)(1-\mu)+\mu\upsilon}{\mu\upsilon p}I\right) = 0$ and $G^D(X) = 1$.

$d \geq d^*$ Repeat step 3 - 6 for $\Pi^F(R^F) = 0$ and $\Pi^D(R^D) > 0$. Q.E.D.

2 Proof of Lemma 2

Repeat step 3 - 6 for $\Pi^F(R^F) = 0$ and $\Pi^D(R^D) = 0$. Q.E.D.

3 Proof of Lemma 3

Repeat step 3 - 6 for $d < 0.5$ with $\Pi^F(R^F) > 0$ and $\Pi^D(R^D) = 0$ and $d \geq 0.5$ with $\Pi^F(R^F) = 0$ and $\Pi^D(R^D) > 0$. Q.E.D.

4 Proof of Proposition 1

We want to derive the Nash equilibrium. To do so, we first compare the best answers of the domestic (foreign) bank given the offer of the foreign (domestic) bank.Suppose that there are no regulatory requirements.

1. For the distance [0,1-d)*

If the foreign bank uses private information, the domestic bank gets zero expected profits with private and verifiable information.

If the foreign bank uses verifiable information, the domestic bank gets zero expected profits with private and verifiable information.

If the domestic bank uses private information, the foreign bank gets expected profits of $I(1-\mu)\frac{\left(\sigma^F-\sigma^D\right)}{\sigma^D}$ with private information and expected profits of $I(1-\mu)\frac{(\upsilon-\sigma)}{\sigma}$ with verifiable information.

If the domestic bank uses verifiable information, the foreign bank gets expected profits of $I(1-\mu)\frac{(\sigma-\upsilon)}{\upsilon}$ with private information and zero expected profits with verifiable information.

Thus, the dominant strategy of the foreign bank is to use private information as $\sigma^F > \upsilon$. The domestic bank is indifferent between private and verifiable information. Because verifiable information provides the better signal and the domestic bank it does not need to invest to implement it, the domestic bank will use verifiable information. As a result, the Nash equilibrium is that the foreign bank uses private information and the domestic bank verifiable information.

2. For the distance [1-d; 0.5)*

If the foreign bank uses private information, the domestic bank gets zero expected profits with private and verifiable information.

If the foreign bank uses verifiable information, the domestic bank gets $I(1-\mu)\frac{(\sigma-\upsilon)}{\upsilon}$ expected profits with private and zero expected profits with verifiable information.

If the domestic bank uses private information, the foreign bank gets expected profits of $I(1-\mu)\frac{\left(\sigma^F-\sigma^D\right)}{\sigma^D}$ with private information and zero expected profits with verifiable information.

If the domestic bank uses verifiable information, the foreign bank gets expected profits of $I(1-\mu)\frac{(\sigma-\upsilon)}{\upsilon}$ with private information and zero expected profits with verifiable information.

Thus, the dominant strategy of the foreign bank is to use private information. The domestic bank is indifferent between private and verifiable information. Because verifiable information provides the better signal and the domestic bank it does not need to invest to implement it, the domestic bank will use verifiable information. As a result, the Nash equilibrium is that both banks use private information.

3. For the distance [0.5; d)*

If the foreign bank uses private information, the domestic bank gets expected profits $I(1-\mu)\frac{\left(\sigma^D-\sigma^F\right)}{\sigma^F}$ with private and zero expected profits with verifiable information.

If the foreign bank uses verifiable information, the domestic bank gets $I(1-\mu)\frac{(\sigma-\upsilon)}{\upsilon}$ expected profits with private and zero expected profits with verifiable information.

If the domestic bank uses private information, the foreign bank gets zero expected profits both with private and verifiable information.

If the domestic bank uses verifiable information, the foreign bank gets expected profits of $I(1-\mu)\frac{(\sigma-\upsilon)}{\upsilon}$ with private information and zero expected profits with verifiable information.

Thus, the dominant strategy of the domestic bank is to use private information. The foreign bank is indifferent between private and verifiable information. Because it needs to incur a cost to implement the verifiable information technology, it will use private information. As a result, the Nash equilibrium is that both banks use private information.

4. For the distance [d;1)*

If the foreign bank uses private information, the domestic bank gets expected profits $I(1-\mu)\frac{\left(\sigma^D-\sigma^F\right)}{\sigma^F}$ with private and expected profits of $I(1-\mu)\frac{(\upsilon-\sigma)}{\sigma}$ with verifiable information.

