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Abstract

Interest-rate spreads fluctuate widely across time and countries. We characterize their behavior using some 3,200 quarterly observations for 21 advanced and 17 emerging economies since the early 1990s. Before the financial crisis, spreads are 10 times more volatile in emerging economies than in advanced economies. Since 2008, the behavior of spreads has converged across country groups, largely because it has adjusted in advanced economies. We also provide evidence on the transmission of spread shocks and find it similar across sample periods and country groups. Spread shocks have become a more important source of output fluctuations in advanced economies after 2008.

JEL-Codes: G150, F410, E320.

Keywords: country spreads, country risk, interest-rate shocks, financial crisis, business cycle, spread shocks, average treatment effect.

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1 Introduction

The global financial crisis is having a lasting impact—on many economies but also on economics as a science. The crisis gave rise to new ideas about what drives the business cycle and revived old ones. Perhaps unsurprisingly, a major research effort during the last decade has been directed towards appropriately capturing the role of financial frictions (for instance, Gilchrist and Zakrajšek 2012; Guerrieri and Lorenzoni 2017; Jermann and Quadrini 2012). Still, prior to the crisis, a specific type of financial disturbance had already been well-established as an important source of the business cycle in emerging market economies: interest-rate shocks (Neumeyer and Perri 2005; Uribe and Yue 2006). According to this earlier research, interest-rate shocks and, in particular, shocks to the "country spread" matter a great deal for emerging markets but are negligible in case of advanced economies. This difference across country groups is plausible because, prior to the crisis, business cycles in emerging markets have been considerable more volatile than in advanced economies (Aguiar and Gopinath 2007).

In this paper, we ask whether country spreads still behave differently in emerging and advanced economies. We tackle this question on the basis of a uniquely suited data set. It covers a broad range of countries and a large number of observations for the period before and after the global financial crisis. A first look at the data motivates the focus of our investigation: the left panel of Figure 1 shows the average country spread for 21 advanced economies (blue dashed line) and 17 emerging economies (red dotted line). For the period up to 2007Q4, we observe that the average spread is very low and stable in advanced economies and very high and volatile in emerging economies. In contrast, the average spread behaves much more similar across country groups in the period since 2008Q1, that is, "after 2008" in what follows.

Our data set includes about 3,200 quarterly observations for the spread, output, as well as a number of key macroeconomic and political indicators. In order to classify the 38 economies in our sample as "advanced" and "emerging" we follow IMF (2015). In the first part of the paper, we explain the construction of our data set and establish new facts. First, before 2008 the mean, the median, and the standard deviation of the spread are at least 10 times higher in emerging economies than in advanced economies. Second, after 2008, both the mean and the median of the spread in emerging economies are only twice as large as in advanced economies. Moreover, the volatility of the spread has fully converged across country groups and this convergence is broad-based and not driven by individual countries. The right panel of Figure 1 displays the standard deviation of the spread before 2008 (horizonal axis) against the one after 2008 (vertical axis) on a country-by-country basis. Blue crosses (red circles) indicate observations for advanced (emerging) economies: the volatility of the spread has increased in all advanced economies but one and it has declined in most emerging economies.

Third, before 2008 the spread is counter-cyclical in emerging economies and a-cyclical in advanced economies. After 2008 it is counter-cyclical for both country groups. Fourth, the variation of spreads is not systematically related to the level of public debt, neither before nor after 2008. Fifth, and last, we observe that while before 2008 the variation of spreads is not systematically related to the

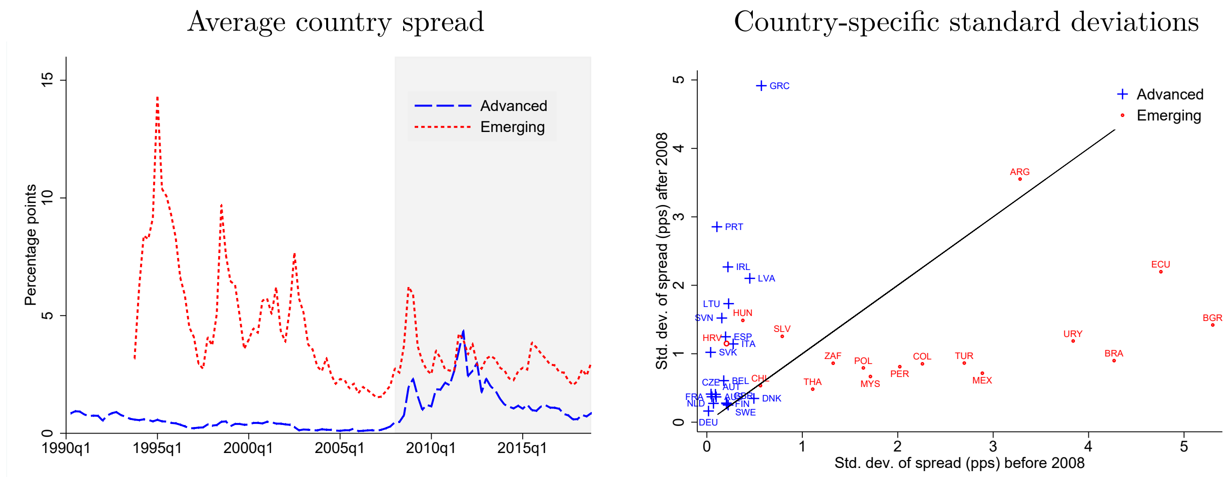

Figure 1: Left panel: Average country spread for 21 advanced economies (blue dashed line), and 17 emerging economies (red dotted line). Shaded area denotes period since 2008Q1. Right panel: country-specific standard deviations for advanced (blue plus signs) and emerging (red circles) economies before 2008 (x-axis) and after 2008 (y-axis). Black line indicates 45 degree line.

exchange-rate regime, after 2008 it is systematically higher the less flexible the exchange rate regime is. We verify that these facts are insensitive to the particular break date in 2008Q1. They also obtain once we drop the observations for years 2007–2008 from our sample.

These patterns raise interesting questions regarding causality. The country spread is certainly endogenous to the fundamentals of a country—a central theme in the literature on sovereign default (e.g., Arellano 2008; Eaton and Gersovitz 1981). Yet spreads also vary for reasons that are exogenous to country-specific developments. One possibility is that global factors cause the spread to vary such as, for instance, changes in risk aversion or the global financial cycle (Longstaff et al. 2011; Rey 2013). This has been documented in particular in the context of emerging market economies (Mauro et al. 2002). A second source of spread variations unrelated to fundamentals is the possibility that spreads shift due to market sentiment or coordination failure as a result of which changes in expectations may become self-fulfilling (e.g., Calvo 1988; Cole and Kehoe 2000; Lorenzoni 2014; Lorenzoni and Werning 2019). Either way, the notion of a "spread shock" is economically meaningful: movements of the spread that are exogenous to the fundamentals of the specific economy under consideration.

In order to identify the dynamic effects of spread shocks, we rely on the causal model by Rosenbaum and Rubin (1983), recently popularized in macroeconomics (e.g. Acemoglu et al. 2019; Angrist and Kuersteiner 2011; Kuvshinov and Zimmermann 2019). In a nutshell, the idea is to measure the causal effect of a "treatment" by appropriately controlling for the fact that the probability of treatment may be endogenous. For our application, we consider the possibility that countries are treated with a large spread increase and define as treatment an increase of the spread by more than one standard deviation and, at the same time, by at least 25 basis points. There are 230 such treatments in our sample. Because they involve large increases in the spread, they are more likely to be caused by shifts in market sentiments or global factors. However, such treatments may still be an endogenous, possibly non-linear, response to changes in fundamentals. To account for "selection into treatment", we follow Angrist et al. (2016) and estimate a logit model which provides us with the propensity score, that is, the probability of a country to be treated, given its fundamentals at a specific point in time. Our conditioning set includes a large number of variables, not only conventional macroeconomic indicators, but also indicators capturing the political stability of a country, as well as forward-looking financial market variables. In a final step, we follow Jordà and Taylor (2016) and employ the augmented inverse propensity score weighted (AIPW) estimator that uses the propensity score to re-randomize observations in order to establish the causal effect of spread shocks. To shed light on the transmission of spread shocks we consider the Average Treatment Effect (ATE) on a large set of outcome variables, both for emerging and advanced economies and for the period before and after 2008.

Our main finding is that the transmission of a given spread shock is fairly similar in advanced and emerging economies—both before and after 2008. The spread increases by about 40 basis points in response to a "treatment". Output and its components contract gradually over a two-year period. The maximum effect on output is a contraction of about 0.3 percent. Importantly, the adjustment takes place in an almost identical manner across country groups. The same holds, minor differences notwithstanding, for fiscal policy. Government consumption, in particular, is fairly unresponsive, while tax revenues decline, and the public deficit-to-GDP ratio rises somewhat. Moreover, we find that the stock market contracts sharply, the real exchange rate depreciates, and bank lending contracts again in both emerging and advanced economies. This result is consistent with the notion that positive spread shocks result in capital outflows. We find that this effect is considerably stronger in emerging economies—suggesting a higher vulnerability to international capital flows in line with the received wisdom. Consistent with this interpretation, monetary policy responds more aggressively in emerging economies. It raises short-term interest rates strongly, in contrast to what we find for advanced economies. There is not much of a response by monetary policy, neither before nor after 2008. Our results are robust across a number of specifications, including alternative break dates and a model with a larger conditioning set of variables accounting for potential endogeneity of treatment. We also consider a parsimonious model of the spread that identifies the effect of spread shocks (both positive and negative) in the spirit of Uribe and Yue (2006). Using this approach we also obtain results that are fairly similar to the ATE in the baseline model.

A key finding of our analysis is that there is almost no change before and after 2008 as far as the transmission mechanism is concerned. This suggests that the change in the unconditional correlation pattern reflects a change in the incidence of shocks. We explore this issue by means of a forecast error variance decomposition. For this purpose we split the sample once more into advanced and emerging economies and the sample period before and after 2008. Consistent with our earlier findings, we find that, on average across horizons, spread shocks have become more important for explaining output fluctuations in advanced economies after 2008. Before 2008 the contribution of spread shocks in advanced economies amounts to 4 percent as opposed to 11 percent in emerging economies. For the period after 2008, the corresponding values are 7 and 11 percent instead, with the largest remaining difference occurring at very short horizons. We also find that the role of country-specific spread shocks as a source of business cycle fluctuations converged across country groups after 2008.

Following Neumeyer and Perri (2005) and Uribe and Yue (2006) several studies have focused on the role of interest rate shocks for the business cycle in emerging economies. Akinci (2013) shows that country spreads are a key source of fluctuations in emerging economies and, in turn, caused by global financial risk shocks. García-Cicco et al. (2010) perform a model-based analysis and find that endogenous changes in country premiums are essential to account for business cycles in emerging market economies. Further research has looked into the importance of interest-rate uncertainty as source of business cycle fluctuation in emerging economies (Born and Pfeifer 2014; Fernández-Villaverde et al. 2011). There is also model-based work that provides microfoundations for interest-rate fluctuations (e.g. Brei and Buzaushina 2015; Fernández and Gulan 2015). Corsetti et al. (2013) and Bocola (2016) put forward models where sovereign risk spills over to the private sector, affecting financing condition adversely. Monacelli et al. (2018) investigate the effect of interest rate shocks on productivity and document differences for emerging and advanced economies. However, their data for advanced economies is limited to the period before 2008.

Furthermore, recent work by Faust et al. (2013), Gilchrist and Mojon (2018), and Gilchrist et al. (2009) has highlighted the predictive role of credit spreads for real activity in advanced economies, notably the US and selected countries of the euro area. In this case, aggregate spread measures are constructed on the basis of individual bond spreads within countries, while our analysis is based on the cross-country spread. Likewise, a recent contribution by Bocola and Dovis (2019) quantifies the role of self-fulfilling expectations during the euro area crisis. Using an estimated structural model they find that non-fundamental risk accounts for 13 percent of the variation in the Italian spread.

Lastly, recent work by Passari and Rey (2015) and Miranda-Agrippino and Rey (2019) provides evidence that spread fluctuations are caused by global financial conditions. Specifically, contractionary US monetary policy shocks are shown to impact global financial conditions and, as a result, various spread measures increase around the globe. International lending contracts because of a deleveraging by global financial intermediaries.

The remainder of the paper is organized as follows. Section 2 provides details on our data set and establishes basic facts about the country spread. What sets our analysis apart from earlier work is both the scope of our data and our focus on the difference across country groups and sample periods. Section 3 introduces the empirical strategy on which we rely to identify spread shocks and their effects. It introduces our measure of treatment and provides a sense of how likely it is for countries to be treated given their fundamentals. We show impulse responses to a spread shock in Section 4, shedding light on the transmission mechanism. We also report the results of a forecast error variance decomposition. A final section concludes.

2 New facts

Our analysis is based on quarterly observations for macroeconomic, fiscal, and financial market variables. Most importantly, our dataset includes country spreads of interest rates. Our sample covers 38 emerging and advanced economies and runs from the early 1990s up to the end of 2018. We build on and extend the database assembled in earlier work (Born et al. 2020). In what follows, we first explain briefly the construction of the country spread and characterize its behavior. Afterwards, we provide a number of new facts concerning the co-movement of the country spread and the fundamentals of a country.

2.1 Country spreads

We follow Uribe and Yue (2006) and measure the country spread as the difference between foreign-currency-denominated government or government-guaranteed bonds and risk-free bonds in the same currency. As a result, changes in the spread reflect changes in default risk and/or risk aversion (rather than expectations about inflation and/or expected currency depreciation). As the construction of the spread is mostly based on liquid securities with comparable maturities, it is also unlikely to be driven by liquidity or term premia. We exclude default episodes from our sample.[1] Throughout our analysis, we focus on the spread rather than the level of the (real) interest rate, because we are interested in differential developments across advanced and emerging economies—as opposed to movements in the underlying risk-free interest rate that is common to both country groups.

As stressed by Neumeyer and Perri (2005), interest rates on government debt are not identical to those of the private sector, but there is generally a very strong co-movement. Like Uribe and Yue (2006), we rely on the JPMorgan Emerging Market Bond Index (EMBI) data set, but also on a number of additional sources, as explained in detail in earlier work (Born et al. 2020). In what follows, we pursue the same approach as in Born et al. (2020), but update the data to include observations up to 2018Q4. In total, there are 1758 country-quarter observations for advanced economies and 1456 for emerging economies. Table A.2 in the appendix provides details on the sample coverage and descriptive statistics at the country level.

In what follows, we compute a number of statistics, both for the period before and after 2008. Specifically, the first sample period ends in 2007Q4, the second starts in 2008Q1, that is, it includes the year 2008. We verify that our results are qualitatively unaffected when we use 2007Q1 or 2009Q1 as alternative break dates.

In Table 1 we report a number of summary statistics for the spread in advanced and emerging economies. The statistics in the left panel refer to the level of the spread measured in percentage points, while the right panel refers to the quarterly change of the spread measured in basis points. A number of observations stand out. First, before 2008 advanced and emerging economies exhibited very different average levels of the spread. In this case, both the mean and the median are more

[1] Default episodes are: Greece (2012Q1-2012Q2, 2012Q4), Argentina (2001Q4-2005Q2, 2014Q3-2016Q2), Ecuador (1999Q3-2000Q3, 2008Q4-2009Q2), Uruguay (2003Q2) and Peru (2000Q3). This classification follows Standard & Poor's (see Witte et al. 2018, Table 13).

Table 1: Descriptive statistics of the country spread before and after 2008Q1

	Before 2008		After 2008		Before 2008		After 2008	
	Adv.	Em.	Adv.	Em.	Adv.	Em.	Adv.	Em.
	Spread level s_{it} (percentage points)				Spread change Δs_{it} (basis points)			
Mean	0.33	4.25	1.50	3.09	−0.24	−3.45	2.72	2.71
Median	0.25	2.84	0.70	2.39	−0.30	−7.38	−0.95	−4.88
Std. Dev.	0.32	3.94	2.22	2.29	12.77	160.07	69.49	98.87
Min	−0.14	0.15	−0.06	0.41	−99.08	−952.59	−314.45	−854.70
Max	2.20	24.22	24.56	19.50	97.50	1 039.00	783.21	795.84
Kurtosis	10.95	6.42	26.61	11.56	20.43	12.86	29.87	20.76
Skewness	2.34	1.74	3.93	2.46	0.10	1.13	2.66	0.91
Observations	870	719	888	737	843	698	885	735

Notes: Level of spread measured in percentage points (left panel) and quarterly change in basis points (right panel).

than 10 times higher in emerging economies than in advanced economies. Likewise, the standard deviation is about 10 times higher. However, before 2008, as the mean spread change in column 6 shows, emerging market spreads were on average on a downward trajectory. Second, for the period after 2008 we find that the spread behaves much more similar in the two country groups. The mean and median spread level in emerging economies are now only bigger by a factor of 2, due to both an increase in the average spread in advanced economies and a decrease in emerging economies compared to the previous period. For the spread level, we can reject the hypothesis that the mean is the same across country groups before and after 2008, on the basis of both a parametric two-sample t-test and the non-parametric Mann-Whitney-U test. For the spread change, only the Mann-Whitney-U test rejects the null.[2] After 2008, the standard deviation and the maximum realization have largely converged to a level previously only reached by emerging economies. The same holds true for average spread changes and their standard deviation. We can reject the null of equal standard deviations for the spread level before 2008, but not after 2008 (p=0.3413). However, for the spread change we can reject the null of equal standard deviations for both sample periods. Importantly, these changes are not driven by individual countries, but are rather broad-based, as the right panel of Figure 1 illustrates. Tables A.2 and A.3 in the appendix provide additional statistics on a country-by-country basis. The maximum spread changes, for instance, increased considerably in all advanced economies. Importantly, we observe a very similar pattern once we omit the 2007/08 period in order to assess the robustness of our findings, see Table A.4 in the appendix.

As a way to visualize the change in the spread distribution over time, we show kernel density estimates in Figure 2. Here, the top panels show the distribution of the spread measured in levels, the bottom panels show the distribution of the quarterly change. We once more contrast data for the period before and after 2008, shown in the left and right column, respectively. In each panel,

[2]The t-test with its clearly violated assumption of normality cannot reject the null of equal means for both sample periods. This is unsurprising given the large underlying standard deviations.

