Working Paper Series

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Foreign banks and the doom loop

No 2540 / April 2021

Abstract

This paper explores whether foreign intermediaries stabilise or destabilise lending to the real economy in the presence of sovereign stress in the domestic economy and abroad. Tensions in the government debt market may lead to serious disruptions in the provision of lending (i.e., the so-called "doom loop"). In this context, the presence of foreign banks poses a fundamental, yet unexplored, trade-off. On the one hand, domestic sovereign shocks are broadly inconsequential for the lending capacity of foreign banks, given that their funding conditions are not hampered by such shocks. On the other, these intermediaries may react more harshly than domestic banks to a deterioration in local loan risk and demand conditions. We exploit granular and confidential data on euro area banks operating in different countries to assess this trade-off. Overall, the presence of foreign lenders is found to stabilise lending, thus mitigating the doom loop.

Non-Technical Summary

This paper explores the role of foreign intermediaries in stabilising or destabilising lending to firms in periods of sovereign stress, i.e., whether they mitigate or exacerbate the so-called "sovereign-bank nexus" or "doom-loop" between governments and banks. Unlike the existing research, we explore the implications of sovereign shocks originating both in the domestic economy and abroad, and how they transmit to lending via local banks and foreign ones. There are two main channels which make the presence of foreign lenders relevant for the doom loop.

On the one hand, a growing body of literature emphasises a *"loan supply channel"* of sovereign stress, which entails a weakening in the intermediation capacity of domestic banks. Indeed, given that the domestic sovereign is perceived as the ultimate explicit or implicit guarantor of the liabilities of (domestic) banks, when its creditworthiness deteriorates, so does the ability of these intermediaries to raise funds. Moreover, a decline in the valuation of government bonds adversely affects the capital and liquidity position of domestic banks due to their structurally large exposure towards domestic government bonds. Given that these mechanisms are largely inconsequential for the lending capacity of foreign intermediaries operating in that country, a more diversified banking sector is expected to be less exposed to the doom loop. At the same time, sovereign stress may originate in the foreign bank's home country, and therefore an open question is how cross-border banks react in this situation, i.e., whether they modify the supply of credit in other countries when their own domestic sovereign is under stress.

On the other hand, a second channel at play is related to the deterioration of local borrowers' condition that follows a shock in the sovereign debt market. This channel has two main components: a first component suggests a drop in the *demand* for new loans on the side of the borrowers, given the worsened economic situation. A second component is related to the *risk* profile of local borrowers: a long-standing result from the literature on international capital flows suggests that, in response to a perceived worsening of the risk profile of local borrowers, a large presence of foreign intermediaries could be problematic because these intermediaries might cut lending more aggressively than their domestic competitors. It is crucial to point out that this channel, which we refer to as *"loan demand and risk channel"* or simply *"loan demand channel"*, originates from a deterioration of the borrower's risk profile. This clearly distinguishes it from the supply channel which operates via a deterioration in banks' intermediation capacity.

All in all, the effect of sovereign stress on lending, in the presence of both domestic and foreign banks, is *a priori* unclear, given the interplay of these two channels.

From an empirical point of view, a very challenging identification issue arises when trying to isolate the role of these two channels for the pass-through of sovereign stress to lending, only based on the correlation between the domestic sovereign yield and lending in a given country. In this paper, we propose a novel approach, exploiting information on lending from cross-border banks in *host* countries. Our identification strategy crucially hinges on distinguishing between sovereign stress in the home and host country, as captured by the 10-year bond yield of the home country of the cross-border banking group and the 10-year bond yield of the host country sovereign in which such intermediary operates. Indeed, movements in the two sovereign yields have different implications for the lending activity of the cross-border banks in host countries. In particular, the sovereign yield in the home country of cross-border banks affects their foreign lending only through the loan supply channel. Instead, the host sovereign yield affects the local lending of foreign cross-border banks only through the loan demand channel.

Our empirical approach relies on the use of a unique and granular database including monthly bank-level information on lending activity in each euro area country, for a representative sample of intermediaries including all main cross-country banking groups operating in the euro area. The sample covers the period July 2007-April 2018.

Our results indicate that both the loan supply and the loan demand channels of transmission are quantitatively relevant. First, an increase in the home sovereign yield entails a strong lending contraction by domestic banks via the loan supply channel. Second, cross-border banks respond to an increase in stress in their home country by deleveraging more aggressively foreign positions. Third, foreign banks cut lending considerably more than domestic banks following an increase in local credit risk (loan demand channel), which shows that foreign investors tend to be more flighty. In addition, a stylised mean-variance model, calibrated with the parameters from the empirical analysis, shows that - under plausible assumptions - a large share of foreign banks is desirable even considering that these lenders may import shocks from their own sovereign.