If the foreign bank uses verifiable information, the domestic bank gets $I(1-\mu)\frac{(\sigma-\upsilon)}{\upsilon}$ expected profits with private and zero expected profits with verifiable information.

If the domestic bank uses private information, the foreign bank gets zero expected profits both with private and verifiable information.

If the domestic bank uses verifiable information, the foreign bank gets zero expected profits both with private and verifiable information.

Thus, the dominant strategy of the domestic bank is to use private information as $\sigma^D > \upsilon$. The foreign bank is indifferent between private and verifiable information. Because it needs to incur a cost to implement the verifiable information technology, it will use private information. As a result, the Nash equilibrium is that both banks use private information.

Suppose that the domestic bank must use verifiable information.

1. For the distance [0,1-d)*

If the domestic bank uses verifiable information, the foreign bank gets expected profits of $I(1-\mu)\frac{(\sigma-\upsilon)}{\upsilon}$ with private information and zero expected profits with verifiable information. In equilibrium, the foreign bank uses private information and the domestic bank verifiable information.

2. For the distance [1-d; 0.5)*

If the domestic bank uses verifiable information, the foreign bank gets expected profits of $I(1-\mu)\frac{(\sigma-\upsilon)}{\upsilon}$ with private information and zero expected profits with verifiable information. In equilibrium, the foreign bank uses private information and the domestic bank verifiable information.

3. For the distance [0.5; d)*

If the domestic bank uses verifiable information, the foreign bank gets expected profits of $I(1-\mu)\frac{(\sigma-\upsilon)}{\upsilon}$ with private information and zero expected profits with verifiable information. In equilibrium, the foreign bank uses private information and the domestic bank verifiable information.

4. For the distance [d;1)*

If the domestic bank uses verifiable information, the foreign bank gets zero expected profits both with private and verifiable information. The foreign bank is indifferent between private and verifiable information. Because it needs to incur a cost to implement the verifiable information technology, it will use private information. In equilibrium, the foreign bank uses private information and the domestic bank verifiable information. Q.E.D.

5 Proof of Proposition 2

First, we compare the repayments offered by the domestic bank in the case with and without a difference in regulation.

For the distance [1-d*; 0.5) the cdf is

- with regulatory provisions: $F^{with-1}=F^D\left(R^D\right)=\frac{\sigma}{\upsilon}\frac{\mu\upsilon(pR-I)-(1-\mu)(1-\upsilon)I}{(\sigma\mu(\upsilon pR-I)-I(1-\upsilon)(1-\mu-\sigma))}$
- without regulatory provisions: $F^{w.out-1}=F^D\left(R^D\right)=\frac{\sigma}{\sigma^D}\frac{\mu\sigma^D(pR-I)-(1-\mu)\left(1-\sigma^D\right)I}{(\sigma\mu(\sigma^D pR-I)-I(1-\sigma^D)(1-\mu-\sigma))}$

As $F^{w.out-1}<F^{w.out-2}$ and $F^{with-1}=F^{with-2}>F^{w.out-2}$ we can show that $F^{with-1}>F^{w.out-1}$. As a result, the repayments offered are lower if regulatory provisions are in place.

For the distance [0.5;d*] the cdf is

- with regulatory provisions: $F^{with-2} = F^D\left(R^D\right) = \frac{\sigma}{\upsilon}\frac{\mu\upsilon(pR-I)-(1-\mu)(1-\upsilon)I}{(\sigma\mu(\upsilon pR-I)-I(1-\upsilon)(1-\mu-\sigma))}$
- without regulatory provisions: $F^{w.out-2} = F^D\left(R^D\right) = \frac{\mu\sigma(pR-I)-(1-\mu)(1-\sigma)I}{(\sigma\mu(\sigma^D pR-I)-I(1-\sigma^D)(1-\mu-\sigma))}$

At d* $\sigma = \upsilon$ only the numeraters differ and $F^{with-2} - F^{w.out-2} > 0$ as $\sigma^D > \sigma$. As a result, the repayments offered are lower if regulatory provisions are in place.