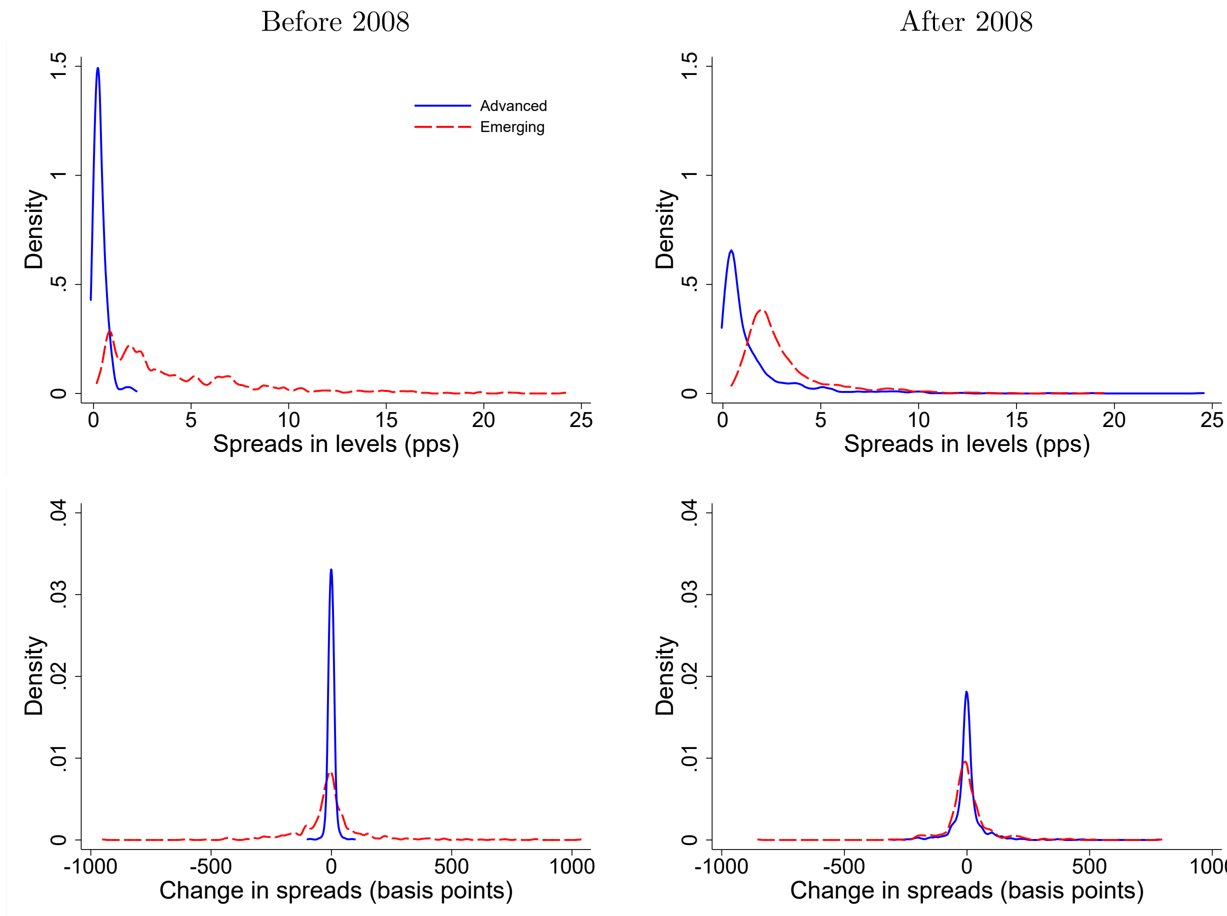

Figure 2: Distribution of the spread in levels (top) and in changes (bottom) before 2008 (left) and after 2008 (right). Kernel density estimate for advanced economies (blue solid line) and emerging economies (red dashed line); spread level measured in percentage points, change of spread in basis points. The kernel density estimate employs an Epanechnikov kernel with bandwidth 8 for the spread change and 0.15/0.25 (before/after 2008) for the spread level.

the solid line displays the distribution for advanced economies and the dashed line represents the distribution for emerging economies. We again note that the two country groups are very different before 2008 and much more similar in terms of their distribution after 2008. Before 2008, the mass of the observations for advanced economy spreads is close to zero, both in terms of the level and the change. This changes considerably after 2008: the distribution becomes wider and less concentrated around zero—a feature formerly characterizing the distribution for emerging economies. Turning to higher moments, we find the distribution to be right-skewed for all time periods, country groups, and both spread measures. Given that spreads are bounded from below, this is unsurprising. But it is noteworthy that the skewness has increased after 2008 and more so for advanced economies (see also Table 1). We also find the distribution of spread changes to be leptokurtic, that is, the mass of observed changes is clustered around 0 with more extreme observations in both tails of the

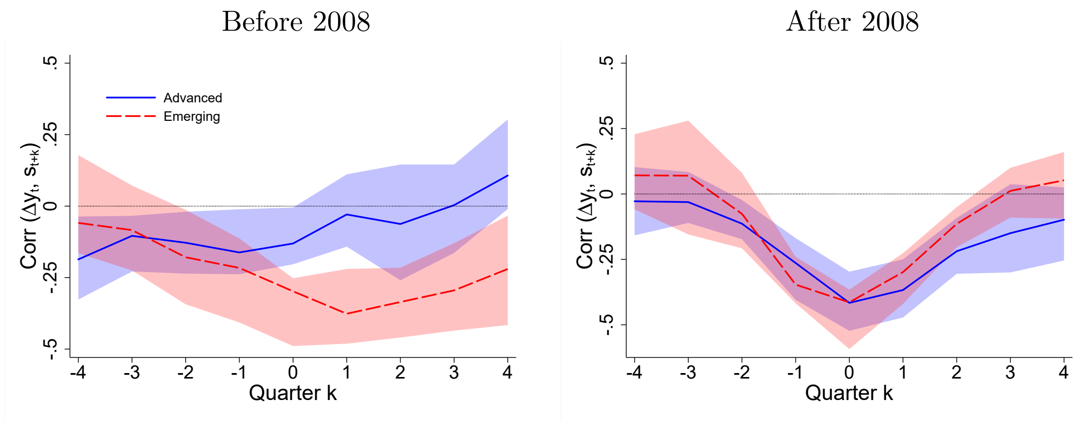

Figure 3: Cross-correlation functions for output growth Δy_t and spread s_{t+k}, measured in levels at lead/lag $k = 0, \ldots, \pm 4$ before 2008 (left panel) and after 2008. The blue solid line depicts the average correlation for advanced economies, the red dashed line for emerging economies. Shaded areas indicates 25% and 75% interquartile range in the respective country group.

distribution (compared to a Gaussian distribution with the same first two moments). While positive excess kurtosis (that is >3) is pervasive for both country groups in both sample periods, it is larger to begin with and also increased more for advanced economies (see also Table 1).

2.2 Country spreads and fundamentals: co-movement

Neumeyer and Perri (2005) highlight a striking pattern regarding the cyclicality of interest rates. On the basis of data for the period up to the early 2000s for five emerging and five advanced economies, they show that the contemporaneous co-movement of output and real interest rates at business cycle frequencies is negative for emerging economies, but zero to positive for advanced economies. Fernández and Gulan (2015) consider data up to 2010Q3 and report similar results. We revisit these findings for the spread component of interest rates on the basis of our data set, which includes more countries and more recent observations after the global financial crisis. Figure 3 displays the cross-correlation between output growth and the spread.[3]

Again, we show results for the period before 2008 in the left panel and results for the period after 2008 in the right panel. For the period before 2008 (left panel), the contemporaneous correlation for emerging economies is counter-cyclical, with the strongest (negative) correlation at lead 1. For advanced economies, the correlation is slightly negative, and more or less acyclical at all leads and lags. This pattern changes after 2008, when the contemporaneous correlation turns strongly counter-

[3] In contrast to the previous two papers, we use growth rates of output instead of deviations from an HP-filtered trend. The use of a one-sided filter instead of a two-sided one preserves the temporal ordering of the time-series. We report results for HP-filtered series in Appendix A.3. For the period before 2008 (left panel), we obtain a similar pattern as Neumeyer and Perri (2005) and Fernández and Gulan (2015) for output and real interest rates: counter-cyclical spreads for emerging economies and slightly pro-cyclical ones for advanced economies. This pattern only changes after 2008, when the contemporaneous correlation turns counter-cyclical for advanced economies as well.

Table 2: Unconditional relationship between output and spread

Advanced economies					Emerging economies				
	Before 2008		After 2008			Before 2008		After 2008	
	$\sigma(Y)$	$\rho(Y,s)$	$\sigma(Y)$	$\rho(Y,s)$		$\sigma(Y)$	$\rho(Y,s)$	$\sigma(Y)$	$\rho(Y,s)$
Australia	0.80	−0.02	0.43	−0.23	Argentina	2.30	−0.62	2.41	−0.38
Austria	0.44	−0.15	0.70	−0.36	Brazil	0.96	−0.25	1.30	−0.63
Belgium	0.61	−0.18	0.53	−0.29	Bulgaria	0.47	0.36	1.04	−0.44
Czech Republic	0.68	−0.43	0.93	−0.72	Chile	1.02	−0.38	0.95	−0.41
Denmark	0.99	−0.18	0.92	−0.38	Colombia	1.03	−0.53	0.68	−0.37
Finland	1.19	−0.23	1.40	−0.47	Croatia	1.18	0.03	1.22	−0.44
France	0.41	−0.09	0.51	−0.23	Ecuador	1.40	−0.51	1.06	−0.17
Germany	0.66	−0.41	0.98	−0.30	El Salvador	0.56	−0.58	0.58	−0.43
Greece	0.88	−0.07	1.54	−0.44	Hungary	0.58	0.06	1.14	−0.61
Ireland	1.74	0.18	4.05	−0.17	Malaysia	0.80	−0.48	1.21	−0.68
Italy	0.56	−0.10	0.77	−0.34	Mexico	1.41	−0.36	1.19	−0.59
Latvia	1.86	−0.66	1.88	−0.67	Peru	1.45	−0.30	0.95	−0.27
Lithuania	1.33	0.24	2.37	−0.53	Poland	1.41	0.08	0.69	−0.11
Netherlands	0.52	0.00	0.75	−0.62	South Africa	0.86	−0.47	0.58	−0.62
Portugal	0.67	−0.14	0.83	−0.45	Thailand	1.62	−0.49	2.21	−0.40
Slovakia	1.56	0.07	1.67	−0.18	Turkey	2.45	−0.33	2.49	−0.43
Slovenia	0.77	−0.46	1.25	−0.38	Uruguay	2.56	−0.36	1.41	−0.05
Spain	0.25	0.10	0.69	−0.52					
Sweden	0.61	−0.08	1.11	−0.59					
United Kingdom	0.65	−0.01	0.67	−0.40					
United States	0.71		0.67	−0.47					
Total	0.85	−0.13	1.17	−0.42	Total	1.30	−0.30	1.24	−0.41

Notes: Standard deviation of output growth ΔY_t and contemporaneous correlation with the spread level s_t in advanced and emerging economies before 2008 and after 2008. In the last line we report the equally-weighted country average.

cyclical for advanced economies as well. As the right panel of the figure shows, the cross-correlation function now exhibits a similar U-shaped pattern for both emerging and advanced economies. We observe a very similar picture once we omit the 2007/08 period, see Figure A.1 in the appendix.

In Table 2, we report more details on a country-by-country basis. For each advanced economy (left panel) we report standard deviations of output growth and the spread (in levels) for the period before and after 2008. The same statistics are reported for each emerging economy in our sample (right panel). The table shows that the convergence in the correlation pattern is not driven by specific countries: the contemporaneous correlation of output and the spread declined in all advanced economies, except for Germany and Slovenia.

Next, we turn to the co-movement between the spread and the debt-to-GDP ratio shown in Figure 4. As before, the left and right panels display data for the periods before and after 2008, respectively. The top row refers to the level of the spread, the bottom row to the change. Blue plus signs indicate observations for advanced economies, while red circles refer to observations for emerging economies. For the period before 2008, depicted in the left panels, we observe distinct

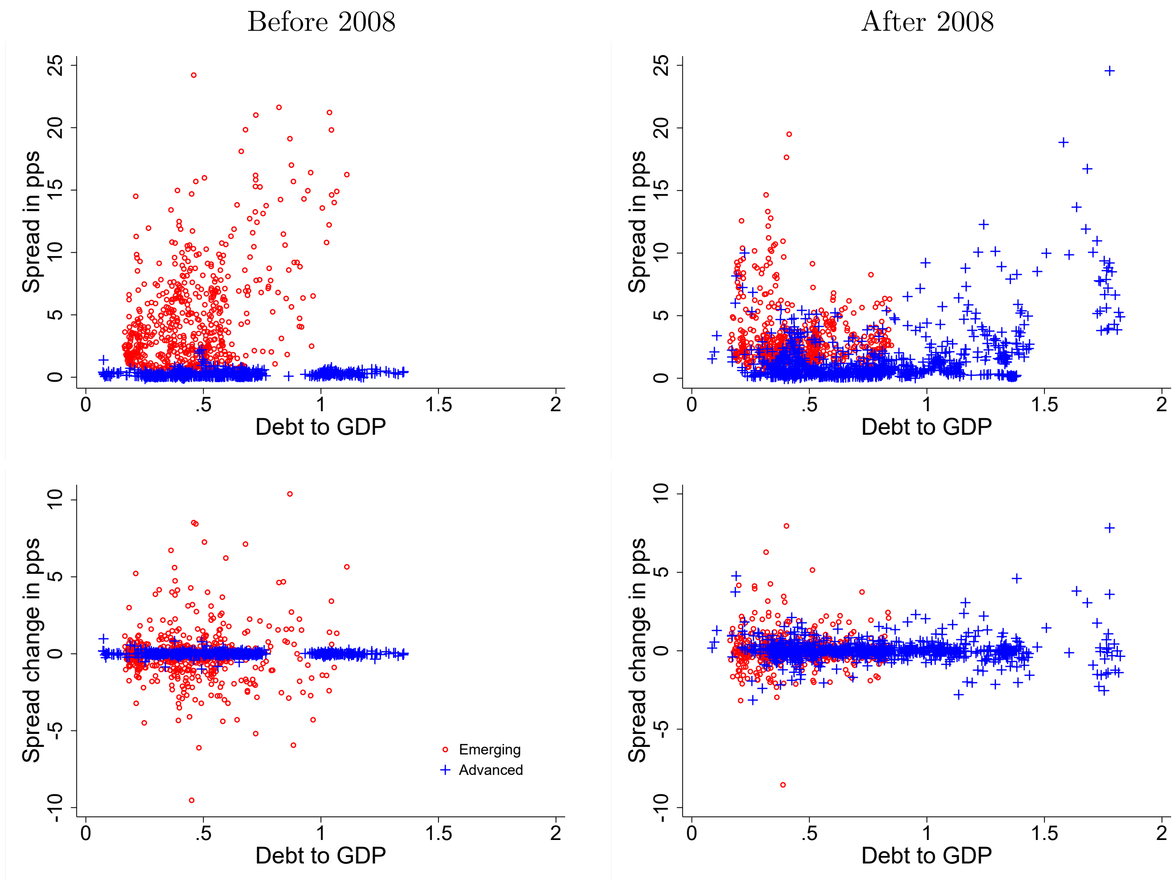

Figure 4: Spread and debt-to-GDP ratio. Top: spread measured in levels (percentage points). Bottom: quarterly spread changes (in percentage points). Blue plus signs indicate observations for advanced economies and red circles indicate observations for emerging economies. Public debt-to-GDP ratio refers to general or central government (external) debt relative to GDP/GNI.

patterns for emerging and advanced economies. The debt-to-GDP ratio varies considerably in both country groups, from 7 to 135 percent in advanced economies and from 17 to 111 percent in emerging economies. Yet, even though the range of the debt-to-GDP ratio observed in both country groups is similar, the spread in levels (top left panel) seems to be positively associated with the level of debt in emerging economies, but not much in advanced economies. Again, we observe a notable change for the period after 2008 (top right panel): debt-to-GDP ratios in advanced economies now reach considerably higher levels (of up to 182 percent). The opposite holds true for emerging economies, where the largest observation now only reaches 85 percent of GDP. Moreover, after 2008, the spread in levels exhibits a positive comovement with debt in advanced economies as well. For spread changes (bottom panels) we observe that they differ systematically across country groups, but hardly with the level of debt. After 2008, the range of spread changes appears still largely unrelated to the level of debt.

Finally, we investigate how spread changes vary across exchange rate regimes. For this purpose,

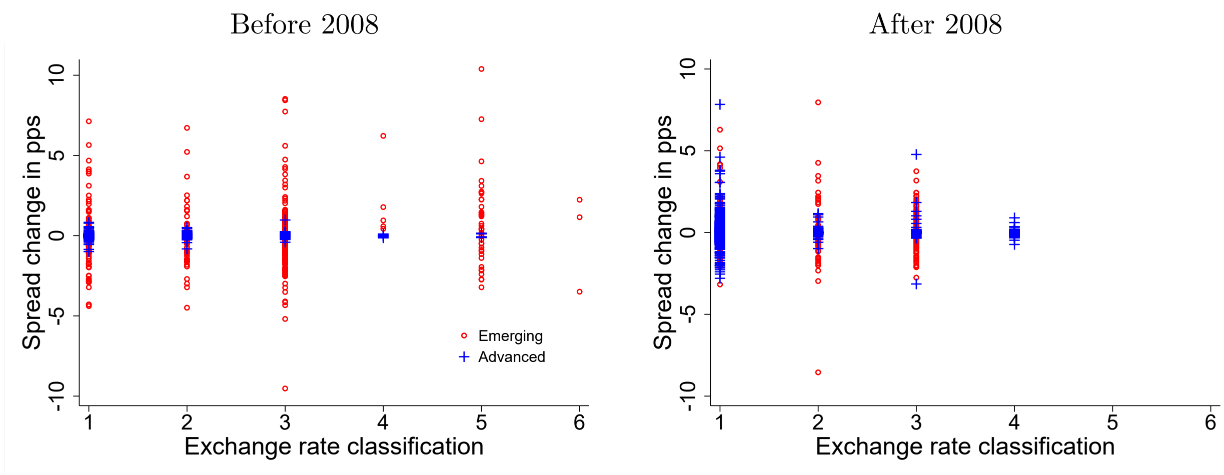

Figure 5: Spread change versus exchange rate classification before 2008 (left panel) and after 2008 (right panel). Blue plus signs indicate observations for advanced economies and red circles indicate observations for emerging economies. The exchange rate regime classification follows the coarse classification of Ilzetzki et al. (2019): 1 denotes peg, 2 crawling peg, 3 managed float, 4 freely floating, 5 freely falling, and 6 denotes dual market. After 2008, there are no observations of categories 5 and 6 in our sample.

we rely on the coarse regime classification of Ilzetzki et al. (2019). It allows for six categories, which feature increasingly flexible exchange rate regimes: an exchange rate peg (1), a crawling peg (2), a managed float (3), a freely floating exchange rate (4), a freely falling exchange rate (5), and a dual market (6). We order these categories from left to right on the horizontal axis in Figure 5, again for the period before 2008 (left panel) and after 2008 (right panel). We measure the quarterly change in the spread along the vertical axis and use red circles for observations for emerging economies and blue plus signs for advanced economies. Again, we observe that the basic patterns in the data change across the two sample periods. Prior to 2008 there is no apparent systematic relation between spread changes and exchange rate regimes. While spreads generally vary little for advanced economies, the variation in spread changes does not differ much across exchange rate regimes in emerging economies. In contrast, after 2008 variation in spread changes is systematically higher, the less flexible the exchange rate regime. This finding is consistent with the notion that some of the variation in spreads is due to self-fulfilling expectations which, in theory, are more likely to take place if monetary policy is lacking autonomy (Bianchi and Mondragon 2018; De Grauwe 2012; Lorenzoni and Werning 2019).[4] The notion that spreads vary for reasons unrelated to fundamentals, for instance, because expectations become self-fulfilling, provides the rationale for the strategy that we use to identify exogenous variation in the spread. We take up this issue in the next section.

[4]This effect should be less important in case of foreign currency debt. However, even in this case self-fulling runs may be more likely the less flexible the exchange rate regime. For if monetary policy is able to act as a lender of last resort for domestic debt, this may free up resources to satisfy the claims of foreign-currency debt holders. See, e.g., Bocola and Lorenzoni (forthcoming).

3 Measuring the effects of spread shocks

In the remainder of the paper we focus on spread shocks and how they impact both emerging and advanced economies before and after 2008. As argued in the introduction, there are strong reasons to expect that the country spread fluctuates partly for reasons which are exogenous, either because of global developments or shifts in market sentiment. Our identification strategy is based on the causal model by Rosenbaum and Rubin (1983), which permits estimation of a "treatment effect". In the context of our analysis a treatment boils down to being exposed to a large spread increase, as we explain in some detail in what follows. In Section 3.2 we present a measure of how likely it is for a country to be treated at a particular point in time, that is, its propensity score. In Section 3.3 we explain how we rely on the propensity score as we employ an augmented inverse propensity score weighted (AIPW) estimator in order to establish the causal effect of sovereign spread shocks. Last, we also discuss an alternative strategy to measure spread shocks.

3.1 Treatment

In our baseline, we focus on large increases of the spread in order to capture events that are potentially more disruptive than garden-variety changes of the spread. Moreover, large changes are also more likely to be caused by exogenous factors, to the extent that country-specific fundamentals change only gradually. Still, large changes of the spread may also reflect an endogenous response to fundamentals. We account for this possibility once we control for selection into treatment on the basis of a large set of fundamentals as well as for potentially non-linear selection effects. In our baseline, we consider only spread increases rather than spread changes, because their effect is not necessarily symmetric. In our robustness analysis we pursue an alternative approach for which we no longer restrict our analysis to spread increases. Instead, we consider both positive and negative spread shocks.