These findings suggest that a geographically diversified banking system might support the creation of a fully-fledged Banking Union for the Eurozone by alleviating the sovereign-bank nexus.

1   Introduction

The "sovereign-bank nexus", or "doom loop", has been at the centre of the economic and policy debate since the recent European sovereign debt crisis. When the sovereign debt market experiences periods of stress, the lending capacity of local banks tends to be impaired. The resulting credit crunch leads to a deterioration of the economy, which eventually ends up exacerbating the stress in the sovereign debt market even further.[1] Recently, the Covid-19 crisis has been accompanied by a deterioration of banks' asset quality mitigated by government interventions all around the globe via massive guarantee programmes for the private sector, with possible risks of reactivation of the loop between the public sector and banks.

In this paper, focusing on the euro area, we explore whether an integrated banking system characterised by cross-border banks operating in different countries would help to absorb idiosyncratic shocks in sovereign debt markets, thus supporting the provision of credit to non-financial corporations. Indeed, the implications for the sovereign-bank nexus of a banking sector populated by foreign institutions are far from trivial. Several channels are at work and all need to be assessed.

First, there is the *"loan supply channel"* of sovereign stress (see, e.g., Broner et al., 2014). Following an increase in domestic sovereign stress, this channel works through a deterioration of the funding capacity of domestic banks (but not of foreign banks). Indeed, given that the domestic sovereign is perceived as the ultimate explicit or implicit guarantor of local bank liabilities, when its creditworthiness deteriorates, so does the ability of domestic banks to raise funds. Moreover, a decline in the valuation of government bonds adversely affects bank capital and liquidity positions due to the banks' exposure to the domestic sovereign and in relation to the wide utilisation of government securities as collateral in secured liquidity and funding transactions. With regard to foreign banks, sovereign stress in host countries is largely inconsequential for their lending capacity, given that their liabilities are guaranteed by other governments and their holdings of host country sovereign bonds are typically negligible (see, e.g., Altavilla et al., 2017). Therefore, according to these mechanisms, the presence of foreign banks should be beneficial in terms of the mitigation of the sovereign-bank nexus. At the same time, foreign banks may import negative shocks from their own sovereign sector via their consolidated balance sheets (see, e.g., Fillat et al., 2018), which would exacerbate the doom loop. Thus, while it appears clear that a country populated

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[1]See, among others, Lane (2012), Acharya et al. (2014), Angelini et al. (2014), Fahri and Tirole (2019), Anderson et al. (2020).

only by domestic banks would be very exposed to sovereign stress originating within the same country, the effects of also having foreign banks in that system is *a priori* unclear.

A second channel of transmission works through borrower-specific factors, instead of lender factors. This channel has a "standard" *demand* component and a *risk* component, related to the perceived creditworthiness of borrowers. The first component suggests a drop in the demand for new loans on the part of the borrowers, given the deteriorated economic situation following a shock in the sovereign market (Bocola, 2016). Indeed, when the sovereign debt market worsens, so does the economy at large. This is due, among other factors, to the fact that confidence fades, investment and consumption plans are delayed, and that the government might be forced into contractionary policies in order to restore trust in the sustainability of public finances. The second (risk-related) component implies that foreign intermediaries may react more aggressively to a deterioration in the local economic situation (Albertazzi and Bottero, 2014), including when it is due to an outbreak of domestic sovereign tensions. Indeed, funds from international investors tend to be prone to sudden stops, which is well known since the seminal contribution of Calvo (1998). All else being equal, the stronger this effect, the more detrimental the presence of foreign lenders for the doom loop. It is crucial to point out that this channel, which we refer to as *"loan demand and risk channel"* or simply *"loan demand channel"*, originates from a deterioration of the borrower's risk profile. This clearly distinguishes it from the supply channel which operates via a deterioration in banks' intermediation capacity.

While a growing body of the literature emphasises the presence of the two channels, no attempt has been made to simultaneously and consistently assess them. This is interesting for two reasons. First, it allows us to identify what channel is quantitatively predominant. Second, and more broadly, this exercise is an indirect assessment of the fundamental trade-off in finance between the benefits of relationship-lending (as postulated in the seminal contributions by Sharpe, 1990; Rajan, 1992; von Thadden, 2004) and of an armlength but more diversified set of lenders (as in Detragiache et al., 2000, and Ongena and Smith, 2000), although looking at a specific shock, such as those materialising in the sovereign debt markets.