For the distance [d*;1] the cdf is

- with regulatory provisions: $F^{with-3} = F^D\left(R^D\right) = \frac{\mu\sigma(pX-I)-(1-\mu)(1-\sigma)I}{(\sigma\mu(\upsilon pX-I)-I(1-\upsilon)(1-\mu-\sigma))}$
- without regulatory provisions: $F^{w.out-3} = F^D\left(R^D\right) = \frac{\mu\sigma(pR-I)-(1-\mu)(1-\sigma)I}{(\sigma\mu(\sigma^D pR-I)-I(1-\sigma^D)(1-\mu-\sigma))}$

At d* $\sigma = \upsilon$, only the numeraters differ and $F^{with-3} - F^{w.out-3} > 0$ as $\sigma^D > \upsilon$. As a result, the repayments offered are lower if regulatory provisions are in place.

The profit of the domestic bank is

- if the domestic bank is subject to regulation:

$$\int_0^{1-d^*} I\left(1-\mu\right)\frac{\left(\upsilon-\sigma\right)}{\sigma}dd$$

- if the domestic bank is not regulated:

$$\int_0^{0.5} I\left(1-\mu\right)\frac{\left(\sigma^D-\sigma^F\right)}{\sigma^F}dd$$

As $d^* > 0.5$ and $\sigma^D > \upsilon$ for d ϵ $[0; 1-d^*]$, $\int_0^{0.5} I\left(1-\mu\right)\frac{\left(\sigma^D-\sigma^F\right)}{\sigma^F}dd > \int_0^{1-d^*} I\left(1-\mu\right)\frac{\left(\upsilon-\sigma\right)}{\sigma}dd$.

Second, we determine the profit of the foreign bank. It is:

- if the domestic bank is subject to regulation:

$$\int_0^{d^*} I\left(1-\mu\right)\frac{\left(\sigma-\upsilon\right)}{\upsilon}dd$$

- if the domestic bank is not regulated:

$$\int_0^{1-d^*} I\left(1-\mu\right)\frac{\left(\sigma-\upsilon\right)}{\upsilon}dd + \int_{1-d^*}^{0.5} I\left(1-\mu\right)\frac{\left(\sigma^F-\sigma^D\right)}{\sigma^D}dd$$

As $d^* > 0.5$ and $\sigma^D > \upsilon$ for d ϵ $[1-d^*; 0.5]$, $\int_0^{d^*} I\left(1-\mu\right)\frac{\left(\sigma-\upsilon\right)}{\upsilon}dd > \int_0^{0.5} I\left(1-\mu\right)\frac{\left(\sigma-\upsilon\right)}{\upsilon}dd$. Q.E.D.

6 Proof of Proposition 3

Distance influences the quality of the private signal σ. We do not want to specify a function how distance influences the quality of the signal. Therefore we investigate how a change in σ affects the repayments offered and the probability that an offer is made.

6.1 If the domestic bank is obliged to used verifiable information

6.1.1 Effect of distance on the probability that a loan is offered to good firms

$d < d^*$

- The foreign bank offers a loan to all firms with a positive private signal, i.e. it is always active on the credit market. The higher σ, i.e. the closer the firm is to the bank, the more likely a good firm is to receive an offer.
- The domestic bank offers loans to firms with a positive verifiable signal with a certain probability. The verifiable signal itself is independent of the distance between bank and firm. The probability that the domestic bank is active on the credit market is $G^D(X) = \sigma \frac{\mu\upsilon(pX-I)-I(1-\upsilon)(1-\mu)}{\upsilon(\sigma\mu(\upsilon pX-I)-I(1-\upsilon)(1-\sigma-\mu))}$.
  Comparative statics shows

  $$\frac{\partial\left(\sigma \frac{\mu\upsilon(pX-I)-I(1-\upsilon)(1-\mu)}{\upsilon(\sigma\mu(\upsilon pX-I)-I(1-\upsilon)(1-\sigma-\mu))}\right)}{\partial\sigma} = -\left(\mu\upsilon\left(pX-I\right)-I\left(1-\upsilon\right)\left(1-\mu\right)\right)\frac{I(1-\upsilon)(1-\mu)}{\upsilon(\sigma\mu(\upsilon pX-I)-I(1-\upsilon)(1-\sigma-\mu))^2} < 0$$
- Accordingly, the effects of σ on the probability that a loan is offered to a good firm have opposing signs for the domestic and the foreign bank. Thus, we have to compare their magnitude. For the domestic bank it is 1. For $G^D\left(R^D\right)$ it could be $\lesseqgtr 1$. Hence, we cannot determine its sign.