To operationalize the notion of a treatment with a large spread increase, we define a dummy variable that assumes a value of one whenever the change of the spread for a given country-quarter observation is larger than one standard deviation and, in addition, at least 25 basis points. Otherwise, the dummy is zero:

$$D_{i,t} = \mathbb{1}(\Delta s_{i,t} >= \sigma_i \wedge \Delta s_{i,t} >= 25\text{bp}) \ . \tag{1}$$

Here and in what follows the subscripts t and i refer to the quarter and the country of an observation, respectively. $\Delta s_{i,t}$ is the change in the spread, as measured at the end of a quarter, and σ_i is the country-specific standard deviation of spread changes.[5]

On the basis of this definition, 229 observations in our sample qualify as treatments. This amounts to 7.25 percent of the observed spread changes.[6] Table A.5 in the appendix reports the

[5] Mauro et al. (2002), in their emerging market economy analysis, consider a spread increase large if it exceeds two standard deviations.

[6] This is well below the 16 percent of observations we would expect outside of the one-sigma interval of a normal distribution. The reason is that spread changes are not normally distributed (see Table 1) and because we require a

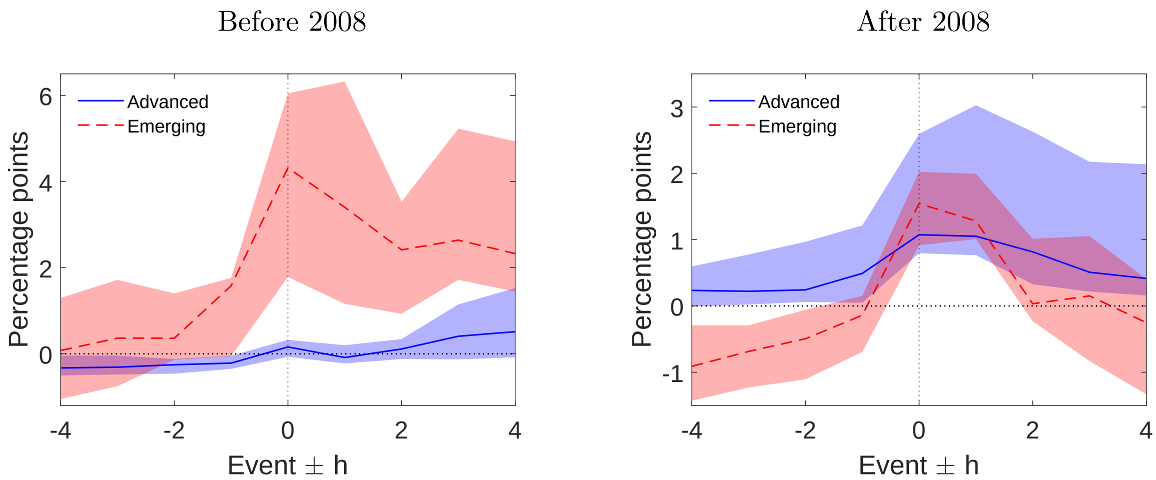

Figure 6: Spread deviations from country-mean around treatments, before (left) and after 2008 (right) in advanced (solid line) and emerging economies (dashed line). Country-specific spread movements around treatments are measured as the average of spread deviations from the respective country mean over all events in the country in the event window $t \pm h$. Lines indicate the median of country-specific spread movements, shaded areas indicate the 25% and 75% interquartile range across countries. Time is measured in quarters. For definition of treatment, see main text, equation (1).

maximum spread change along with the number of treatments for each country in the sample.[7] Table A.6 in the appendix lists all the countries which have been treated in a specific quarter. We find that treatments are fairly evenly distributed across time and countries. In 49 out of 156 quarters there is at least one treatment. Each country in our sample has been treated at least once. Still, perhaps unsurprisingly, treatments also bunch in quarters associated with major crises: 1998Q3, 2008Q3, 2008Q4, 2010Q2, and 2011Q3. For all countries in our sample we find that the spread increases by more than one standard deviation at the time of the treatment, suggesting that we indeed capture episodes of exceptionally large spread increases.

Figure 6 illustrates how spreads evolve in an event window centered around the quarter in which a treatment takes place. To account for the fact that the level of the spread differs across countries, we first express the country-specific spread in terms of deviations from the country mean. We then compute the country-mean of these spread deviations over all events in the respective country. The left panel represents data for the period before 2008, the right panel for the period after 2008. The solid line represents the median over the individual mean-country-spreads for advanced economies around treatments. The dashed line represents the median for emerging economies. The shaded area represents the 25%-75% interquartile range across countries. The horizontal axis captures four quarters before to four quarters after treatment.

In the period before 2008, the median spread movement around treatments amounts to a

treatment to raise the spread by at least 25 basis points. When dropping the latter requirement, 8.16 percent of the observations qualify as treatments.

[7]Recall that we exclude country-quarter observations for which countries are in default.

4 percentage point increase above the country average in emerging economies. At the same time, the average spread movement around treatments is fairly moderate in advanced economies, namely 0.15 percentage points above the country average and 36 basis points relative to the pre-treatment period. In advanced economies, the spread is flat in the year preceding the event, while it is already elevated in the quarter before the treatment in emerging economies. After treatment takes place, the spread remains high for an extended period only in emerging economies. For the period after 2008 a different picture emerges. The spread movement around treatments in advanced and emerging economies is now of about the same size. For emerging economies we observe a somewhat sharper rise of the spread at the time of the treatment. For advanced economies the spread is already elevated prior to treatment and persistently high afterwards. By and large, however, we find once more that the dynamics in advanced and emerging economies have become fairly well aligned after 2008. In the appendix, we display event windows on a country-by-country basis, see Figures A.4 and A.5.

3.2 Selection into treatment

The selection into treatment is not random, but likely to depend on fundamentals. In order to quantify how the probability of treatment varies with fundamentals, we run a logistic regression. Formally, a country's likelihood of receiving a treatment at a given point in time, $D_{i,t}$, conditional on some observable fundamentals $X_{i,t}$, that is, its *propensity score*, is given by

$$p(D_{i,t} = 1|X_{i,t}) = G(X_{i,t}\beta) \ , \tag{2}$$

where G is a logistic cumulative density function and β denotes a vector of regression coefficients. A low propensity score p indicates that, based on the fundamentals $X_{i,t}$, experiencing a treatment is unlikely. As a consequence, the treatment is likely to be caused by exogenous factors. The vector $X_{i,t}$ in our model contains a large number of contemporaneous and lagged control variables, dummy variables, and country-fixed effects. In the baseline specification, we do not allow for time-fixed effects because we do not want to eliminate spread variation that is likely due to global economic developments and, hence, exogenous to country-specific developments. In section 4.2 below, we will investigate the effect of country-specific spread shocks by including time-fixed effects in order to capture common global developments.

Note that it is generally recommended to "over-model" the propensity score, that is, to include a large number of covariates because this ensures that the conditional independence assumption (CIA) (see below) is indeed satisfied. In our baseline model, $X_{i,t}$ features key macroeconomic variables such as GDP growth, public debt, and inflation, a number of indicators that capture the political stability of a country, as well as financial variables like stock prices and the exchange rate (see Table A.1 in the appendix for details). The latter are particularly important due to their inherently forward-looking nature. For a subset of country-quarter observations we have an even larger conditioning set available: Additional control variables like the term spread, the short-term interest rate, a measure of credit, as well as forecasts of GDP and government spending growth are

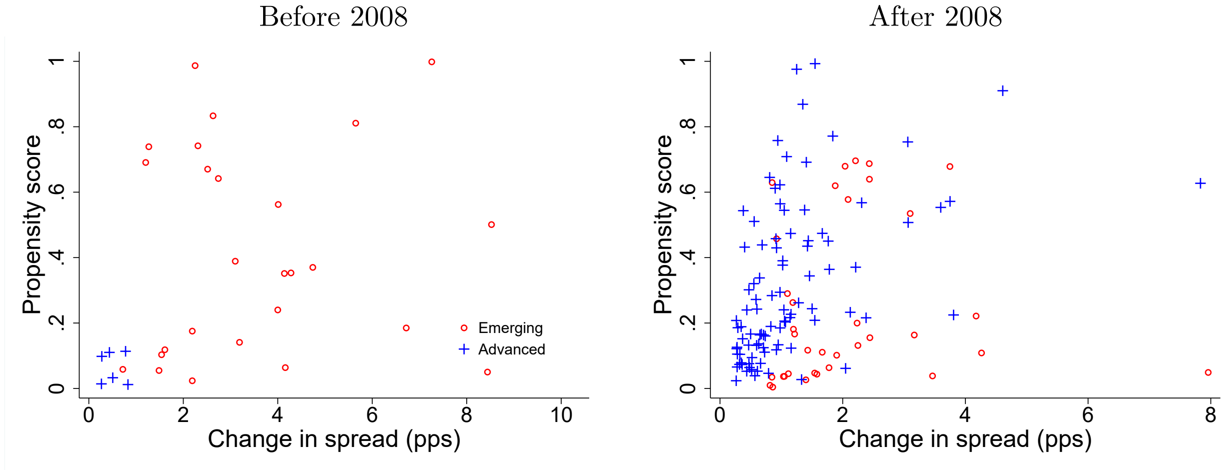

Figure 7: Propensity score and spread change before 2008 (left panel) and after 2008 (right panel) for treatment events $D_{i,t} = 1$. Blue plus signs (red circles) indicate observations for advanced (emerging) economies.

well-suited to capture potential anticipation effects. Whenever we rely on the larger set of control variables we refer to the "extended model" as opposed to the "baseline model". Given the limited availability of control variables, we estimate the logit model (2) on 161 treatments in case of the baseline model and 76 treatments in case of the extended model.

Figure 7 correlates the estimated propensity score with the change in the spread for the observations in our baseline sample for which a treatment has taken place according to definition (1).[8] As before, we use red circles to refer to observations for emerging market economies and blue crosses for advanced economies. The left panel refers again to the period before 2008, while the right panel refers to the period after 2008. First, we note that there are very few treatments for advanced economies before 2008. To alleviate concerns about the small number of treatments biasing our subsequent estimation of average treatment effects, we also pursue an alternative identification strategy in Section 3.4. It uses a continuous spread shock measure in each single period and therefore many more observations. Still, we obtain results very similar to the baseline. Second, in the period before 2008 there are many treatments of emerging economies for which the propensity score is moderate. This suggests that the treatment cannot be well explained by fundamentals. Instead, it is likely caused by exogenous factors. Third, the same holds for the period after 2008, although in this case both for emerging and advanced economies.

Before we move on to estimating treatment effects, we formally assess the goodness-of-fit of our model. To this end, we follow Jordà and Taylor (2016) and report the Area Under the Curve (AUC)-statistic.[9] For the baseline (extended) model, we obtain a value of 0.8730 (0.9457) with a

[8] Table A.7 in the appendix reports the point estimates as well as the implied average marginal effects, while Tables A.8 and A.9 report the means and standard deviations of the estimated propensity scores $\hat{p}$ on a country-by-country basis.

[9] The AUC statistic summarizes the predictive ability of the estimation model to classify the observations correctly into treatment and control group. The AUC can take values between 0.5 (no predictive power) up to 1 (full accuracy).

standard error of 0.0139 (0.0155). This suggests that both models are doing a good job in predicting treatments. The resulting propensity score allows us to control for selection into treatment as we estimate the ATE below. In addition, we check whether the so-called overlap condition is satisfied in the context of our analysis. It ensures that we can compute the treatment effect for all realizations of the control variables in our sample (see e.g. Imbens 2004; Wooldridge 2010).[10] We find that the distributions of the estimated propensity scores indeed show considerably overlap, see Figure A.6 in the appendix.

3.3 Estimating the treatment effect

In order to establish the causal effect of a treatment we have to account for the fact that the spread itself responds to the fundamentals of a country, that is, to macroeconomic and political factors in the economy. To address this issue, we follow Jordà and Taylor (2016) and employ the augmented inverse propensity score weighted (AIPW) estimator. Intuitively, we construct a matching-type estimator that compares a control and a treatment group. To deal with non-random allocation into the respective groups, the propensity score is used to re-randomize the observations. Observations with characteristics $X_{i,t}$ causing a high propensity score are more likely to be in the treatment group and are therefore weighted down. At the same time, observations with a low propensity score—for which the treatment is more likely to be exogenous—tend to be undersampled and receive more weight in the estimator.

We introduce some notation to fix ideas. Generally, in order to establish the causal effects of a treatment $D_{i,t} = d, d \in \{0, 1\}$, defined as in equation (1) above, we rely on the conditional independence assumption (CIA) (Rosenbaum and Rubin 1983):[11]

$$Y_{i,t+h}(d) - Y_{i,t} \perp D_{i,t} \quad | \quad X_{i,t} \qquad \text{for } h > 0\,, \tag{3}$$

where $Y_{i,t+h}(d) - Y_{i,t}$ denotes the potential outcome of variable Y at time $t + h$ relative to its baseline value. This baseline value is observed at time t and we assume it not to be affected by the treatment.[12] An exception is the spread for which we study the response to the treatment relative to its value in the pre-treatment period $t - 1$. The vector $X_{i,t}$ contains control variables as described in Section 3.2. Intuitively, equation (3) states that, conditional on the controls, the allocation of observational units to the control and treatment group, respectively, is independent of potential outcomes. We estimate the treatment effect for each variable of interest in quarters $h = 1, \ldots, 8$ after treatment.

Rosenbaum and Rubin (1983) show that if the overlap condition is satisfied and the CIA holds,

Its estimator is asymptotically normally distributed. See Jordà and Taylor (2011) and Hanley and McNeil (1982) for details.

[10] Formally, the overlap assumption is defined as $0 < p(D_{i,t} = 1|X_{i,t}) < 1$. Intuitively, for every observation with characteristic vector $X_{i,t}$, we require a strictly positive probability of being in the treatment group as well as in the control group. Otherwise, we would be trying to compare observational units that are "incomparable".

[11] See Lunceford and Davidian (2004) and Wooldridge (2010) for a discussion.

[12] Note that as we estimate the propensity score, we permit a contemporaneous effect of the control variables on the spread.

then the latter will also hold if one conditions only on the propensity score:

$$Y_{i,t+h}(d) - Y_{i,t} \perp D_{i,t} \quad | \quad p(D_{i,t} = 1 | X_{i,t}) \qquad \text{for } h > 0\,. \tag{4}$$

Intuitively, instead of effectively matching units in the treatment and control groups that are similar along all dimensions of the covariates $X_{i,t}$, it is sufficient if they have a similar propensity score. As discussed in the previous subsection, we find that condition (4) is satisfied in the context of our analysis. Hence, we simply use the propensity score as estimated above to compute the AIPW estimator, which provides us with the average causal effect of an exogenous increase in the spread on our outcome variables of interest.

Specifically, we employ an AIPW estimator with regression adjustment, which is the most efficient one in its class of so-called doubly-robust estimators (Lunceford and Davidian 2004).[13] Formally, we use

$$\begin{aligned} ATE^h_{AIPW} =& \frac{1}{N}\sum_{t=1}^{N}\left\{ \left[\frac{D_t(Y_{t+h}-Y_t)}{\hat{p}_t} - \frac{(1-D_t)(Y_{t+h}-Y_t)}{(1-\hat{p}_t)}\right]\right. \\ & \left. - \frac{D_t - \hat{p}_t}{\hat{p}_t(1-\hat{p}_t)}\left[(1-\hat{p}_t)m^h_1(X) + \hat{p}_t m^h_0(X)\right]\right\}, \end{aligned} \tag{5}$$

where treatment takes place at time t and the effect on the dependent variable is captured at horizon $t + h$. In the expression above, we drop the panel index i to ease notation.

Two things are noteworthy about this estimator. First, by including propensity-score weights $\hat{p}_t$ and $(1 - \hat{p}_t)$ in the denominator in the first line of Equation (5) we achieve a random allocation of observational units into treatment and control group. Second, the second line of Equation (5) features a regression adjustment component, which among other things stabilizes the estimator in case the propensity score gets close to zero or one (see Lunceford and Davidian 2004).[14] This is an issue of some concern in light of the estimated propensity scores reported in Tables A.8 and A.9.[15]

For inference, we use the asymptotic normality of the AIPW estimator and rely on an empirical sandwich estimator of the variance, as explained in Lunceford and Davidian (2004), to compute clustered robust standard errors.

3.4 An alternative approach

Our baseline approach focuses on specific treatments—defined as a large increase of the spread. As argued in Section 3.1 above, in this way we are more likely to capture events that are a) particularly disruptive and b) not caused by country fundamentals. In order to assess the robustness of our results, we purse an alternative strategy in the spirit of Uribe and Yue (2006), who identify spread

[13] In this class, consistent estimation of the ATE is achieved as long as either the model for the conditional mean or the propensity score model are correctly specified.

[14] The terms $m^h_d(X), d \in \{0, 1\}$ are the conditional means derived from the conditional mean model. This is a regression of $(Y_{t+h} - Y_t)$ on the covariates X_t, conditional on the subsample of treatment ($d = 1$) or control ($d = 0$).

[15] An alternative to including a regression adjustment term is truncation. We find that our results are fairly robust as we consider a truncated propensity score at ±5%, ±10%, and ±20%.

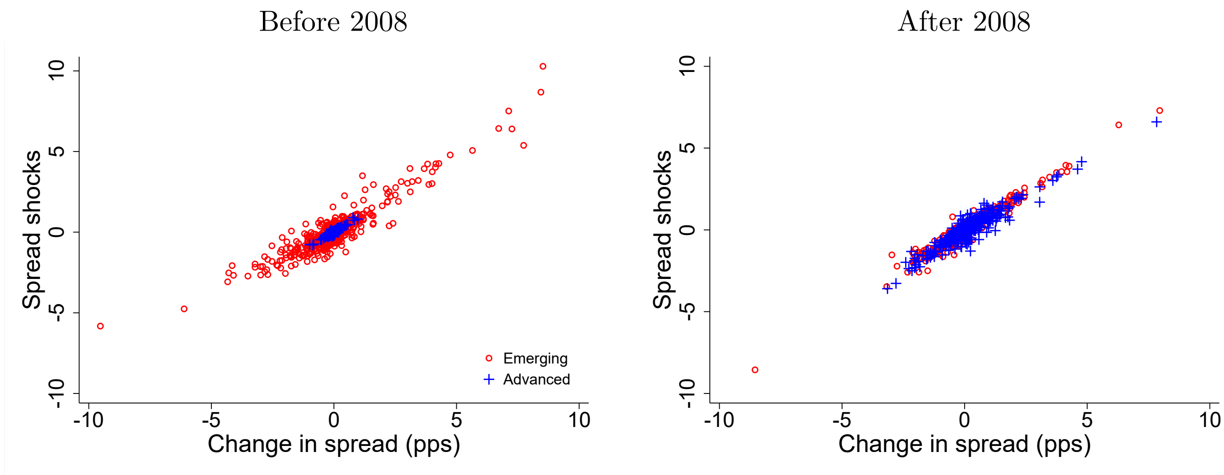

Figure 8: Spread shocks (vertical axis), as captured by linear model (6), measured against change in spread in percentage points (horizontal axis) before and after 2008. Blue plus signs (red circles) indicate observations for advanced (emerging) economies.

shocks using a VAR-style recursive scheme with the spread ordered last.[16] Given this identifying assumption, the relevant regression equation for the spread change (analogous to the definition of treatment) is given by:

$$\Delta s_{i,t} = \eta_i + X_{i,t}\beta + \varepsilon_{i,t}\,, \tag{6}$$

where the column vector of controls $X_{i,t}$ contains current and one-period lagged values of GDP growth and net exports as well as the lag of the spread. $\varepsilon_{i,t}$ are mean zero structural innovations, that is "spread shocks", and η_i are country-fixed effects.[17] In terms of identification, model (6) just like our baseline, allows for a contemporaneous effect of fundamentals on the spread change, but rules out that fundamentals respond immediately to spread changes. However, following Uribe and Yue (2006), model (6) is much more parsimonious than our baseline model for two reasons. First, with OLS regressions, "over-modeling" as in the case of propensity score estimation is not advocated. Second, because the model features fewer explanatory variables, we can estimate the OLS regressions separately for the groups of advanced and emerging economies before and after 2008.

In Figure 8 we correlate spread shocks, that is, the residuals from regression (6), $\hat{\varepsilon}_{i,t}$, and the change in the spread. As before red circles refer to observations for emerging economies, while blue plus signs refer to observations for advanced economies, the left panel shows results for the period before 2008, the right panel for the period after 2008. For the period before 2008 we again observe a different distribution between advanced and emerging economies. Shocks are small in the former and quite sizeable in the latter. After 2008, the shocks have again become much more comparable

[16] Technically, they estimate a panel VAR equation by equation and include the US interest rate and the country interest rate separately. But, as they argue, this is equivalent to including the spread directly.