From an empirical point of view, a very challenging identification issue arises when trying to isolate the role of the loan supply and demand channels for the pass-through of sovereign stress to lending, only based on the correlation between the domestic sovereign yield and lending in a given country. In this paper, we propose a novel approach, exploiting information on lending from cross-border banks in *host* countries.

Our identification strategy crucially hinges on distinguishing between sovereign stress in the home and host country, as captured by the 10-year bond yield of the home country of the cross-border banking group and the 10-year bond yield of the host country sovereign in which such intermediary operates. Indeed, movements in the two sovereign yields have different implications for the lending activity of the cross-border banks in host countries. In particular, the sovereign yield in the home country of cross-border banks affects their foreign lending only through the loan supply channel. Instead, the host sovereign yield affects the local lending of foreign cross-border banks only through the loan demand channel.

Our empirical approach relies on the use of a unique and granular database including monthly bank-level information on lending activity in each euro area country, for a representative sample of intermediaries including all main cross-country banking groups operating in the euro area. The sample covers the period July 2007-April 2018.

Our main findings suggest that both the loan supply and loan demand channels are relevant drivers of lending activity. First, a 100 basis points increase in the home sovereign yield entails a lending contraction by domestic banks of around 0.4 percentage points (p.p.) - on average on domestic and foreign loan exposure - via the loan supply channel. Second, cross-border banks respond to an increase in stress in their home country by deleveraging more aggressively foreign positions (-0.6 p.p.) compared to domestic loans exposure (-0.1 p.p.). Third, foreign banks cut lending considerably more than domestic banks following an increase in local credit risk: a 100 basis points increase in the host sovereign yield entails a lending contraction by foreign banks of 0.4 p.p. through the loan demand channel and of 0.1 p.p. by domestic banks, which shows that foreign investors tend to be more flighty.

Overall, combining these effects together, and taking into account that the supply channel is partially inactive for cross-border banks given that their funding conditions are not affected by stress in the host country sovereign, we find that a large share of foreign lenders in the domestic economy is always preferable in the presence of shocks to the domestic sovereign, as it stabilises credit. In addition, a stylised mean-variance model, calibrated with the parameters from the empirical analysis, shows that - under plausible assumptions - a large share of foreign banks is desirable even considering that these lenders may import shocks from their own sovereign.

The remainder of the paper is structured as follows. Section 2 reviews the related literature, Section 3 presents the data and some descriptive statistics, Section 4 illustrates the empirical methodology, Section 5 shows our results and Section 6 assesses the overall benefits of a more diversified banking sector. Finally, Section 7 concludes.

2 Related literature

Our paper contributes to a growing literature that studies the effects of sovereign stress on lending activity. Most studies focus on the *loan supply channel* and, especially, the role of sovereign exposures in the transmission mechanism.

In particular, Gennaioli et al. (2014) develop a model in which government defaults bring about a decline in private lending, which is larger for countries where banks have higher sovereign exposure. In a second paper, Gennaioli et al. (2018) provide additional evidence on the relationship between government bond holdings and the sovereign-bank nexus using a large bank-level dataset which comprises 20 sovereign default episodes in 17 countries between 1988 and 2012. The authors find systematic evidence of a negative relationship between sovereign holdings and lending during sovereign defaults, and show that pre-crises government bond holdings are strong predictors of a decline in bank lending. De Marco (2019) shows that losses on sovereign debt lead to a cut in lending supply to financially-constrained firms, both in stressed and non-stressed countries, and the higher the share of short-term funding of the banks, the more this is true. Popov and Van Horen (2015) study the syndicated lending of European banks during the sovereign debt crisis and show that foreign sovereign stress affected negatively the lending of banks with sizeable holdings of government debt of stressed-countries relative to banks less exposed to that debt. Altavilla et al. (2017) illustrate that sovereign exposure considerably amplifies the transmission mechanism of sovereign stress to lending, especially in stressed countries. The banks in stressed-countries contracted both their domestic and foreign lending in response to an increase in domestic sovereign stress, and the higher their sovereign exposure, the more this is true. Bofondi et al. (2018), focusing on the Italian banking sector only, show that Italian banks tightened their credit supply and increased lending rates following the sovereign debt crisis more than foreign banks whose head institution resided in countries that were less exposed to sovereign stress. In addition, Correa et al. (2016) find that U.S. branches of euro area cross-border banks reduced their lending to U.S. firms due to the strong liquidity shock generated by depositors' bank run during the European Sovereign debt crisis. Finally, Giannetti and Laeven (2012) highlight that foreign lenders, when hit by shocks that negatively affect bank wealth in their home market, have a tendency to rebalance their portfolio away from host markets to their domestic market. However, they do not focus explicitly on the transmission of sovereign shocks.