$d \geq d^*$

- The foreign bank offers loans to all firms with a positive private signal provided it is active on the credit market. The probability that the foreign bank receives a positive signal and offers a loan is $\sigma F^F(X) = \sigma\upsilon\frac{\mu\sigma(pX-I)-I(1-\sigma)(1-\mu)}{\sigma(\mu\sigma(\upsilon pX-I)-I(1-\upsilon)(1-\mu-\sigma))}$. Thus, comparative statics show

$$\frac{\partial\left(\sigma\upsilon\frac{\mu\sigma(pX-I)-I(1-\sigma)(1-\mu)}{\sigma(\mu\sigma(\upsilon pX-I)-I(1-\upsilon)(1-\mu-\sigma))}\right)}{\partial\sigma} = \frac{\mu\upsilon I\left(Xp-I\right)\left(1-\mu\right)\left(2\upsilon-1\right)}{\left(\mu\sigma\left(\upsilon pX-I\right)-I\left(1-\upsilon\right)\left(1-\mu-\sigma\right)\right)^2} > 0$$

- The domestic bank offers loans to all firms with a positive verifiable signal, i.e. it is always active on the credit market. Since the quality of the verifiable signal is independent of the distance between bank and firm, there is no effect of distance.

- Thus, in this parameter range firm receive a loan with higher probability if they are closer to the foreign bank.

6.1.2 Effect of distance on the repayments offered by the domestic bank

$d < d^*$

The cumulative density function of the domestic bank's repayments provided it grants a loan is given by:

$$G^D\left(R^D\right) = \frac{\left(\mu\upsilon\left(pR^F - I\right) - (1-\mu)(1-\upsilon)I\right)\left(\sigma\mu\left(\upsilon pX - I\right) - (1-\mu-\sigma)(1-\upsilon)I\right)}{\left(\mu\sigma\left(\upsilon pR^F - I\right) - (1-\mu-\sigma)(1-\upsilon)I\right)\left(\mu\upsilon\left(pX - I\right) - (1-\mu)(1-\upsilon)I\right)}$$

Thus comparative statics shows that $\frac{\partial\left(\frac{\left(\mu\upsilon\left(pR^F-I\right)-(1-\mu)(1-\upsilon)I\right)\left(\sigma\mu(\upsilon pX-I)-(1-\mu-\sigma)(1-\upsilon)I\right)}{\left(\mu\sigma\left(\upsilon pR^F-I\right)-(1-\mu-\sigma)(1-\upsilon)I\right)\left(\mu\upsilon(pX-I)-(1-\mu)(1-\upsilon)I\right)}\right)}{\partial\sigma} = -\frac{\left(\mu\upsilon\left(pR^F-I\right)-I(1-\upsilon)(1-\mu)\right)\left(\mu\upsilon pI\left(X-R^F\right)(1-\upsilon)(1-\mu)\right)}{\left(\mu\sigma(\upsilon pR^F-I)-I(1-\upsilon)(1-\mu-\sigma)\right)^2\left(\mu\upsilon(pX-I)-I(1-\upsilon)(1-\mu)\right)} < 0.$

$d \geq d^*$

The domestic bank will always be active on the credit market. Its cumulative density function is given by

$F^F\left(R^F\right) = \frac{\sigma\mu\left(pR^F-I\right)-I(1-\mu)(1-\sigma)}{\sigma\mu(\upsilon pR^F-I)-I(1-\upsilon)(1-\sigma-\mu)}$. Comparative statics show

$\frac{\partial\left(\frac{\sigma\mu\left(pR^F-I\right)-I(1-\mu)(1-\sigma)}{\sigma\mu(\upsilon pR^F-I)-I(1-\upsilon)(1-\sigma-\mu)}\right)}{\partial\sigma} = \frac{\left(pR^F-I\right)I\mu(-1+2\upsilon)(1-\mu)}{\left(\mu\sigma\upsilon pR^F-I\mu\sigma-I+I\upsilon+I\mu-I\mu\upsilon+I\sigma-I\sigma\upsilon\right)^2} > 0$

As the firm is closer to the foreign bank, σ increases and the cumulative densitiy function increases implying that the repayments offered by the domestic bank decrease.