[17] The R^2 of these OLS regressions (for various sample splits) ranges between 0.78 and 0.90, which indicates that around 10 to 20 percent of the variation in the spread is left unexplained by the model and hence can be attributed to non-fundamental shocks. This finding is in line with the decomposition of Bocola and Dovis (2019).

in terms of size across the two country groups. This suggests that there is considerable exogenous variation in the spread.

We use the residuals of regression (6) as a measure of the spread shock and estimate its dynamic effect on various outcome variables via local projections (Jordà 2005). Letting $Y_{i,t+h}$ denote the variable of interest in period $t+h$, we regress it on spread shocks in period t on the basis of the following specification:

$$Y_{i,t+h} - Y_{i,t} \ = \alpha_{i,h} + \psi_h \hat{\varepsilon}_{i,t} + u_{i,t+h} \ , \tag{7}$$

where $Y_{i,t}$ again denotes the unshocked baseline value of variable Y. In equation (7), the coefficients ψ_h, which we estimate by OLS, provide a direct estimate of the impulse response at horizon h to a spread shock.[18] The error term $u_{i,t+h}$ is assumed to have zero mean and strictly positive variance. $\alpha_{i,h}$ denotes country-fixed effects. We compute clustered robust standard errors.

The local projection framework also allows us to compute the contribution of the spread shocks to the forecast error variance of our variables of interest. Following Gorodnichenko and Lee (forthcoming), we compute the variance share of the shock at horizon h as the R^2 of the following regression

$$\hat{u}_{i,t+h} = \gamma_0 \hat{\varepsilon}_{i,t+h} + \ldots + \gamma_h \hat{\varepsilon}_{i,t} + \nu_{i,t+h} \, , \tag{8}$$

where $\hat{u}_{i,t+h}$ is the forecast error of the local projection (7) at horizon h and $\nu_{i,t+h}$ is a mean 0 disturbance.

4 Results

We first shed some light on how spread shocks are transmitting through the economy, as we study the dynamic adjustment to spread shocks by means of impulse response functions. Second, we establish that our results are robust across a number of alternative specifications. Lastly, we report the contribution of spread shocks to output fluctuation on the basis of a forecast error variance decomposition. Throughout, we are interested in possible differences across country groups and sample periods.

4.1 Shock transmission

We now show the impulse responses to a spread shock. First, we report results for the AIPW estimator in equation (5) with the treatment defined in equation (1). In Figure 9, the (blue) solid and (red) dashed lines represent the point estimates for advanced and emerging economies, respectively. In each instance, the shaded area indicates the 90 percent confidence interval based on clustered robust standard errors. We measure time in quarters along the horizontal axis. The vertical axis

[18] The shock is thus a generated regressor in the second stage (Coibion and Gorodnichenko 2015). Still, Pagan (1984) shows that the standard errors obtained after a regression on the shocks are asymptotically valid under the null that the coefficient is 0.

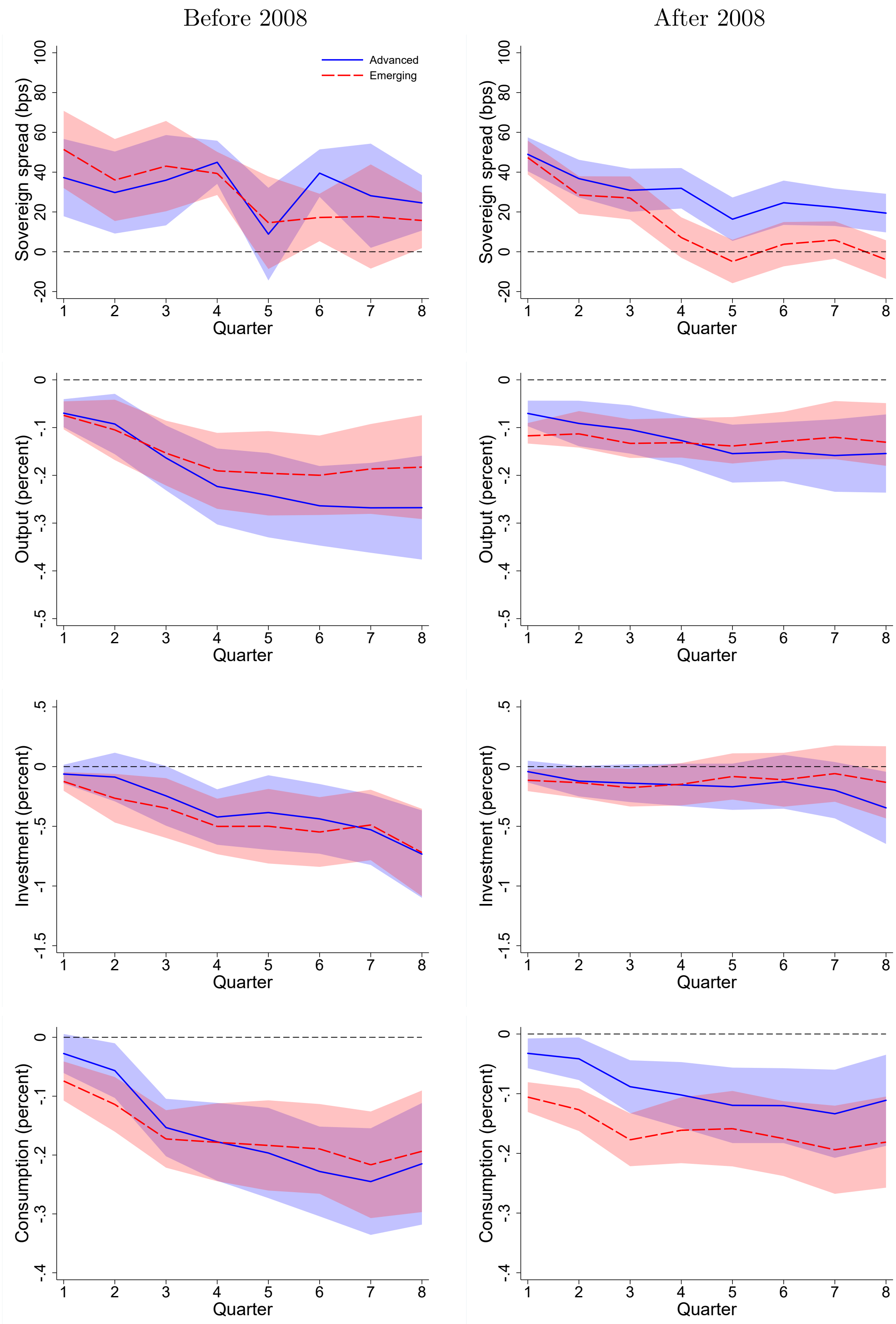

Figure 9: Impulse responses of the spread and real national accounts variables to a $h = 0$ sovereign spread shock based on the ATE estimator in equation (5) together with the treatment definition in (1). Solid (blue) and dashed (red) line represents deviation from pre-shock treatment level for advanced and emerging economies, respectively. Shaded areas correspond to 90% confidence intervals based on clustered robust standard errors. Horizontal axis measures time after treatment in quarters.

measures the deviation relative to the pre-shock level in either percent or basis points. As before, the left column shows results for the period before 2008, the right column for the period after 2008.

Our main finding is that the dynamic adjustment to a spread shock does not differ much across country groups or sample periods. We find this result particularly noteworthy in light of the facts established in Section 2 above. As shown in the top row, spreads remain elevated for an extended period of about four quarters. The initial increase is about 50 basis points. After three quarters, spreads are still some 20 basis points higher than prior to treatment. This pattern is remarkably similar across countries, both for the period before and after 2008.

The adjustment of output is shown in the second row. It is again highly similar across country groups, in particular in the period before 2008. Output declines immediately by about 0.1 percent and continues to decline in the following one to two years. According to the point estimate, the maximum effect is about 0.3 percent in advanced economies and 0.2 percent in emerging economies. After 2008 the effect is a bit weaker. It is similar on impact, but afterwards there is less of a decline. Overall these numbers are in the same ballpark as those established by the earlier literature on the effect of interest increases due to monetary policy shocks. In a recent paper, Coibion et al. (2017), for instance, find that US output declines by about 0.6 percent in response to a US monetary policy shock that raises the Fed funds rate by 100 basis points (see their Figure 2).

The fact that the output effect is more moderate after 2008 seems to be driven by the weaker response of investment, shown in the third row of the figure. It is almost identical across country groups both before and after 2008, but generally weaker after 2008. We show the responses of private consumption in the bottom row of the figure. In emerging economies it is unchanged across sample periods. In advanced economies, it is almost identical to that in emerging economies before 2008 and somewhat weaker after 2008.

We obtain additional insights into the transmission mechanism as we consider the impulse responses of the real exchange rate and of financial variables in Figure 10. Here, the top row shows the response of the real effective exchange rate. It declines in response to the shock, that is, the currency depreciates in real terms in both country groups and for both sample periods. We note, however, that the response is considerably stronger in emerging economies. The depreciation is consistent with the notion that the spread shock reflects a capital outflow shock—for instance because global risk aversion increases or because there is a run on the country. Consistent with this interpretation, we find that real bank lending contracts in response to the spread shock (second row). The effect is similar across sample periods and somewhat stronger in emerging economies than in advanced economies—consistent with the notion that emerging economies are more vulnerable to a reversal of international capital flows (see, for instance, Broner et al. 2013). In the third row, we show the response of the real stock market index. It contracts strongly, but the response is again remarkably similar across sample periods and country groups.

Recent work by Miranda-Agrippino and Rey (2019) shows that a contractionary US monetary policy shock raises global risk aversion and induces a deleveraging of global financial intermediaries such that domestic credit declines. At the same time credit spreads go up. Consistent with our

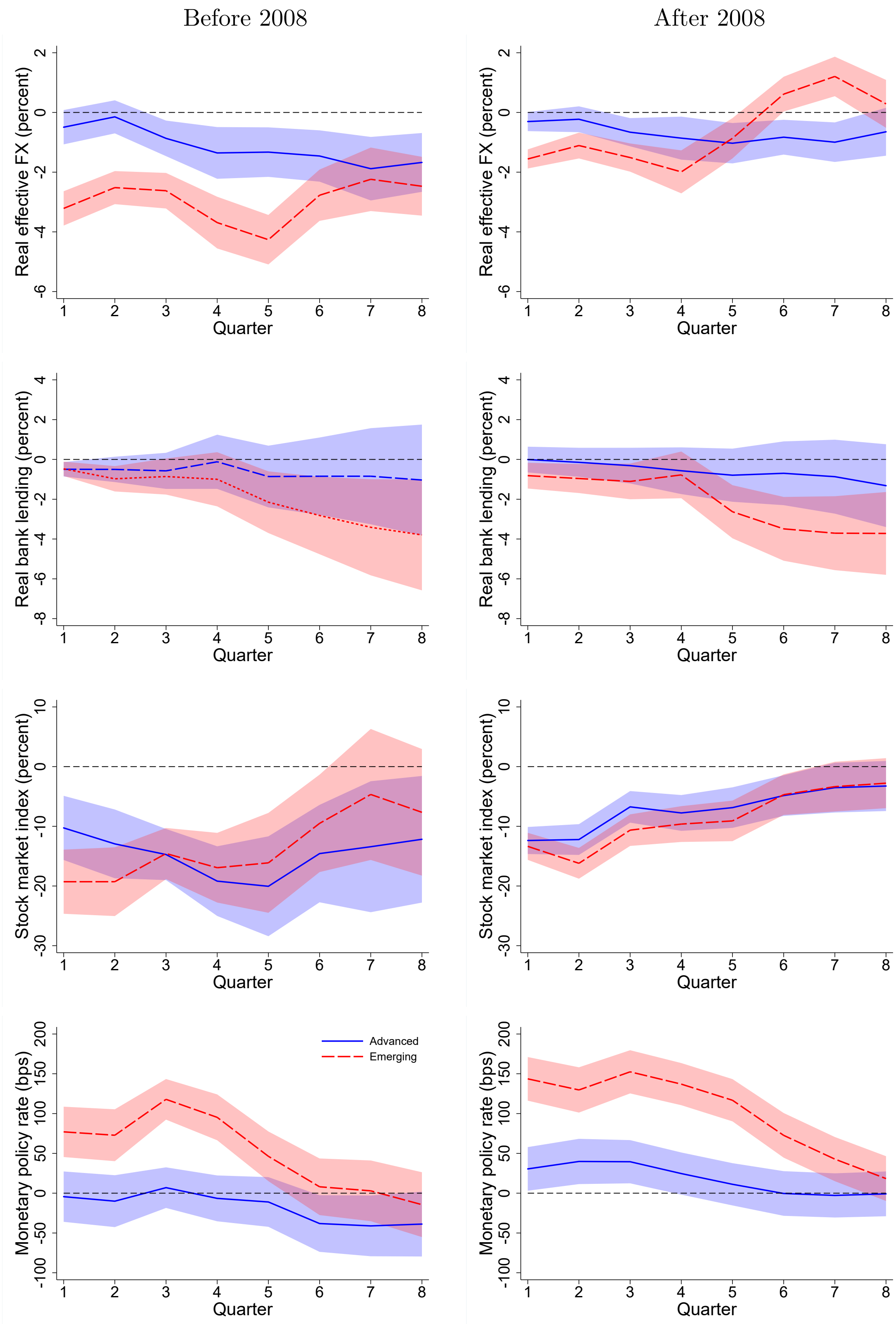

Figure 10: Response of exchange rate and financial variables to spread shock. See Figure 9 for details.

findings, their shock affecting spreads also appreciates the dollar in real terms against a basket of currencies and triggers a sharp decline of the FTSE and the German DAX. Miranda-Agrippino and Rey (2019) look more closely at monetary policy in the UK and the euro area and find that short-term policy rates decline in response to the shock, although the response is not significant in the UK. We show the response of monetary policy to our identified spread shock in the last row of Figure 10 and observe rather strong differences across emerging and advanced economies. For both sample periods we find that interest rates go up in emerging economies and, in fact, strongly so. In advanced economies their response is very much muted. The difference across country groups may reflect a stronger dependency of emerging economies on capital flows such that monetary policy may respond more aggressively in order to prevent large capital outflows—in line with the notion of limited monetary policy independence in emerging economies (Rey 2013).

In Figure 11 we show the response of net exports and real fiscal variables to the spread shock. By and large, we again find a very similar adjustment pattern across country groups and sample periods. The top panels show the response of the trade balance-to-GDP ratio. In general, it is not very responsive to the shock. An exception are net exports in emerging economies after 2008, where we observe an immediate and sizable decline in response to the shock. In the second row, we show the response of real government consumption. It is fairly unresponsive on impact, before subsequently declining gradually, most notably in the period before 2008. To rationalize this finding, recall that government consumption consists largely of items that are not automatically responding to the cycle. At the same time, it takes time to adjust spending because of decision and implementation lags (Blanchard and Perotti 2002). Our results support the idea that, at least prior to 2008, there is a fiscal retrenchment if a country's financing conditions deteriorate. However, this effect takes place with a considerable delay only—in line with the evidence and arguments put forward in Born et al. (2020)

The budget-deficit-to-GDP ratio, in turn, increases persistently and somewhat more strongly in advanced economies, both before and after 2008 (third row). The increase of the deficit ratio is consistent with the decline of GDP, shown in Figure 9 above. But we also find that real tax revenues, shown in the last row of Figure 11, decline somewhat. In this case the decline is more pronounced before 2008. After 2008 the decline is considerably weaker in both country groups. However, the change across samples is more pronounced for emerging economies. This finding, in turn, is consistent with the notion that fiscal policy in emerging economies has become less pro-cyclical (Frankel et al. 2013).

Overall, we find that the transmission of spread shocks is fairly similar in advanced and emerging economies. Output and its components contract in an almost identical manner. The same holds, notwithstanding minor differences, for fiscal policy as well as for financial variables. An exception is monetary policy and the exchange rate. Here, we observe a strong contraction in emerging economies and a much weaker one in advanced economies. But throughout we find that there is almost no change before and after 2008. This suggests that any change in the correlation pattern documented in Section 2 reflects a change in the incidence of shocks rather than in the transmission

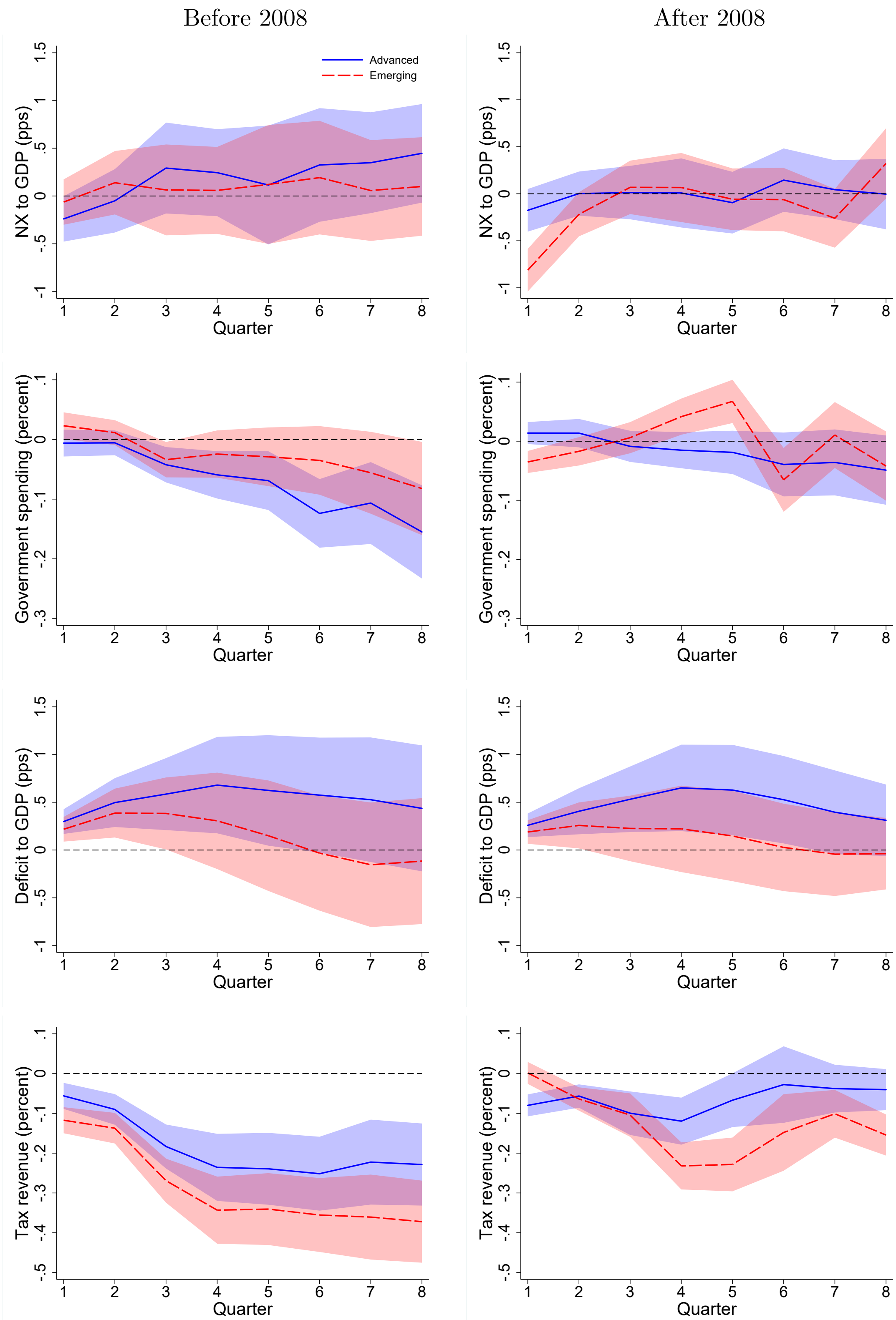

Figure 11: Response of net exports and real fiscal variables to spread shock. See Figure 9 for details.