A smaller share of the literature has focused on the *loan demand channel* of sovereign stress transmission, but only in isolation to the loan supply channel. One of the first

studies on the borrower specific determinants of sovereign stress transmission - which directly relate to this channel - is Arteta and Hale (2008). This paper shows that sovereign crises in emerging markets were followed by a decline in foreign credit to domestic private firms in the non-financial sector. Moreover, Albertazzi and Bottero (2014) find that, in the post-Lehman collapse, foreign lenders contracted their credit supply to the same firm more than domestic banks, in response to the increase in credit risk and the deterioration of economic conditions that followed the collapse. More recently, Arellano et al. (2020) suggest that sovereign stress may be transmitted to firms not only via a credit supply crunch, but also endogenously through a contraction in the demand of labour input and intermediate good on the side of the borrowers, which therefore cut their demand for new loans.

Altogether, the evidence of these studies points towards an important role of the supply channel in the transmission of sovereign stress to lending. Moreover, some studies indicate that cross-border banks tend to react aggressively to a deterioration in demand conditions. However, most of these papers do not look directly at sovereign risk, and, even those that do so, do not consider the implications of the loan supply channel of sovereign stress transmission within the same analysis.[2] A unified framework which encompasses these two channels, and the transmission of sovereign shocks from both home and abroad, is instead what is needed to assess the role of foreign lenders for the provision of credit to the private sector.

3 Data

Our analysis is based on two unique and proprietary ECB monthly datasets, for 326 euro area banks: the "Individual Balance Sheets Items" dataset (IBSI) and the "Individual MFI Interest Rates" (IMIR). The data used here cover the period from June 2007 to April 2018. In particular, they include granular observations on loan volumes, loan rates and sovereign exposures of each bank. These data are then complemented with data on sovereign yields, macroeconomic and financial variables which are obtained from Thomson Reuters, Datastream, Bureau van Dijk (Bankscope) and ECB sources (see data Appendix).

Table 1 presents the country of origin and bank-type (i.e., head, domestic, and foreign subsidiaries, cross-border banks) for the 326 intermediaries in our dataset. In particular, the second column reports the total number of banks operating in each

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[2]A strand of the literature has explored the role of cross-border banks for lending, but independently from the transmission of sovereign stress. For example, Żochowski, Franch and Nocciola (2021) focus on the role of prudential regulation on cross-border lending by international banks.

Table 1: Distribution of euro area banks

Countries	All banks	Head	Domestic subsidiaries	Foreign subsidiaries	Cross-border
	(2)	(3)	(4)	(5)	(6)
Austria	14	7	6	1	0
Belgium	13	6	6	1	5
Cyprus	7	5	0	2	2
Estonia	5	0	0	5	2
Finland	18	8	2	8	0
France	41	11	24	6	13
Germany	68	43	13	12	10
Greece	8	6	2	0	3
Ireland	17	4	2	11	4
Italy	38	22	10	6	11
Latvia	7	3	0	4	3
Lithuania	5	1	0	4	3
Luxembourg	14	3	0	11	3
Malta	4	3	0	1	1
Netherlands	15	8	0	7	4
Portugal	6	4	0	2	0
Slovakia	5	0	0	5	1
Slovenia	7	4	0	3	2
Spain	34	21	7	6	10
Total	**326**	159	72	95	**77**

Note: The table reports the total number of banks in each euro area country (Column 2), which is divided into head banks (3) domestic subsidiaries (4) and foreign subsidiaries which operate in that country (5). Cross-border banks are head banks which have at least one branch or subsidiary in another euro area country (6). Note that the panel is unbalanced. Thus, 326 refers to the overall number of banks used in the empirical analysis, which does not mean that all these banks are present in all years covered in the sample (2007-2018) *Source*: ECB's IBSI and IMIR dataset.

euro area country. Not surprisingly, the most represented countries appear to be the biggest eurozone ones, i.e., Germany, France, Italy, and Spain. The 326 banks are then divided into head banks (third column), domestic subsidiaries (fourth column) and foreign subsidiaries or branches (fifth column). Head banks are either individual institutions or banks which have control over, or own, one or more banks. These controlled banks are subsidiaries or branches of the head bank, and are located either in the same country of the head bank, or abroad. Among the 326 banks in our sample, the majority is constituted by head banks (159), followed by foreign subsidiaries (95), and domestic subsidiaries (72).