6.2 If the domestic bank is not subject to regulatory provisions

6.2.1 Effect of distance on the probability that a loan is offered to good firms

1. For the distance [0,1-d)*

See argument above for $d < d^*$.

2. For the distance [1-d; 0.5)*

- The foreign bank offers a loan to all firms with a positive private signal, i.e. it is always active on the credit market. The higher σ, i.e. the closer the firm is to the bank, the more likely a good firm is to receive an offer.
- The domestic bank offers loans to firms with a positive private signal with a certain probability. The closer the firm is to the foreign bank, the less likely a good firm is to receive an offer from the domestic bank. The probability that the

domestic bank is active on the credit market and makes an offer to a good firm is $\sigma^D G^D(X) = \sigma^F \frac{\mu\sigma^D(pX-I)-I\left(1-\sigma^D\right)(1-\mu)}{\upsilon(\sigma^F\mu(\sigma^D pX-I)-I(1-\sigma^D)(1-\sigma^F-\mu))}$.

Comparative statics shows

$$\frac{\partial\left(\sigma^F \frac{\mu\sigma^D(pX-I)-I\left(1-\sigma^D\right)(1-\mu)}{\upsilon(\sigma^F\mu(\sigma^D pX-I)-I(1-\sigma^D)(1-\sigma^F-\mu))}\right)}{\partial\sigma^F} =$$
$$-\left(\mu\sigma^D(pX-I)-I\left(1-\sigma^D\right)(1-\mu)\right)\frac{I\left(1-\sigma^D\right)(1-\mu)}{\upsilon(\sigma^F\mu(\sigma^D pX-I)-I(1-\sigma^D)(1-\sigma^F-\mu))^2} < 0$$
$$\frac{\partial\left(\sigma^F \frac{\mu\sigma^D(pX-I)-I\left(1-\sigma^D\right)(1-\mu)}{\upsilon(\sigma^F\mu(\sigma^D pX-I)-I(1-\sigma^D)(1-\sigma^F-\mu))}\right)}{\partial\sigma^D} =$$
$$-\sigma^F I\mu(1-\mu)\left(1-2\sigma^F\right)\frac{pX-I}{\upsilon(\sigma^F\mu(\sigma^D pX-I)-I(1-\sigma^D)(1-\sigma^F-\mu))^2} > 0$$

Thus, the probability that the domestic bank is active on the credit market decreases in σ^F (an increase in σ^F is accompanied by an decrease in σ^D).

- Accordingly, the effects of σ on the probability that a loan is offered to a good firm have opposing signs for the domestic and the foreign bank. Thus, we cannot determine its sign.

3. For the distance [0.5; 1)

- The foreign bank offers loans to all firms with a positive private signal provided it is active on the credit market. The probability that the foreign bank receives a positive signal and offers a loan is $\sigma^F F^F(X) = \sigma^D \frac{\mu\sigma^F(pX-I)-I\left(1-\sigma^F\right)(1-\mu)}{(\mu\sigma^F(\sigma^D pX-I)-I(1-\sigma^D)(1-\mu-\sigma^F))}$. Thus, comparative statics show

$$\frac{\partial\left(\sigma^D \frac{\mu\sigma^F(pX-I)-I\left(1-\sigma^F\right)(1-\mu)}{(\mu\sigma^F(\sigma^D pX-I)-I(1-\sigma^D)(1-\mu-\sigma^F))}\right)}{\partial\sigma^F} =$$
$$\frac{\mu\sigma^D I(pX-I)(1-\mu)\left(2\sigma^D-1\right)}{\left(\mu\sigma^F(\upsilon pX-I)-I(1-\sigma^D)(1-\mu-\sigma^F)\right)^2} > 0$$
$$\frac{\partial\left(\sigma^D \frac{\mu\sigma^F(pX-I)-I\left(1-\sigma^F\right)(1-\mu)}{(\mu\sigma^F(\sigma^D pX-I)-I(1-\sigma^D)(1-\mu-\sigma^F))}\right)}{\partial\sigma^D} =$$
$$-\frac{\left(\mu\sigma^F(pX-I)-I\left(1-\sigma^F\right)(1-\mu)\right)I\left(1-\sigma^F\right)(1-\mu)}{\left(\mu\sigma^F(\upsilon pX-I)-I(1-\sigma^D)(1-\mu-\sigma^F)\right)^2} < 0$$

As a firm is closer to the foreign bank σ^D decreases but σ^F increases. As a result, the probability that the foreign bank is active on the credit market increases.