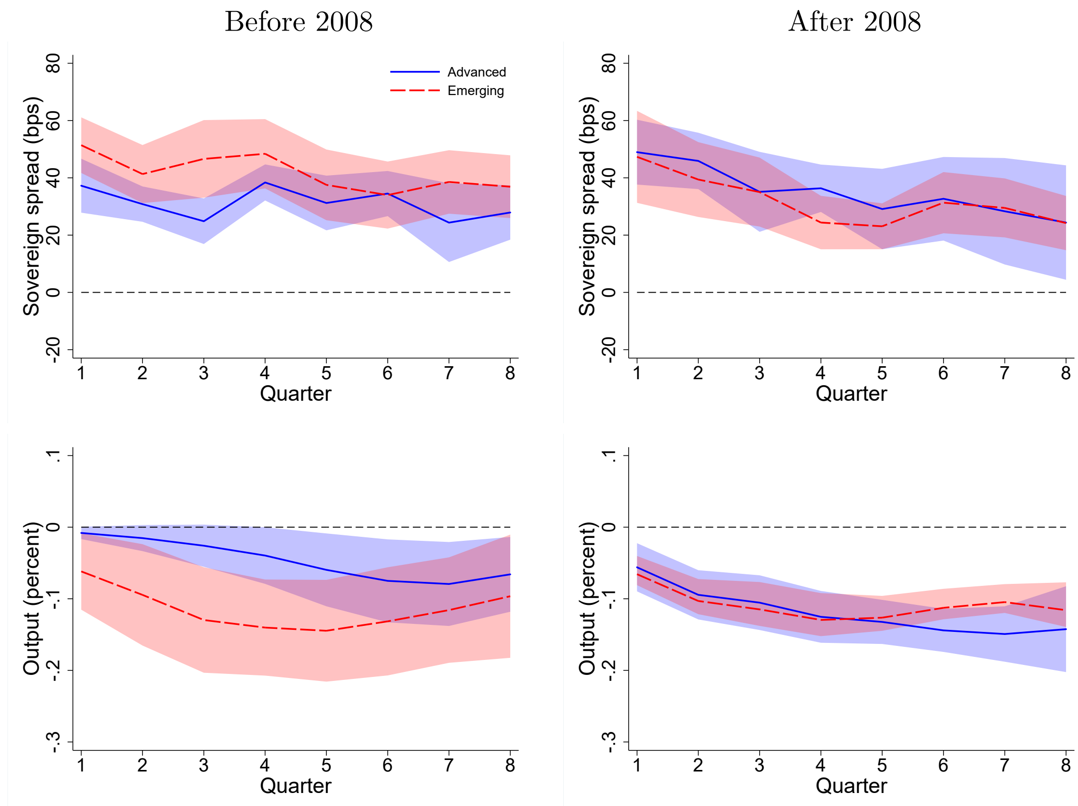

Figure 12: Impulse responses to a sovereign spread shock based on the local projection in equation (7) together with spread shocks identified using equation (6). The left panel shows results for the period before 2008 and the right panel after 2008. Solid (blue) and dashed (red) line indicate point estimates for advanced and emerging economies, respectively. Shaded areas correspond to 90% confidence intervals based on clustered robust standard errors computed for advanced (blue) and emerging economies (red). All variables are expressed relative to their pre-shock level. Responses have been re-scaled to have the same $h = 1$ spread response as the ATE estimator. The horizontal axis indicates quarters.

mechanism. We assess this issue more systematically below.

We obtain very similar results once we use an alternative framework for estimating the effect of spread shocks. In this case, as explained in Section 3.4, rather than accounting for the propensity score of a treatment in estimating the ATE, we rely on a more conventional recursive identification scheme in the spirit of Uribe and Yue (2006). We show results in Figure 12. To make results comparable to those shown in Figure 9 above, we re-scale the response of the impulse responses so as to match the $h = 1$ response of the spread for each sample period and country group. The organization of the figure follows Figure 9, except that we now only report results for the spread (top row) and output (bottom row). As before, we find that the adjustment of both variables is quite similar before and after 2008 as well as across country groups. In addition, we note that the adjustment pattern of both variables is quite similar to what we display in Figure 9. This is quite remarkable because the conceptual and methodological approach that we use in both instances is quite distinct. Most importantly, we note that the results in our baseline are based on a much larger

Table 3: Forecast error variance decomposition

	Advanced Economies				Emerging Economies			
	Before 2008		After 2008		Before 2008		After 2008	
Horizon h	Spread	Output	Spread	Output	Spread	Output	Spread	Output
1	0.45	0.00	0.16	0.00	0.38	0.00	0.42	0.00
2	0.51	0.01	0.21	0.01	0.48	0.02	0.53	0.05
3	0.50	0.02	0.24	0.03	0.50	0.07	0.55	0.11
4	0.46	0.03	0.24	0.05	0.50	0.11	0.52	0.14
5	0.46	0.06	0.24	0.08	0.50	0.14	0.46	0.16
6	0.43	0.06	0.24	0.09	0.45	0.13	0.42	0.14
7	0.41	0.06	0.26	0.10	0.42	0.14	0.42	0.13
8	0.39	0.06	0.28	0.10	0.41	0.14	0.42	0.12
9	0.34	0.05	0.28	0.10	0.40	0.14	0.40	0.11
10	0.33	0.04	0.28	0.09	0.38	0.14	0.33	0.11
11	0.31	0.04	0.28	0.09	0.36	0.14	0.28	0.10
12	0.28	0.04	0.29	0.10	0.35	0.15	0.29	0.10
∅	0.41	0.04	0.25	0.07	0.43	0.11	0.42	0.11

Notes: Forecast error variance decomposition for the spread and output based on local projections (see Section 3.4).

set of control variables and on a more narrowly defined set of shocks. In particular, in the baseline specification we only estimate the effect of an increase in the spread, while results shown in Figure 12 are based on all shocks, regardless of their sign. We find our key results are largely confirmed.[19]

4.2 Spread shock contribution to business cycle variance

In Section 2 above we established a new fact: that country spreads have become much more volatile in advanced economies after 2008 and indeed almost as volatile as in emerging economies. At the same time, we find little evidence for a change in the transmission of spread shocks after 2008, neither in emerging nor in advanced economies. Against this background, we ask two questions. First, does the increase in the volatility reflect an increase in the incidence of spread shocks? Second, and relatedly, does the increase in the volatility of spreads translate into a larger role of spread shocks as a source of business cycle fluctuations in advanced economies?

In order to answer these questions, we compute a forecast error variance decomposition, as detailed in Section 3.4. As always, we split the sample into advanced and emerging economies and distinguish the period before and after 2008. In Table 3 we report the contribution of spread shocks to the forecast error variance of the spread and output for a forecast horizon of 1 to 12 quarters. The bottom row reports the average across those 3 years.

In response to the first question, and focusing on the average contribution, we note that the

[19]The response of the other variables are generally also very similar to what we obtain for the baseline. They are available on request.

Table 4: Forecast error variance decomposition: country-specific shocks

	Advanced Economies				Emerging Economies			
	Before 2008		After 2008		Before 2008		After 2008	
Horizon h	Spread	Output	Spread	Output	Spread	Output	Spread	Output
1	0.44	0.00	0.05	0.00	0.39	0.00	0.15	0.00
2	0.49	0.00	0.09	0.01	0.50	0.02	0.21	0.00
3	0.51	0.01	0.15	0.02	0.53	0.07	0.25	0.02
4	0.50	0.01	0.19	0.04	0.51	0.12	0.33	0.04
5	0.52	0.03	0.23	0.05	0.51	0.15	0.38	0.07
6	0.53	0.02	0.25	0.06	0.44	0.14	0.38	0.08
7	0.55	0.02	0.27	0.07	0.41	0.15	0.38	0.08
8	0.54	0.02	0.29	0.07	0.40	0.14	0.38	0.09
9	0.52	0.02	0.29	0.08	0.38	0.13	0.40	0.10
10	0.53	0.02	0.29	0.08	0.35	0.12	0.41	0.12
11	0.55	0.02	0.28	0.08	0.32	0.11	0.41	0.12
12	0.54	0.02	0.27	0.08	0.32	0.11	0.44	0.13
∅	0.52	0.02	0.22	0.05	0.42	0.11	0.34	0.07

Notes: Forecast error variance decomposition for the spread and output based on local projections (see Section 3.4).

contribution of spread shocks to the forecast error variance of the spread itself has actually declined in advanced economies after 2008. Before 2008 the contribution of shocks was about 40 percent and similar to what we find for emerging economies. After 2008, it is reduced to about 25 percent. In emerging economies there is no strong change over time.

In response to the second question, we note that before 2008 spread shocks account for only 4 percent of output variation in advanced economies and for about 11 percent in emerging economies. The latter finding is consistent with the value of 12 percent reported by Uribe and Yue (2006). After 2008, we find that the contribution in advanced economies has gone up to 7 percent, while it is still 11 percent for emerging economies. Hence, while we find that the relative importance of spread shocks for the volatility of the spread itself has declined in advanced economies after 2008, we observe that the volatility of the spread has increased by so much in absolute terms that the contribution of spread shocks to the volatility of output has actually gone up in advanced economies. For this reason, we conclude that, by and large, the role of spread shocks as a source of business cycle fluctuations has become more aligned across country groups.

Historically, spread levels in both advanced and emerging economies have spiked after global or regional events that presumably featured a significant common component. The Tequila crisis in 1994/95, the Asian financial crisis in 1997, the Global Financial Crisis in 2007/08, and the European debt crisis in 2011/12, for instance, are clearly visible in Figure 1. In order to isolate the effect of country-specific shocks, we include time-fixed effects in the shock identification equation (6) and the local project equation (7).[20]

Table 4 displays the forecast error variance contribution of the identified country-specific spread shocks to spreads and output *after* common factors have been controlled for. Put differently, here we decompose the forecast error variance of the country-specific spread and as well as output. Now a somewhat more nuanced picture emerges compared to the case with both common and country-specific shocks in Table 3. Advanced and emerging economies also have become more similar in terms of the variance share of output explained by country-specific spread shocks. But the reason is not simply an increase in the importance of spread shocks in advanced economies after 2008, but also that emerging economies have been less affected by country-specific spread shocks during this period. Turning to the share of the spread variance that is explained by country-specific spread shocks after accounting for the common international component, we now find a significant drop after 2008 in both groups.

4.3 Further robustness

We also make sure that our main result is robust across a number of specifications. First, we estimate the propensity score on the basis of a larger set of control variables, see Section 3.2 for details.[21] Importantly, these variables include forecasts for GDP among others and are thus potentially important to capture anticipation effects. Unfortunately, they are available for advanced economies only. For these countries, the estimated impulse responses of the spread and output to a spread shock in the extended model are very similar to the baseline results, see Figure A.7 in the appendix.

Second, we consider a more conservative treatment definition. In this case, we require either the spread increase to be at least 50 basis points (alternative treatment definition 1) or the spread to increase by more than two standard deviations (alternative treatment definition 2). In this case, we obtain 196 and 113 treatments, respectively. Based on these alternative treatment definitions, we again estimate impulse responses to a spread shock and report the responses of the spread and output in Figures A.8 and A.9 in the appendix. They are again quite similar to the baseline.

Third, we consider alternative sample periods. Rather than distinguishing the period before and after 2008, we drop the 2007/08 period from our sample. Figure A.10 in the appendix shows the impulse responses of the spread and output to the spread shock for both alternatives. The responses are very similar to what we obtain for the baseline.

Fourth, we drop the US and Germany from the sample because one could argue that these countries should be considered as risk-free benchmark countries that are hardly subject to spread shocks. Results, shown in Figure A.11 in the appendix, are again similar to the baseline.

[20]Figure A.12 in the appendix displays the IRFs. The transmission of country-specific shocks is again similar across country groups and time periods, albeit quantitatively smaller. The same holds true when adding time-fixed effects to our logit model (2) and the conditional mean model employed in (5). The ATE results are displayed in Figure A.13.

[21]The right panel of Figure A.6 in the appendix displays the distribution of the estimated propensity scores for the extended model, while Table A.9 reports details on a country-by-country basis.

5 Conclusion

In this paper we ask whether country spreads behave differently in emerging and advanced economies. We find that this is the case before 2008, in line with the received wisdom and much of the earlier research. However, the behavior of spreads after 2008 is no more different. We establish this result on the basis of a large data set which contains quarterly observations for 21 advanced and 17 emerging economies since the early 1990s. Our data runs up to the end of 2018. In the first part of the paper, we document the basic facts for the period before and after 2008. We do not repeat these facts here, except for one: before 2008 the spread is about 10 times more volatile in emerging economies than in advanced economies, after 2008 the volatility is basically the same in both country groups. Other moments have converged as well and this is mostly because advanced economies have converged towards levels common in emerging economies before 2008.

In the second part, we provide evidence on the transmission of spread shocks, again allowing for differences across country groups and sample periods. Here, our main result is that the transmission of spread shocks is fairly similar in advanced and emerging economies and there is also no evidence for a significant change in the transmission mechanism after 2008. A spread shock induces a fairly persistent increase of the spread and a contraction of economic activity. Overall the response of fiscal policy is rather moderate. There are some spending cuts, tax revenues decline and the government deficit increases somewhat, but there are no large differences in the adjustment mechanism across time and country groups. We also find that the real exchange rate depreciates and that bank lending contracts in response to the spread shock. This is consistent with the notion that the spread shock reflects a capital outflow. The effect is considerably more pronounced in emerging economies and so is the response of monetary policy, which raises short-term rates in response to the shock. However, also these patterns of adjustment do not change much across sample periods.

Lastly, as we summarize our findings regarding the importance of spread shocks in accounting for the volatility of spreads and output, we highlight a tentative policy implication. We find that the relative importance of spread shocks for the volatility of the spread is rather low in advanced economies after 2008, both relative to the pre-2008 period and relative to emerging economies. This points to a relatively larger role of shocks to fundamentals and their transmission for explaining spread movements. It also indicates that advanced economies are now more vulnerable to market assessment regarding these fundamentals. Identifying the specific reasons for this is beyond the scope of the present paper. But policy makers ignore this increased vulnerability at their own peril.

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A Appendix

A.1 Descriptive statistics

Table A.1: Description of outcome and control variables

Variable	Description	Source
Consumption	Real private consumption	Eurostat, National Sources
Credit-to-GDP	Credit lending to private non-financial sector by banks at market value relative to GDP Data available except for: Croatia, Slovenia, Latvia, Lithuania, Slovakia, Bulgaria, Ecuador Uruguay, and Peru	BIS
Debt-to-GDP	General or central government outstanding debt relative to GDP. For Ecuador, El Salvador, Malaysia and Thailand: External debt stock as % of GNI (annual data interpolated to quarterly frequency). Data available except for: Chile and Uruguay	Eurostat, Worldbank QPSD, and International Debt Statistics
Deficit-to-GDP	Net lending or borrowing respectively relative to real GDP	Eurostat, IMF Government Finance Statistics
Floating	Fixed versus floating. We rely on the coarse classification of Ilzetzki et al. (2019) where codes 1 and 2 are classified as a peg, while 3 to 6 are classified as floating	Ilzetzki et al. (2019)
Real effective FX rate	Log effective real exchange rate; an increase indicates an appreciation of the economy's currency against a broad basket of currencies	BIS, complemented by Darvas (2012)
G	Government spending is exhaustive real government spending	Eurostat, National sources
G growth	First log difference of real government spending G.	
G growth forecast	Expected government spending growth at time t List of available countries, see GDP growth forecast	Oxford Economics
GDP	Real GDP	Eurostat, National sources
GDP growth	First log difference of real GDP	
GDP growth forecast	Expected GDP growth at time t. Data available for: Austria, Czech Republic Denmark, Finland, France, UK US, Germany, Greece, Ireland, Italy, Malaysia, Netherlands, Portugal, Spain, Sweden, Thailand	Oxford Economics
IMF assistance	Dummy variable which equals 1 if a country has a Standby Arrangement (with or without Supplemental Reserve Facility) or an Extended Fund Facility and 0 otherwise.	Monitoring of Fund Arrangements (MONA) database
Inflation	Inflation based on GDP Deflator	Eurostat, National sources
Investment	Real Investment	Eurostat, National Sources
Interest Rate	Policy or short term interest rate	IMF, OECD
NFA	Net financial assets	Lane and Milesi-Ferretti (2007)
NX share	Net export share of GDP	Eurostat, National sources
Political risk	Total political risk index from International Country Risk Guide (ICRG) ranging between 0 (low risk) and 100 (high risk). Composed of 12 subcomponents covering different aspects of political risk	PRS Group
Political stability	Government stability index from ICRG ranging from 0 (low risk) to 12 (high risk). Subcomponent of political risk, see above	PRS Group
Political turnover	Dummy variable indicating an ideological leadership change: 1 if new incumbent reaches office with different political orientation, 0 else	Archigos Database of Political Leadership, own classifications
Real bank lending	Credit-to-GDP multiplied by real GDP. For more information, see description and data sources for Credit-to-GDP and GDP	
Stock Market Index	Real log stock market index detrended	Datastream (Thomson Reuters)
Tax revenue	Log linearly detrended real total government revenues	Eurostat, IMF World Revenue Longitudinal Dataset (WoRLD)
Tax-to-GDP	Total government revenues relative to real GDP, linearly detrended	Eurostat, IMF World Revenue Longitudinal Dataset (WoRLD)
Term spread	10–year term spread, difference between bond market and money market rate. Data available except for: Croatia, Hungary, Latvia, Turkey, Argentina, Chile Colombia, Ecuador, Brazil, El Salvador, Uruguay, Peru	Datastream (Thomson Reuters)

Table A.2: Descriptive statistics for spread changes (end of quarter) measured in basis points.

					Before 2008		After 2008	
Country	Group	First obs	Last obs	Obs	min(Δs_i)	max(Δs_i)	min(Δs_i)	max(Δs_i)
Australia	A	2003q2	2010q3	25	−14	11	−73	90
Austria	A	1994q1	2018q4	100	−15	20	−62	85
Belgium	A	1992q1	2018q4	108	−35	17	−87	104
Czech Republic	A	2004q2	2018q4	59	−4	11	−98	109
Denmark	A	1988q4	2018q4	111	−99	83	−58	98
Finland	A	1992q3	2018q4	106	−30	41	−47	73
France	A	1999q2	2018q4	79	−12	12	−54	60
Germany	A	2004q2	2018q4	59	−4	4	−30	47
Greece	A	1992q3	2018q4	101	−40	50	−254	783
Ireland	A	1992q1	2018q4	108	−25	18	−280	205
Italy	A	1989q2	2018q4	119	−20	32	−204	238
Latvia	A	2006q2	2018q4	51	−7	98	−314	477
Lithuania	A	2005q3	2018q4	54	−24	57	−240	375
Netherlands	A	1999q2	2018q4	79	−8	11	−40	59
Portugal	A	1993q3	2018q4	102	−14	14	−215	307
Slovakia	A	2004q2	2018q4	59	−7	9	−205	116
Slovenia	A	2003q2	2018q4	63	−51	31	−183	178
Spain	A	1992q4	2018q4	105	−55	22	−75	144
Sweden	A	1993q2	2018q4	92	−83	51	−35	102
United Kingdom	A	1993q1	2018q4	104	−41	25	−47	81
United States	A	2008q1	2018q4	44			−23	61
Argentina	E	1994Q1	2018q4	75	−291	565	−855	796
Brazil	E	1994q3	2018q4	98	−953	852	−165	184
Bulgaria	E	1994q4	2018q4	97	−594	468	−211	417
Chile	E	1999q3	2018q4	78	−55	89	−148	165
Colombia	E	1997q2	2018q4	87	−433	560	−208	225
Croatia	E	2004q2	2018q4	59	−24	38	−174	310
Ecuador	E	1995q2	2018q4	85	−519	1 039	−317	629
El Salvador	E	2002q3	2018q4	66	−67	90	−201	515
Hungary	E	1999q2	2018q4	79	−67	63	−190	375
Malaysia	E	1997q1	2018q4	88	−439	622	−200	221
Mexico	E	1994q1	2018q4	100	−611	726	−185	204
Peru	E	1997q2	2018q4	85	−299	368	−176	244
Poland	E	1995q1	2018q4	96	−349	224	−124	190
South Africa	E	1995q1	2018q4	96	−175	300	−157	243
Thailand	E	1997q3	2018q4	86	−253	225	−123	86
Turkey	E	1996q3	2018q4	90	−322	382	−212	188
Uruguay	E	2001q3	2018q4	68	−415	774	−276	318

Notes: "A" denotes advanced economies, while "E" denotes emerging economies following the classification in IMF (2015). US observations before 2008 are missing since CDS data is not available.

Table A.3: Standard deviation of spreads and spread changes in advanced and emerging economies before 2008 and after 2008

	Before 2008		After 2008			Before 2008		After 2008	
	$\sigma(s_{it})$	$\sigma(\Delta s_{it})$	$\sigma(s_{it})$	$\sigma(\Delta s_{it})$		$\sigma(s_{it})$	$\sigma(\Delta s_{it})$	$\sigma(s_{it})$	$\sigma(\Delta s_{it})$
Advanced economies					*Emerging economies*				
Australia	0.097	6.605	0.370	41.702	Argentina	3.282	191.484	3.552	260.232
Austria	0.090	6.212	0.407	26.131	Brazil	4.267	286.385	0.899	66.925
Belgium	0.177	7.432	0.607	32.969	Bulgaria	5.301	169.717	1.420	96.427
Czech Republic	0.044	3.651	0.411	30.455	Chile	0.562	30.648	0.534	44.754
Denmark	0.474	24.684	0.347	25.016	Colombia	2.258	164.523	0.853	63.747
Finland	0.209	9.766	0.268	19.765	Croatia	0.206	16.186	1.149	84.340
France	0.053	5.182	0.371	23.541	Ecuador	4.757	274.815	2.198	186.510
Germany	0.017	1.925	0.163	12.253	El Salvador	0.790	40.092	1.254	113.369
Greece	0.571	15.895	4.916	200.478	Hungary	0.377	25.733	1.487	97.193
Ireland	0.221	7.166	2.268	87.394	Malaysia	1.714	130.962	0.667	61.203
Italy	0.279	9.684	1.143	66.244	Mexico	2.886	172.559	0.716	57.482
Latvia	0.450	35.931	2.101	112.558	Peru	2.021	124.781	0.811	63.468
Lithuania	0.228	28.935	1.732	100.568	Poland	1.640	78.104	0.793	56.406
Netherlands	0.069	5.023	0.275	18.647	South Africa	1.323	68.257	0.862	69.835
Portugal	0.105	6.273	2.855	102.097	Thailand	1.109	73.002	0.483	35.729
Slovakia	0.040	4.048	1.021	58.982	Turkey	2.697	154.774	0.864	68.489
Slovenia	0.157	19.205	1.522	70.285	Uruguay	3.838	215.049	1.186	83.917
Spain	0.196	10.085	1.248	50.283					
Sweden	0.223	18.506	0.250	19.955					
United Kingdom	0.205	11.223	0.279	18.979					
United States			0.113	11.604					
Mean	0.321	12.770	2.215	69.485	Average	3.938	160.067	2.291	98.868

Notes: Spreads are measured in percentage points and spread changes in basis points.

Table A.4: Descriptive statistics of the country spread for the period before 2007Q1 and from 2009Q1 onwards

	Before 2007		After 2009		Before 2007		After 2009	
	Adv.	Em.	Adv.	Em.	Adv.	Em.	Adv.	Em.
	Spread level s_{it} (percentage points)				Spread change Δs_{it} (basis points)			
Mean	0.35	4.52	1.56	3.02	−0.74	−4.76	−1.38	−8.31
Median	0.26	3.16	0.72	2.36	−0.74	−12.88	−1.83	−8.83
Sd	0.33	4.02	2.29	2.23	12.22	167.80	67.76	84.80
Min	−0.14	0.19	−0.06	0.41	−99.08	−952.59	−314.45	−854.70
Max	2.20	24.22	24.56	19.50	82.89	1 039.00	783.21	628.69
Kurtosis	10.54	6.03	25.31	11.26	20.06	11.83	32.78	24.59
Skewness	2.28	1.65	3.83	2.44	−0.64	1.12	2.63	−0.54
Observations	792	651	804	670	767	630	802	668

Notes: Level of spread measured in percentage points (left panel) and quarterly change in basis points (right panel). The years 2007 and 2008 have been dropped from the sample.

A.2 Cross-correlogram: Alternative sample periods

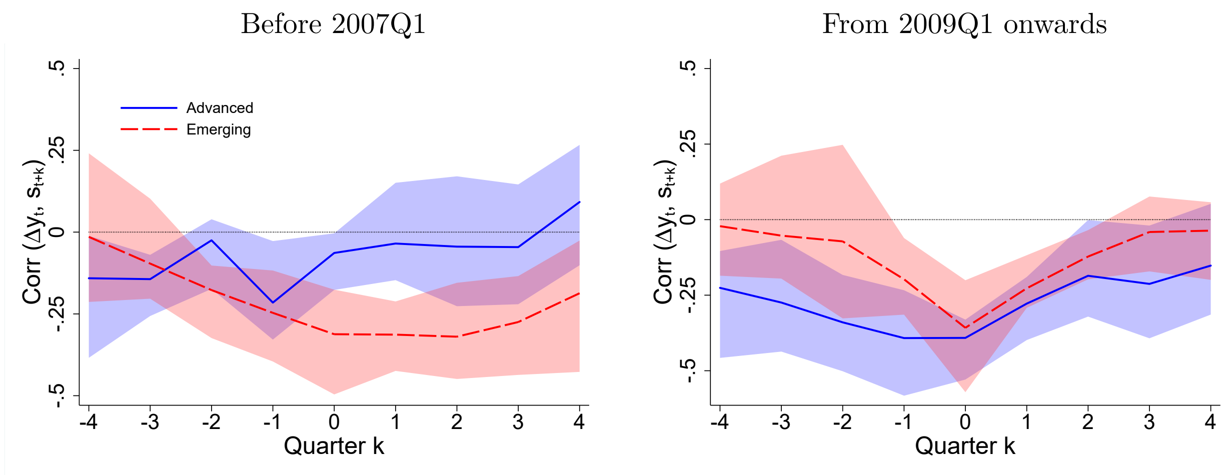

Figure A.1: Cross-correlation functions for output growth Δy_t and spread s_{t+k}, measured in levels at lead/lag $k = 0, \ldots, \pm 4$ for the period before 2007Q1 and from 2009Q1 onwards. For details, see Figure (3).

A.3 Cross-correlogram HP-filter

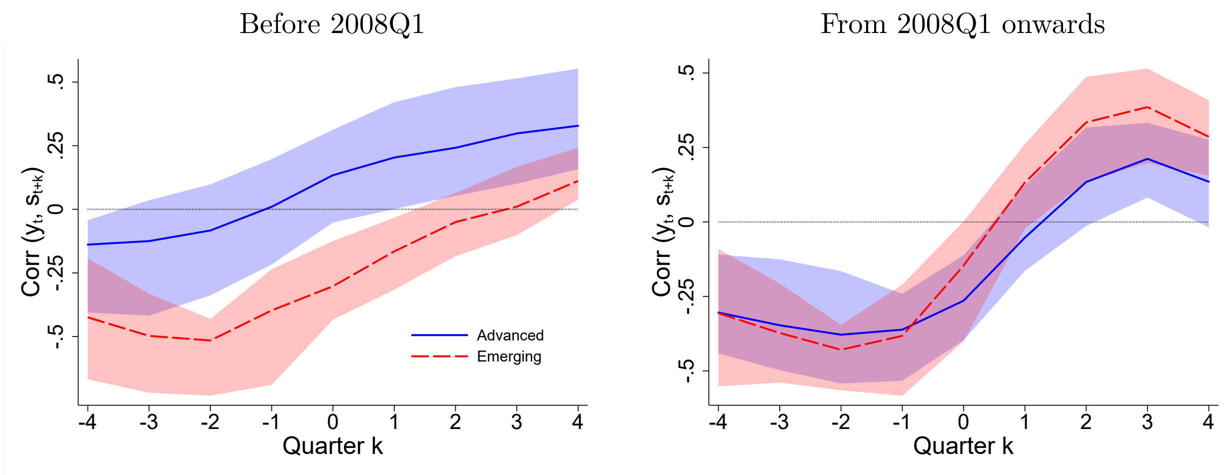

Figure A.2: Cross-correlation functions for output y_t and spread s_{t+k}, measured in levels at lead/lag $k = 0, \ldots, \pm 4$ before 2008 (left panel) and after 2008. The blue solid line depicts the average correlation for advanced economies, the red dashed line for emerging economies. Shaded areas indicates 25% and 75% interquartile range in the respective country group. Output is HP-filtered with $\lambda = 1600$.

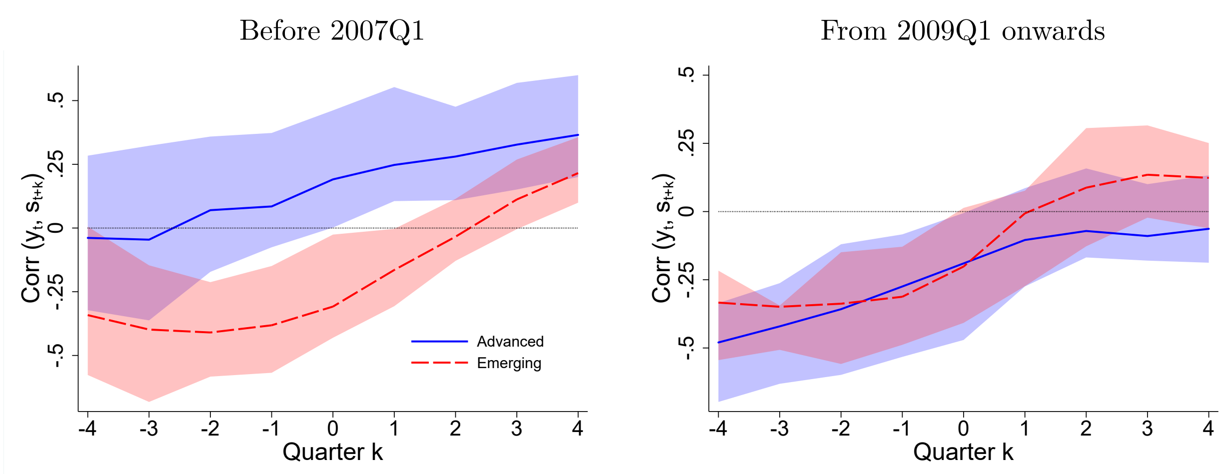

Figure A.3: Cross-correlation functions for output y_t and spread s_{t+k}, measured in levels at lead/lag $k = 0, \ldots, \pm 4$ for the period before 2007Q1 and from 2009Q1 onwards.. For details, see Figure (A.2).

A.4 Treatments and their propensity score

Table A.5: Number of treatments and share of treatments in total number of spread changes by country (excluding default episodes)

Country	$\sum D_i$ (>25bp)	% of nobs	$\sum D_i$(>50bp)	% of nobs	$\sum D_i(>2\sigma)$	% of nobs
Argentina	9	12.00	9	12.00	2	2.67
Australia	1	4.00	1	4.00	1	4.00
Austria	4	4.00	2	2.00	3	3.00
Belgium	8	7.41	2	1.85	3	2.78
Brazil	6	6.12	6	6.12	4	4.08
Bulgaria	8	8.25	8	8.25	3	3.09
Chile	10	12.82	6	7.69	3	3.85
Colombia	6	6.90	6	6.90	2	2.30
Croatia	4	6.78	4	6.78	2	3.39
Czech Republic	6	10.17	2	3.39	2	3.39
Denmark	6	5.41	4	3.60	4	3.60
Ecuador	8	9.41	8	9.41	3	3.53
El Salvador	6	9.09	6	9.09	2	3.03
Finland	3	2.83	2	1.89	3	2.83
France	4	5.06	2	2.53	3	3.80
Germany	2	3.39	0	0.00	2	3.39
Greece	9	8.91	9	8.91	5	4.95
Hungary	6	7.59	6	7.59	3	3.80
Ireland	8	7.41	8	7.41	5	4.63
Italy	8	6.72	6	5.04	5	4.20
Latvia	4	7.84	4	7.84	1	1.96
Lithuania	6	11.11	6	11.11	2	3.70
Malaysia	5	5.68	5	5.68	2	2.27
Mexico	5	5.00	5	5.00	3	3.00
Netherlands	2	2.53	1	1.27	2	2.53
Peru	7	8.24	7	8.24	4	4.71
Poland	6	6.25	6	6.25	4	4.17
Portugal	7	6.86	7	6.86	4	3.92
Slovakia	7	11.86	7	11.86	3	5.08
Slovenia	6	9.52	6	9.52	2	3.17
South Africa	10	10.42	10	10.42	3	3.13
Spain	8	7.62	7	6.67	6	5.71
Sweden	6	6.52	2	2.17	3	3.26
Thailand	7	8.14	7	8.14	3	3.49
Turkey	12	13.33	12	13.33	4	4.44
United Kingdom	3	2.88	1	0.96	3	2.88
United States	1	2.27	1	2.27	1	2.27
Uruguay	5	7.35	5	7.35	3	4.41
Total	229	mean: 7.24	196	mean: 6.20	113	mean: 3.57

Table A.6: Quarters t with treatment D in country i

Quarter t	Countries with $D_t = 1$ according to Equation (1)
1989Q2	Denmark
1994Q1	Argentina, Mexico
1994Q4	Argentina, Bulgaria, Mexico
1995Q1	Argentina, Brazil, Bulgaria, Mexico, Poland, South Africa
1997Q3	South Africa, Thailand
1997Q4	Bulgaria, Denmark, South Africa, Thailand, Turkey
1998Q2	Brazil, Bulgaria, Malaysia, Peru, Thailand, Turkey
1998Q3	Argentina, Brazil, Bulgaria, Colombia, Ecuador, Finland, Malaysia, Mexico, Peru, Poland, South Africa, Thailand, Turkey
1999Q1	Ecuador
1999Q2	Colombia
2000Q1	Chile, Colombia, Sweden
2000Q2	Chile, Colombia
2000Q4	South Africa, Turkey
2001Q1	Turkey
2001Q3	Argentina, Brazil, Chile, Poland, Turkey
2001Q4	Denmark
2002Q1	Uruguay
2002Q2	Chile, Brazil, Peru, Turkey, Uruguay
2002Q3	Brazil, Colombia, Ecuador, Peru, Turkey, Uruguay
2003Q1	Turkey
2004Q2	Ecuador, Turkey
2005Q3	Sweden
2005Q4	Denmark, Sweden
2006Q4	Ecuador
2007Q2	Sweden
2007Q3	Chile
2008Q1	Belgium, Czech Republic, El Salvador, Lithuania, Hungary, South Africa
2008Q3	Argentina, Belgium, Chile, Czech Republic, Ecuador, El Salvador, Latvia, Lithuania, Peru, Slovakia, South Africa
2008Q4	Argentina, Australia, Austria, Belgium, Bulgaria, Chile, Colombia, Croatia, Czech Republic, Denmark, El Salvador, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malaysia, Mexico, Netherlands, Peru, Poland, Slovakia, Slovenia, South Africa, Spain, Sweden, Thailand, Turkey, United Kingdom, United States, Uruguay
2009Q1	Czech Republic, France, Ireland, Latvia, Lithuania, Portugal
2009Q4	Greece, United Kingdom
2010Q2	Austria, Belgium, Bulgaria, Croatia, Czech Republic, El Salvador, Greece, Hungary, Ireland, Italy, Lithuania, Poland, Portugal, Spain
2010Q3	Ireland
2010Q4	Belgium, Greece, Ireland, Spain
2011Q1	Ireland, Portugal
2011Q2	Belgium, Greece, Ireland, Italy, Portugal, Slovakia, Slovenia, Spain
2011Q3	Argentina, Austria, Belgium, Bulgaria, Chile, Croatia, Czech Republic, Denmark, El Salvador, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Malaysia, Netherlands, Peru, Poland, Portugal, Slovakia, Slovenia, South Africa, Spain, Sweden, Thailand, Turkey, United Kingdom, Uruguay
2011Q4	Austria, Belgium, France, Greece, Hungary, Ireland, Italy, Portugal, Slovakia, Slovenia
2012Q2	Croatia, Italy, Slovenia, Spain
2013Q1	Argentina, Hungary, Slovenia
2013Q3	Slovakia
2014Q2	Slovakia
2014Q4	Ecuador, Greece
2015Q1	Greece
2015Q2	Italy, Spain
2015Q3	Chile, Ecuador, El Salvador, Malaysia, South Africa, Thailand
2016Q1	Portugal
2018Q2	Italy, Spain
2018Q4	Chile

Table A.7: Logit model: coefficients and average marginal effects (AME) based on Equation (2)

Dependent Variable:	Baseline model		Extended model	
Treatment D_t	coeff	AME	coeff	AME
Debt-to-GDP$_t$	17.5430*	0.9855*	115.1179***	4.1949***
	(8.5996)	(0.4838)	(28.2418)	(1.0035)
Debt-to-GDP^2_t	-0.0006	-0.0000	-0.0054***	-0.0002***
	(0.0005)	(0.0000)	(0.0015)	(0.0001)
GDP growth$_t$	-37.7084***	-2.1183***	-71.8303**	-2.6175**
	(9.2445)	(0.5167)	(26.8157)	(0.9629)
G growth$_t$	-1.1192	-0.0629	-15.6519	-0.5704
	(5.5443)	(0.3115)	(14.1591)	(0.5164)
Tax-to-GDP$_t$	0.0121	0.0007	-0.1296	-0.0047
	(0.0949)	(0.0053)	(0.1898)	(0.0069)
Deficit-to-GDP$_t$	10.5446	0.5924	-50.4703	-1.8391
	(14.5264)	(0.8161)	(36.0059)	(1.3067)
NFA$_t$	2.6319	0.1479	-0.9824	-0.0358
	(2.6718)	(0.1502)	(5.0811)	(0.1851)
NX share$_t$	-7.4250	-0.4171	-8.8244	-0.3216
	(6.6155)	(0.3720)	(18.5801)	(0.6766)
Inflation$_t$	-22.5318**	-1.2658**	-93.6485**	-3.4126**
	(8.1768)	(0.4595)	(32.0344)	(1.1592)
FX rate$_t$	-16.7344***	-0.9401***	-24.8502**	-0.9055**
	(3.0005)	(0.1672)	(8.1644)	(0.2897)
Stock market$_t$	-1.3734	-0.1564**	22.2501**	-0.1015
	(1.2316)	(0.0532)	(6.9120)	(0.0842)
Political risk$_t$	-0.4118**	-0.0231**	-0.0242	-0.0009
	(0.1417)	(0.0079)	(0.3366)	(0.0123)
Government stability$_t$	0.4520	0.0254	-0.2159	-0.0079
	(0.2380)	(0.0134)	(0.4999)	(0.0182)
IMF assistance$_t$	0.8033	0.0451	0.6599	0.0240
	(0.4130)	(0.0232)	(1.7848)	(0.0650)
Floating$_t$	-1.5424**	-0.0866**	-4.3400**	-0.1582**
	(0.4883)	(0.0275)	(1.4333)	(0.0513)
Political turnover$_t$	0.1875	0.0105	-0.0145	-0.0005
	(0.4957)	(0.0278)	(1.0258)	(0.0374)
Debt-to-GDP$_{t-1}$	-20.8251*	-1.1699*	-91.1007***	-3.3197***
	(8.3335)	(0.4687)	(25.6742)	(0.9160)
Debt-to-GDP$^2_{t-1}$	0.0008	0.0000	0.0046***	0.0002***
	(0.0005)	(0.0000)	(0.0013)	(0.0000)
GDP growth$_{t-1}$	17.8767*	1.0043*	-18.4398	-0.6719
	(8.1544)	(0.4579)	(31.4582)	(1.1450)
G growth$_{t-1}$	-10.8099	-0.6073	-40.1146*	-1.4618*
	(6.3303)	(0.3562)	(16.7281)	(0.6058)
Tax-to-GDP$_{t-1}$	-0.0077	-0.0004	0.0177	0.0006
	(0.0952)	(0.0053)	(0.1951)	(0.0071)
Deficit-to-GDP$_{t-1}$	15.1266	0.8498	64.9080	2.3653
	(15.0660)	(0.8462)	(40.3421)	(1.4655)
NFA$_{t-1}$A	-3.4585	-0.1943	2.8335	0.1033
	(2.6466)	(0.1488)	(5.2296)	(0.1903)
NX share$_{t-1}$	-1.5166	-0.0852	-6.8379	-0.2492
	(6.7019)	(0.3765)	(19.2400)	(0.7012)
Inflation$_{t-1}$	11.7221	0.6585	-19.7957	-0.7214
	(8.3943)	(0.4709)	(31.0485)	(1.1299)
FX rate$_{t-1}$	14.8142***	0.8322***	28.5589***	1.0407***
	(2.9757)	(0.1656)	(8.5966)	(0.3043)
Stock market$_{t-1}$	1.6735	0.0940	6.0567	0.2207
	(1.3278)	(0.0746)	(3.4333)	(0.1249)
Δs_{t-1}	-0.0011	-0.0001	-0.0074	-0.0003
	(0.0013)	(0.0001)	(0.0054)	(0.0002)
Political risk$_{t-1}$	0.5283***	0.0297***	0.3930	0.0143
	(0.1437)	(0.0080)	(0.3094)	(0.0112)
Government stability$_{t-1}$	-0.8565***	-0.0481***	-0.8497	-0.0310
	(0.2406)	(0.0135)	(0.4597)	(0.0165)