- The domestic bank offers loans to all firms with a positive private signal, i.e. it is always active on the credit market. Since the quality of the private signal is lower for firms closer to the foreign bank, the domestic bank is less likely to offer loans to these firms.

- Accordingly, the effects of σ^F on the probability that a loan is offered to a good firm have opposing signs for the domestic and the foreign bank. Thus, we cannot determine its sign.

6.2.2 Effect of distance on the repayments offered by the domestic bank

1. For the distance [0,1-d)*

See argument above for $d < d^*$.

2. For the distance [1-d; 0.5)*

The cumulative density function of the domestic bank's repayments provided it grants a loan is given by:

$$G^D\left(R^D\right) = \frac{\left(\mu\upsilon\left(pR^F - I\right) - (1-\mu)(1-\upsilon)I\right)\left(\sigma\mu\left(\upsilon pX - I\right) - (1-\mu-\sigma)(1-\upsilon)I\right)}{\left(\mu\sigma\left(\upsilon pR^F - I\right) - (1-\mu-\sigma)(1-\upsilon)I\right)\left(\mu\upsilon\left(pX - I\right) - (1-\mu)(1-\upsilon)I\right)}$$

Thus comparative statics shows that $\frac{\partial\left(\frac{\left(\mu\upsilon\left(pR^F-I\right)-(1-\mu)(1-\upsilon)I\right)(\sigma\mu(\upsilon pX-I)-(1-\mu-\sigma)(1-\upsilon)I)}{\left(\mu\sigma\left(\upsilon pR^F-I\right)-(1-\mu-\sigma)(1-\upsilon)I\right)(\mu\upsilon(pX-I)-(1-\mu)(1-\upsilon)I)}\right)}{\partial\sigma} =$
$-\frac{\left(\mu\upsilon\left(pR^F-I\right)-I(1-\upsilon)(1-\mu)\right)\left(\mu\upsilon pI\left(X-R^F\right)(1-\upsilon)(1-\mu)\right)}{(\mu\sigma(\upsilon pR^F-I)-I(1-\upsilon)(1-\mu-\sigma))^2(\mu\upsilon(pX-I)-I(1-\upsilon)(1-\mu))} < 0.$

Thus, as σ^F increases, the cumulative densitity function of repayments of the domestic bank decreases, which means that it offers lower repayments.

3. For the distance [0.5; 1)

The domestic bank will always be active on the credit market. Its cumulative density function is given by
$F^F\left(R^F\right) = \frac{\sigma\mu\left(pR^F-I\right)-I(1-\mu)(1-\sigma)}{\sigma\mu(\upsilon pR^F-I)-I(1-\upsilon)(1-\sigma-\mu)}$. Comparative statics show

$$\frac{\partial\left(\frac{\sigma\mu\left(pR^F-I\right)-I(1-\mu)(1-\sigma)}{\sigma\mu(\upsilon pR^F-I)-I(1-\upsilon)(1-\sigma-\mu)}\right)}{\partial\sigma} = \frac{\left(pR^F-I\right)I\mu(-1+2\upsilon)(1-\mu)}{(\mu\sigma\upsilon pR^F-I\mu\sigma-I+I\upsilon+I\mu-I\mu\upsilon+I\sigma-I\sigma\upsilon)^2} > 0$$

$$\frac{\partial\left(\frac{\sigma\mu\left(pR^F-I\right)-I(1-\mu)(1-\sigma)}{\sigma\mu(\upsilon pR^F-I)-I(1-\upsilon)(1-\sigma-\mu)}\right)}{\partial\upsilon} =$$
$$-\left(\mu\sigma pR^F - 2\sigma\mu I - I + I\mu + I\sigma\right)\frac{\mu\sigma pR^F+I-I\sigma-I\mu}{(\sigma\mu\upsilon pR^F-\sigma\mu I-I+I\sigma+I\mu+I\upsilon-I\upsilon\sigma-I\upsilon\mu)^2} < 0$$

Thus, as σ^F increases, the cumulative densitity function of the domestic bank increases, which means that it offers lower repayments. Q.E.D.

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