Table A.7: Logit model estimation results according to Equation (2) – continued

Dependent Variable:	Baseline model		Extended model	
Treatment D_t	coeff	AME	coeff	AME
Stock market$_t^2$	-0.1097		-1.8278***	
	(0.0587)		(0.4605)	
D_{t-1} × Stock market$_t$	-0.1332		0.2359	
	(0.0762)		(0.4008)	
GDP growth$_{t-2}$	7.1439	0.4013	60.4079*	2.2013*
	(8.3100)	(0.4664)	(26.4611)	(0.9593)
G growth$_{t-2}$	-13.8706*	-0.7792*	0.6169	0.0225
	(6.3529)	(0.3572)	(18.8570)	(0.6872)
G growth$_{t-3}$	-7.4643	-0.4193	25.5322	0.9304
	(6.2228)	(0.3499)	(18.5595)	(0.6740)
G growth$_{t-4}$	-12.8755*	-0.7233*	-18.6650	-0.6802
	(5.4041)	(0.3042)	(15.4221)	(0.5619)
Stock market$_{t-2}$	1.0253	0.0576	-2.7126	-0.0988
	(1.2592)	(0.0708)	(3.1649)	(0.1153)
Stock market$_{t-3}$	2.7250*	0.1531*	6.4923*	0.2366*
	(1.2150)	(0.0683)	(3.1547)	(0.1141)
Stock market$_{t-4}$	-2.5033**	-0.1406**	-7.2327**	-0.2636**
	(0.8613)	(0.0485)	(2.3299)	(0.0839)
D_{t-1}	0.5435	0.0305	-3.4780	-0.1267
	(0.5790)	(0.0325)	(2.7397)	(0.0996)
D_{t-2}	-0.1948	-0.0109	-0.2511	-0.0092
	(0.3440)	(0.0193)	(0.7783)	(0.0283)
D_{t-3}	0.3609	0.0203	-1.6442	-0.0599
	(0.3350)	(0.0188)	(0.8572)	(0.0312)
D_{t-4}	0.1982	0.0111	0.0299	0.0011
	(0.3567)	(0.0200)	(0.7408)	(0.0270)
D_{t-1}(neg)	-0.0525	-0.0030	-0.5953	-0.0217
	(0.4155)	(0.0233)	(1.0288)	(0.0375)
D_{t-2}(neg)	-0.5162	-0.0290	-1.2669	-0.0462
	(0.4002)	(0.0225)	(0.9004)	(0.0327)
Interest Rate$_t$			0.1166	0.0042
			(0.6530)	(0.0238)
Credit-to-GDP$_t$			17.5733	0.6404
			(13.5510)	(0.4941)
Term spread$_t$			1.1042*	0.0402*
			(0.4792)	(0.0173)
GDP growth forecast$_t$			-322.8091***	-11.7632***
			(92.7298)	(3.3317)
G growth forecast$_t$			102.0260	3.7178
			(52.6013)	(1.9093)
Interest Rate$_{t-1}$			0.9404	0.0343
			(0.6814)	(0.0248)
Credit-to-GDP$_{t-1}$			-13.5219	-0.4927
			(13.1559)	(0.4797)
Term spread$_{t-1}$			-0.3922	-0.0143
			(0.4325)	(0.0157)
GDP growth forecast$_{t-1}$			231.9433***	8.4521***
			(66.3761)	(2.3742)
G growth forecast$_{t-1}$			-157.1149***	-5.7253***
			(46.7019)	(1.6768)
Observations	1965	1965	1003	1003
AUC	0.8730		0.9457	
std(AUC)	0.0139		0.0155	

Notes: Dependent variable is treatment according to Equation (1). Clustered robust standard errors in parenthesis. Constant and country-fixed effects included but not reported. Some country-fixed effects are dropped in estimation due to perfect collinearity. For interaction terms, marginal effects cannot be computed. * p<0.10, ** p<0.05, *** p<0.01. Note that there is no one-to-one relationship between the coefficient and average marginal effects (AME) significance levels (e.g. Greene 2009).

Table A.8: Descriptive statistics of the estimated propensity score by country for the baseline model specification

Country	Mean	Std. Dev.	Median	Min	Max	Obs.
Argentina	0.136	0.167	0.080	0.002	0.811	59
Australia	0.040	0.121	0.010	0.001	0.612	25
Austria	0.060	0.057	0.047	0.003	0.302	67
Belgium	0.107	0.092	0.076	0.003	0.510	75
Brazil	0.074	0.172	0.012	0.001	0.827	68
Bulgaria	0.077	0.091	0.029	0.003	0.323	39
Colombia	0.038	0.065	0.016	0.000	0.370	52
Croatia	0.092	0.106	0.055	0.004	0.535	45
Czech Republic	0.111	0.144	0.057	0.002	0.709	54
Denmark	0.070	0.092	0.046	0.004	0.622	57
Finland	0.028	0.046	0.013	0.001	0.321	71
France	0.061	0.061	0.038	0.004	0.320	71
Germany	0.037	0.042	0.017	0.005	0.189	54
Greece	0.143	0.229	0.023	0.001	0.910	63
Hungary	0.083	0.151	0.028	0.002	0.800	74
Ireland	0.127	0.248	0.007	0.000	0.993	63
Italy	0.088	0.077	0.065	0.008	0.474	75
Lithuania	0.122	0.193	0.034	0.007	0.976	49
Malaysia	0.038	0.098	0.016	0.000	0.696	52
Mexico	0.053	0.143	0.017	0.000	0.998	76
Netherlands	0.028	0.043	0.013	0.002	0.272	72
Peru	0.098	0.145	0.051	0.002	0.670	51
Poland	0.021	0.025	0.010	0.002	0.116	51
Portugal	0.097	0.124	0.036	0.008	0.568	72
Slovakia	0.163	0.164	0.124	0.026	0.931	43
Slovenia	0.103	0.135	0.035	0.004	0.565	58
South Africa	0.089	0.132	0.026	0.002	0.687	56
Spain	0.101	0.155	0.035	0.002	0.778	87
Sweden	0.078	0.090	0.045	0.004	0.489	77
Thailand	0.076	0.191	0.014	0.000	0.987	66
Turkey	0.161	0.232	0.049	0.001	0.833	56
United Kingdom	0.048	0.085	0.024	0.004	0.645	63
United States	0.042	0.025	0.039	0.012	0.104	24
Total	0.082	0.138	0.032	0.000	0.998	1965

Notes: Baseline specification includes a smaller set of control variables. Total indicates the equally-weighted country average/sum. Values have been rounded to 3 decimal places and are bounded away from zero in all instances. Robustness of the results to truncating the propensity score has been verified.

Table A.9: Descriptive statistics of the estimated propensity score by country for the extended model specification

Country	Mean	Std. Dev.	Median	Min	Max	Obs.
Australia	0.040	0.126	0.001	0.000	0.602	25
Austria	0.063	0.140	0.013	0.000	0.938	63
Czech Republic	0.111	0.180	0.024	0.000	0.704	54
Denmark	0.073	0.173	0.007	0.000	0.998	55
Finland	0.029	0.088	0.003	0.000	0.573	69
France	0.055	0.130	0.008	0.000	0.653	67
Germany	0.038	0.083	0.003	0.000	0.432	52
Greece	0.164	0.303	0.005	0.000	0.998	55
Ireland	0.148	0.315	0.001	0.000	1.000	54
Italy	0.106	0.197	0.023	0.000	0.835	73
Malaysia	0.051	0.173	0.000	0.000	1.000	39
Netherlands	0.029	0.099	0.002	0.000	0.778	70
Portugal	0.103	0.234	0.002	0.000	0.978	68
Spain	0.083	0.192	0.007	0.000	0.825	80
Sweden	0.106	0.198	0.019	0.000	0.877	47
Thailand	0.038	0.117	0.000	0.000	0.609	52
United Kingdom	0.054	0.149	0.006	0.000	0.986	56
United States	0.042	0.072	0.018	0.000	0.316	24
Total	0.076	0.183	0.005	0.000	1.000	1003

Notes: Total indicates the equally-weighted country average/sum. Values have been rounded to 3 decimal places and are bounded away from zero and one in all instances. Robustness of the results to truncating the propensity score has been verified.

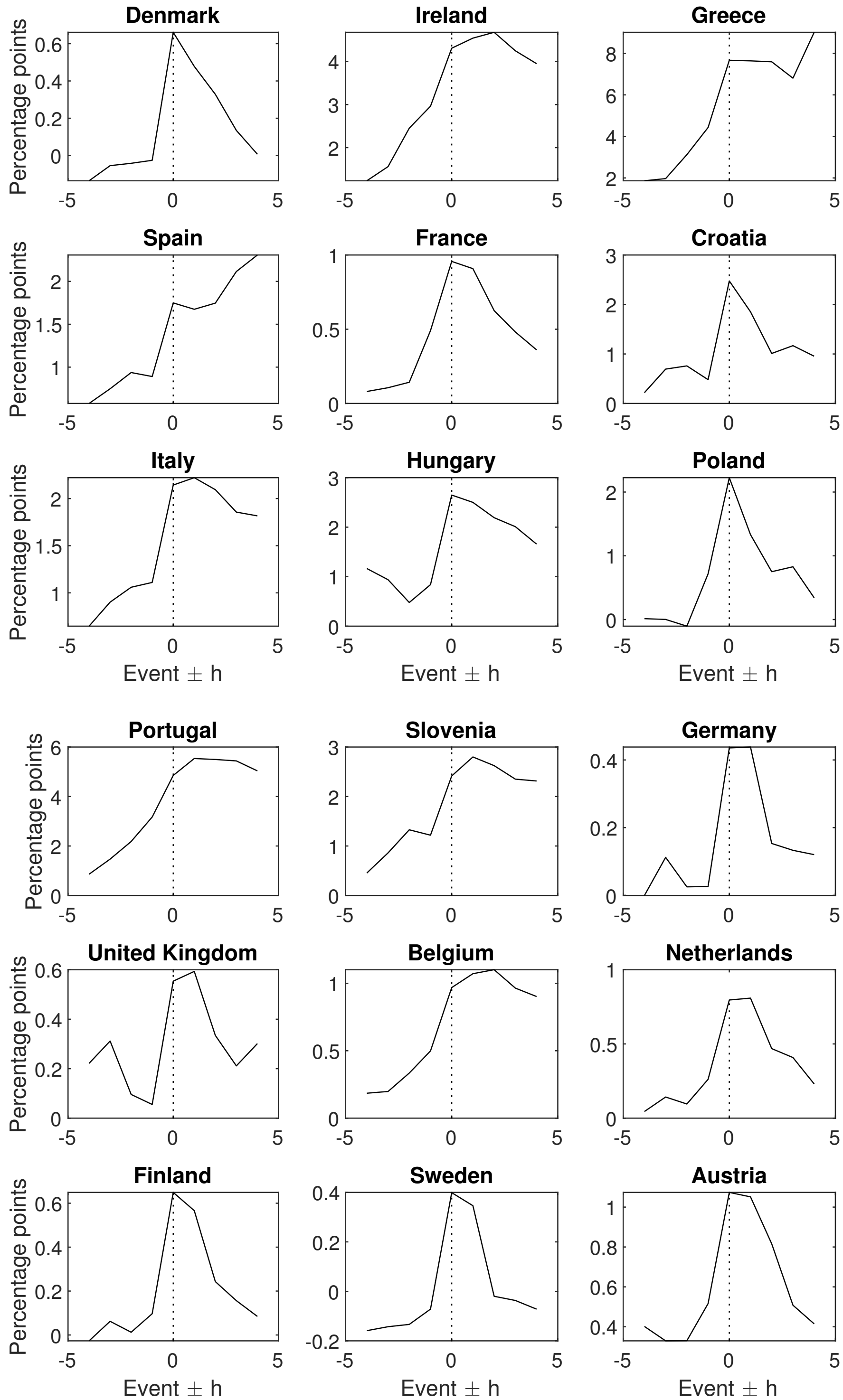

Figure A.4: Event windows country-by-country for the full sample: Treatment in period $t = 0$ and the average spread (in pps) in period $t \pm h$. Country-specific spread movements around treatments are measured as the average of spread deviations from the respective country mean over all events in the country in the event window $t \pm h$. Time is measured in quarters. Treatment is defined according to Equation (1).

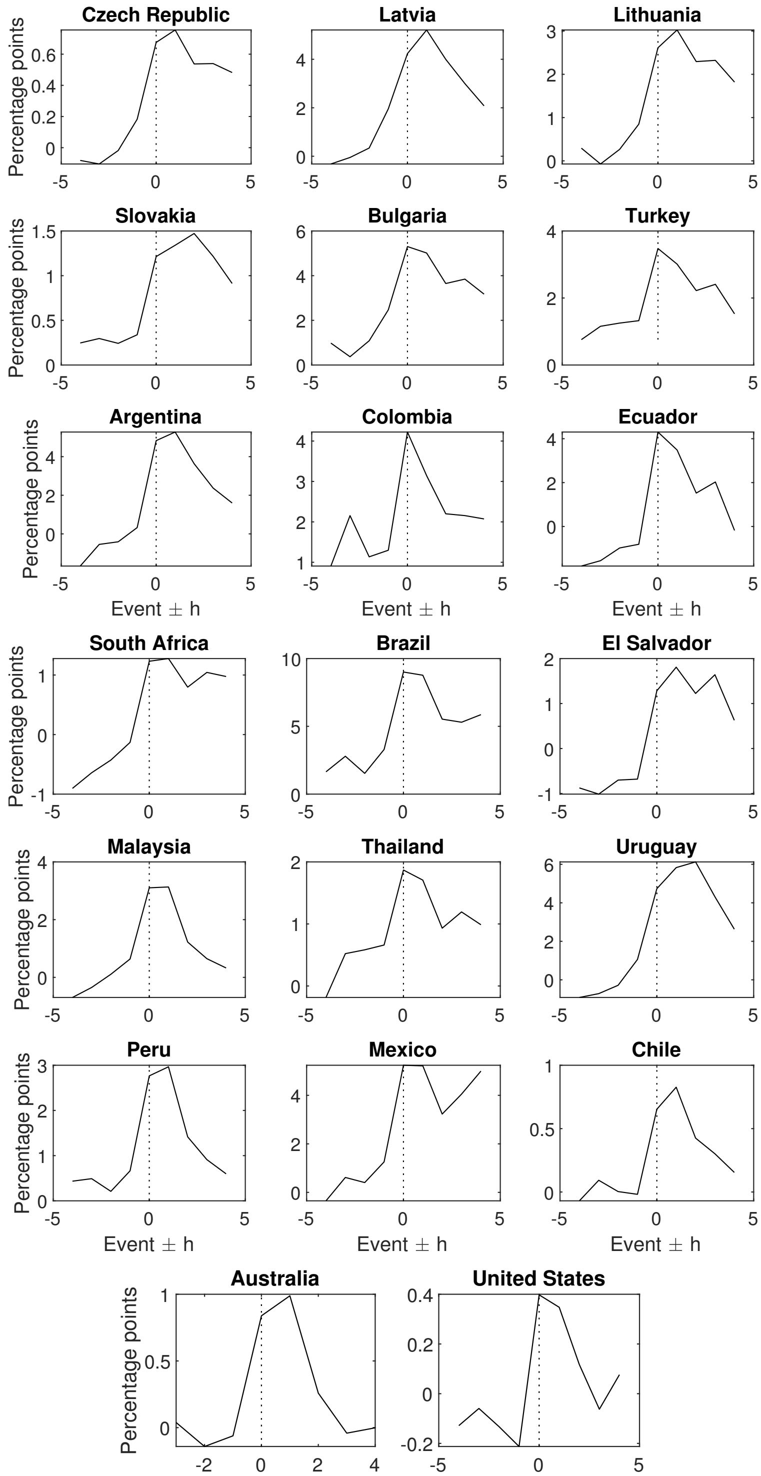

Figure A.5: Event windows country-by-country for the full sample: Treatment in period $t = 0$ and the average spread (in pps) in period $t \pm h$. Country-specific spread movements around treatments are measured as the average of spread deviations from the respective country mean over all events in the country in the event window $t \pm h$. Time is measured in quarters. Treatment is defined according to Equation (1).

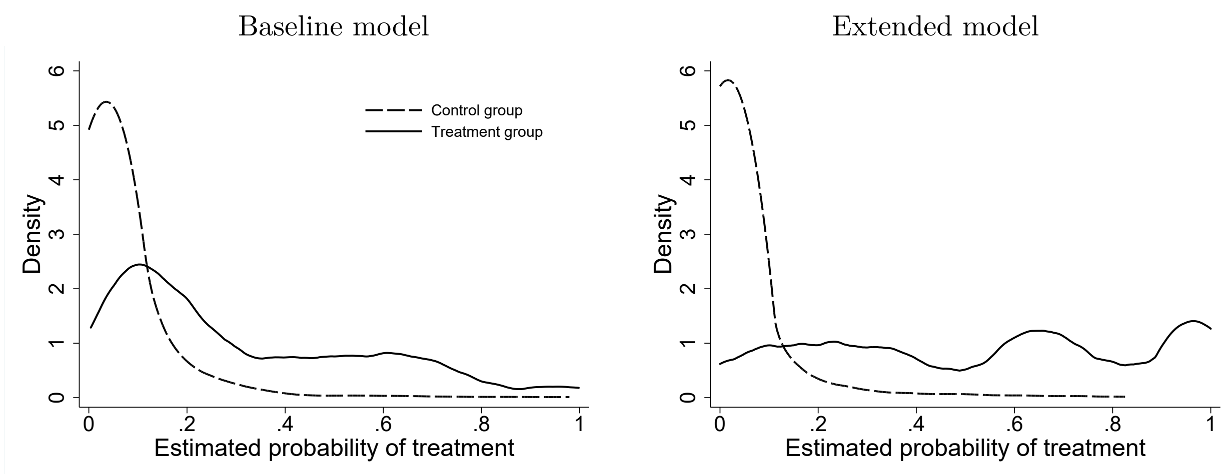

Figure A.6: Distribution of propensity score for the baseline model (left panel) and the extended model (right panel): Kernel density estimate of the predicted probabilities for treatment (solid line) and control group (dashed line) based on an Epanechnikov kernel with bandwidth 0.025.

A.5 ATE: extended model specification

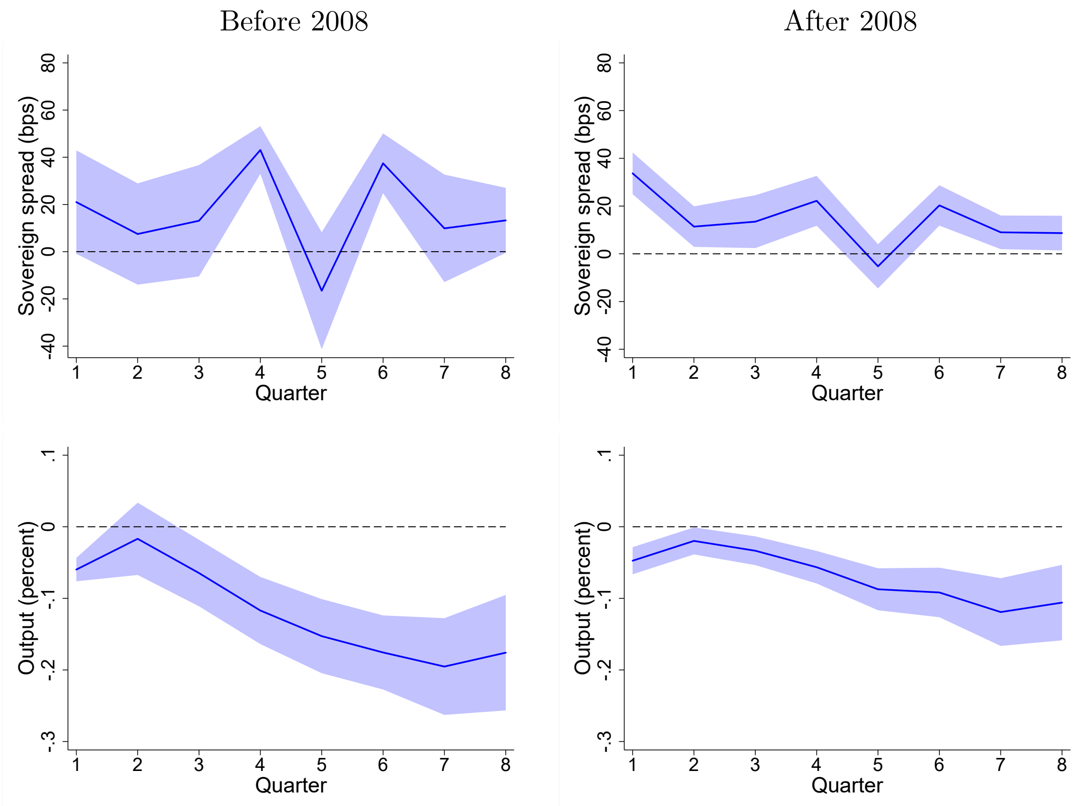

Figure A.7: ATE: responses to a sovereign spread shock (spread increase by more than one standard deviation but at least 25 bp). Extended specification of the first stage and regression adjustment. Response for advanced economies only due to data limitations. For details, see Figure 9.

A.6 ATE: conservative treatment definition

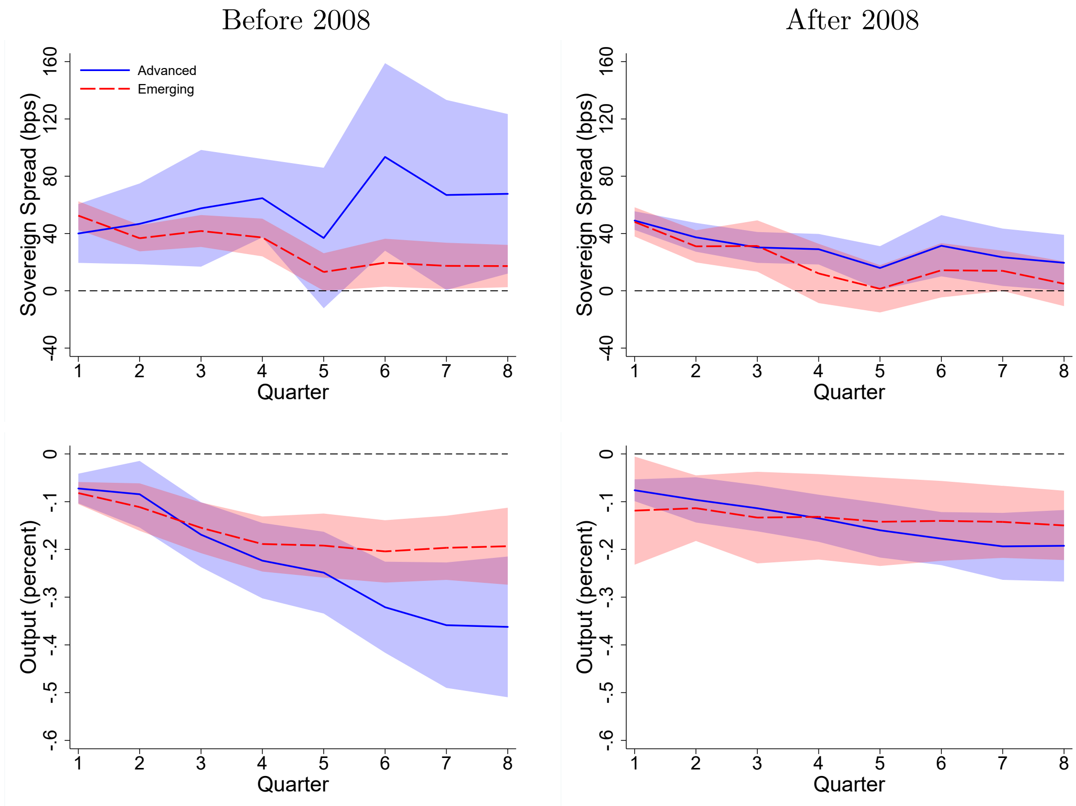

Figure A.8: Impulse responses to a $h = 0$ sovereign spread shock based on the ATE estimator in equation (5) together with a conservative treatment definition of $D_{i,t} = \mathbb{1}(\Delta s_{i,t} >= \sigma_i \wedge \Delta s_{i,t} >= 50\text{bp})$, i.e. increases of at least 50bp. For details, see Figure 9.

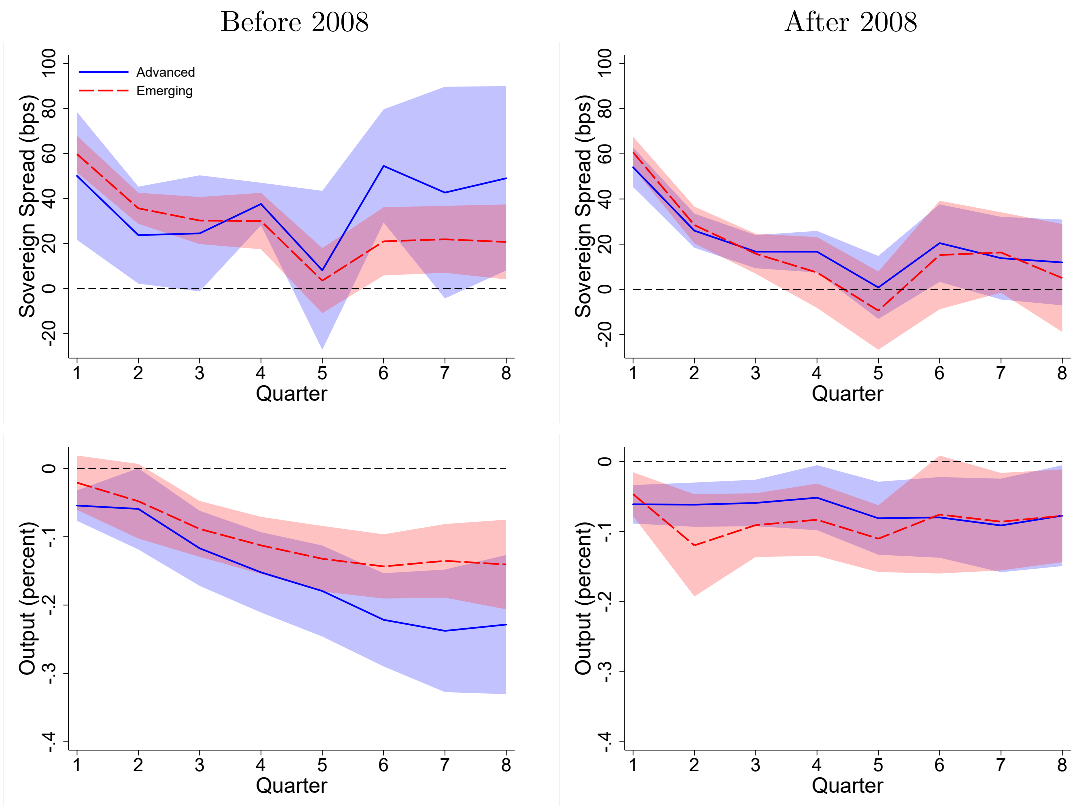

Figure A.9: Impulse responses to a $h = 0$ sovereign spread shock based on the ATE estimator in equation (5) together with a conservative treatment definition of $D_{i,t} = \mathbb{1}(\Delta s_{i,t} >= 2\sigma_i \wedge \Delta s_{i,t} >= 25\text{bp})$, i.e. increases of at least 2 standard deviations. For details, see Figure 9

A.7 ATE: alternative sample split dates

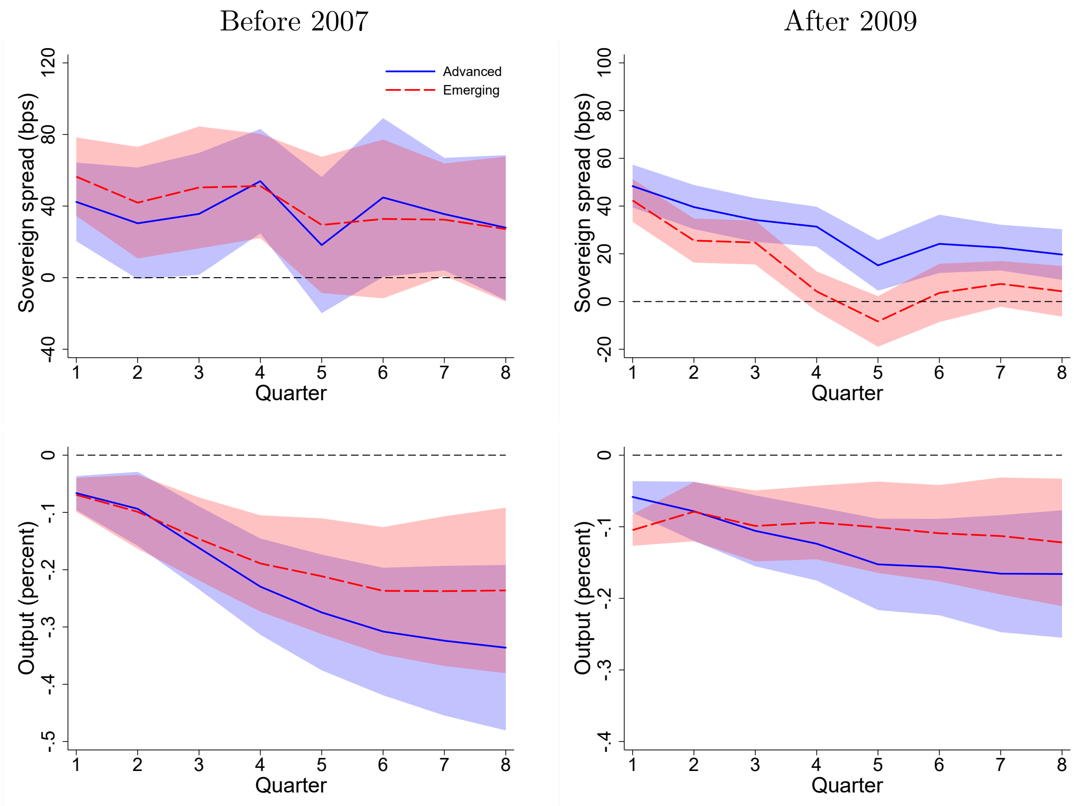

Figure A.10: Impulse responses to a $h = 0$ sovereign spread shock based on the ATE estimator in equation (5) together with the treatment definition in (1) for the sample before 2007Q1 and from 2009Q onwards. For details, see Figure 9.

A.8 ATE: excluding Germany and US

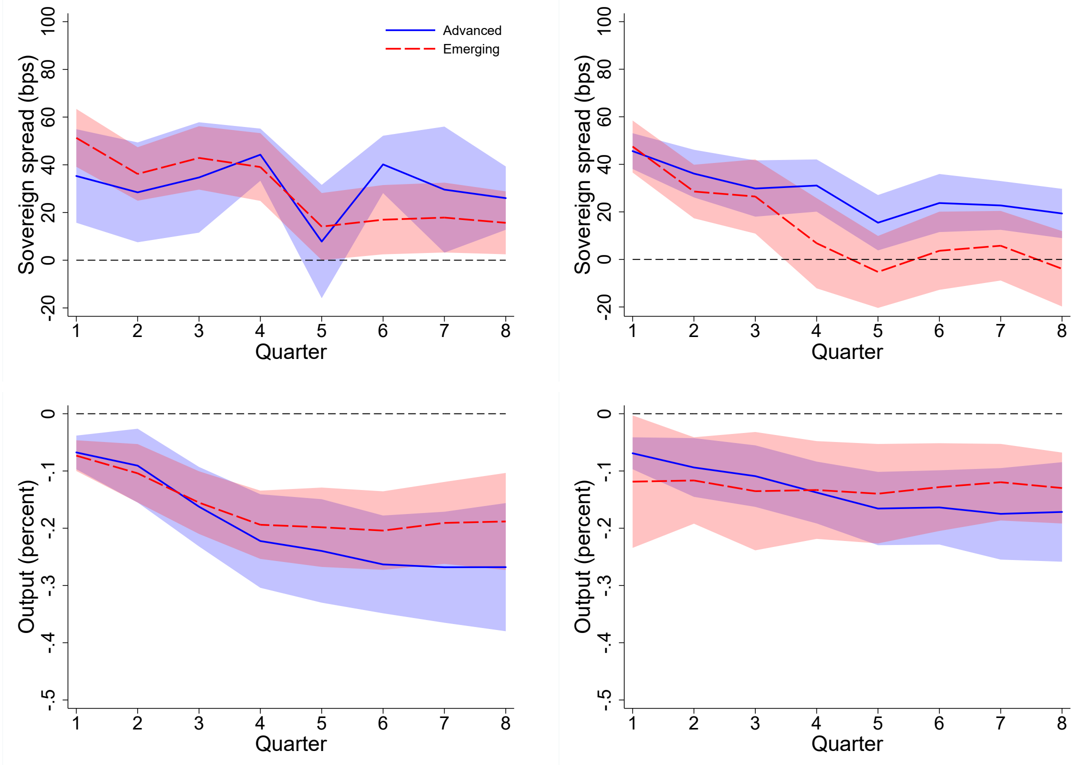

Figure A.11: Impulse responses to a $h = 0$ sovereign spread shock based on the ATE estimator in equation (5) together with the treatment definition in (1) when excluding Germany and the United States. For details, see Figure 9.

A.9 Country-specific spread shocks

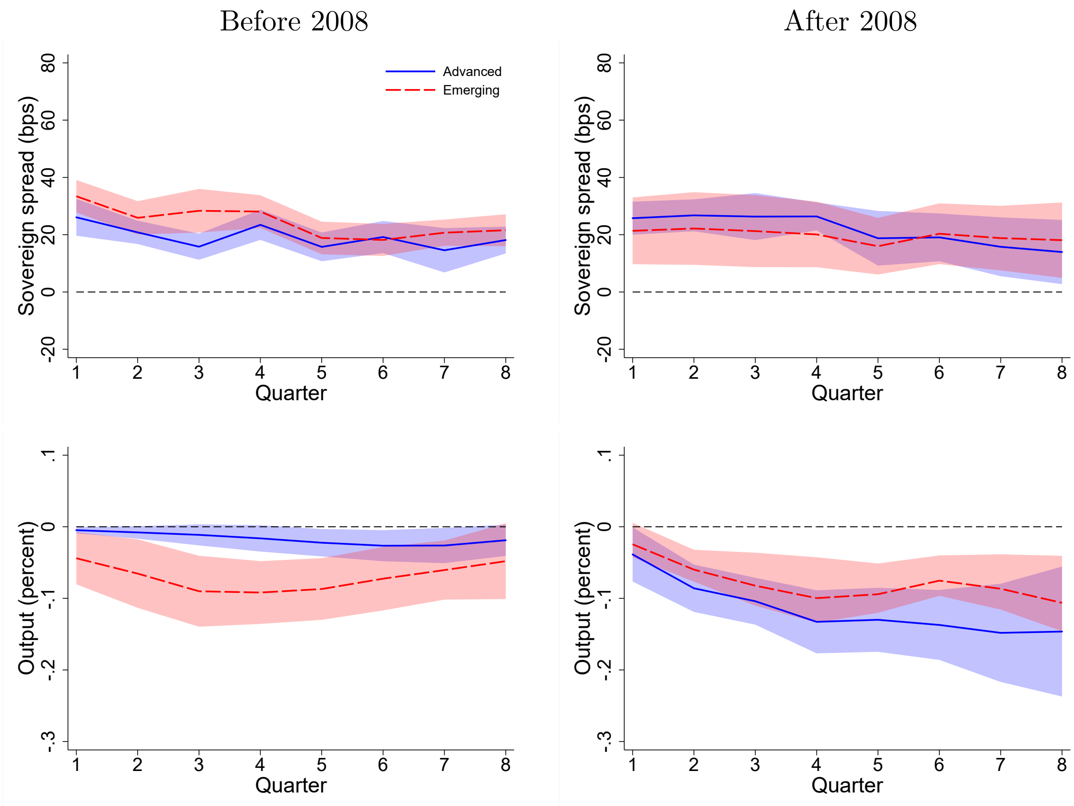

Figure A.12: Impulse responses to a country-specific sovereign spread shock based on the local projection approach with time-fixed effect added to both estimation stages. See Figure 12 for details.

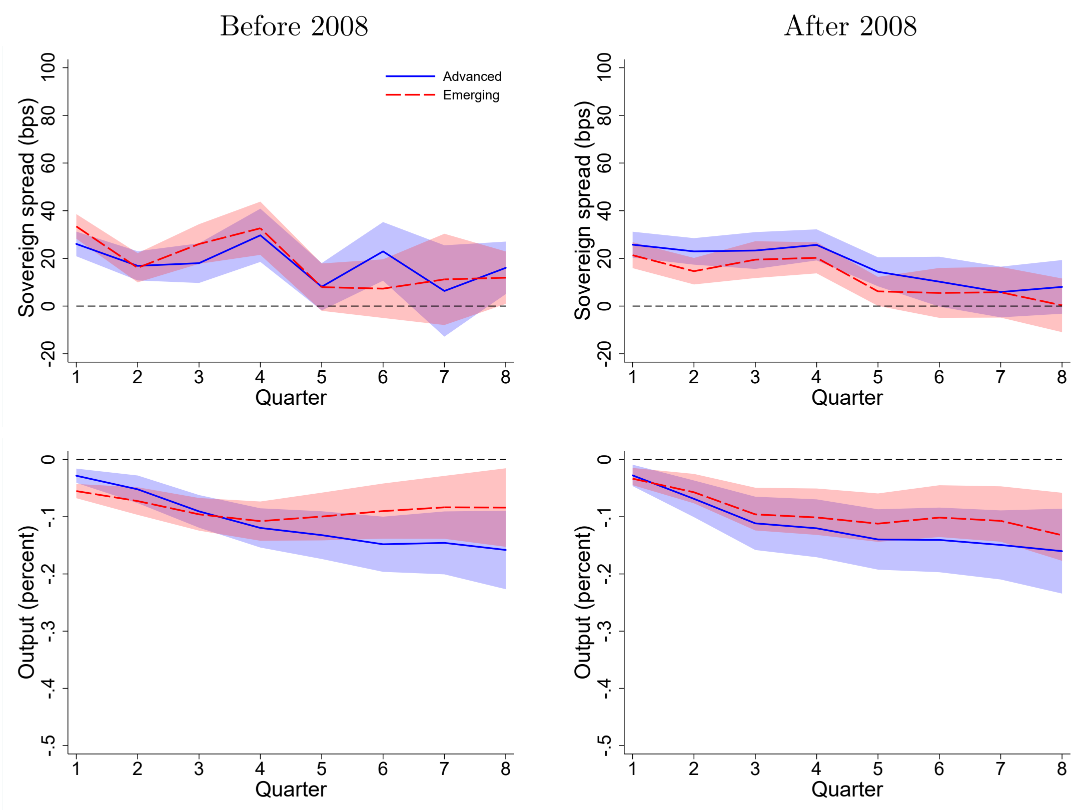

Figure A.13: Impulse responses to a country-specific sovereign spread shock, based on the ATE estimator in equation (5) together with the treatment definition in (1). See Figure 9 for details.