Cross-border banks are reported in the sixth column, and are the key group in our analysis. These are head banks which have at least one foreign subsidiary or branch in one or more other euro area countries.[3] Clearly, not all head banks are cross-border

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[3]Most banks in the sample have origin from a euro area country. However, there are some cases

banks, because some of them are individual banks, and others have subsidiaries only in the domestic market. The sample comprises 77 cross-border banks, which is about 24% of the overall dataset.[4] The cross-border dimension of the sample is crucial to our identifying strategy in that it allows us to differentiate between sovereign stress which generates in the home country of the head bank and in the host countries where the foreign subsidiaries (or branches) operate.

Table 2: Summary Statistics

Sample	Mean	S.D.	N
Cross-border			
Loan volume growth	0.5	6.0	6838
Sovereign Yield	2.9	3.1	5920
Domestic sovereign exposure	3.2	2.7	5309
Capital ratio	11.1	3.4	6495
Liquidity ratio	14.2	9.1	6838
Non cross-border			
Loan volume growth	0.8	4.9	20572
Sovereign Yield	2.8	2.5	18170
Domestic sovereign exposure	4.9	5.0	12446
Capital ratio	13.1	7.6	15128
Liquidity ratio	15.6	16.2	20572
Total			
Loan volume growth	0.8	5.2	27410
Sovereign Yield	2.8	2.7	24090
Domestic sovereign exposure	4.4	4.9	17755
Capital ratio	12.5	6.7	21623
Liquidity ratio	15.2	14.8	27410

Note: The table reports the mean, standard deviation (S.D.) and total number of observations (N) of the main variables used in the empirical analysis: the 3-month growth rate of loans to non-financial institutions, the yield on the domestic 10-year government bond, banks' exposure to sovereign securities as a ratio of main assets, the capital and liquidity ratios. All variables are expressed as percentages. These indicators are grouped for cross-border banks and non cross-border banks. *Source*: ECB's IBSI and IMIR dataset.

Before moving to the description of the econometric methodology, in Table 2, we show a few summary statistics for some key variables in our dataset. Cross-border and non cross-border banks are, on average, very similar along multiple dimensions. If anything, non cross-border tend to have, on average, larger sovereign exposures and higher capital and liquidity ratios. Interestingly, there is high heterogeneity in the distributions of the growth rates of loan volumes to non-financial corporations.

in which the head institution is from a country outside the euro area (for instance, from the U.K., Denmark, or the U.S.). These banks, and their subsidiaries, are not included in our analysis.

[4]Note that Column 6 of Table 1 includes both the head bank and its foreign subsidiaries. For example, Unicredit shows up as a cross-border bank for Italy. Unicredit controls HypoVereinsbank in Germany, which is also counted as a cross-border bank in that country.

4 Empirical methodology

We exploit the cross-border dimension of our dataset to separate, for each bank, the variation in the lending activity specific to lender country (or head bank) characteristics, on the one hand, and the borrower country characteristics, on the other (see Khwaja and Mian, 2008, Amiti and Weinstein, 2018, for a similar approach). Then, we identify the loan supply channel of the sovereign stress transmission arising from the former and the loan demand channel arising from the latter. The key identifying assumption is that idiosyncratic developments in the host country in which a foreign subsidiary operates will not affect the lending activity of the head bank in its home country. Idiosyncratic developments in the home country which affect the funding conditions of the banking group, however, can propagate to the lending activity of a foreign subsidiary. This allows us to isolate movements in the lending activity of a foreign subsidiary which are due to changes in the funding conditions of the banking group, on the one hand, and to changes in demand factors of the host country, on the other.

Let $L_{b(i),j,t}$ indicate the lending activity variable of bank b from home country i which operates in host country j at time t. In the baseline setup, $L_{b(i),j,t}$ corresponds to the annualised 3-months growth rate of loan volumes to non-financial corporations. In order to identify the loan supply channel of the sovereign stress transmission, we consider the following equation:

$$L_{b(i),j,t} = \alpha_{j,t} + \beta S_{i,t-1} + \gamma X_{i,t-1} + \xi_{b(i),j,t} \tag{1}$$

where $\alpha_{j,t}$ are host country-time fixed effects, and $S_{i,t-1}$ is the 10-year sovereign yield of the home country i where the head bank originates. We include the lag of $S_{i,t}$ to allow for a gradual pass-through of sovereign stress to lending. In addition, $X_{i,t-1}$ includes the capital ratio and the liquidity ratio at the consolidated level of bank $b(i)$ to control for regulatory and other factors which might affect lending on top of the sovereign yields. Host country-time fixed effects $\alpha_{j,t}$ capture all the observable and unobservable time-varying characteristics of the host country in which bank $b(i)$ operates, i.e., borrower-specific factors affecting its lending in the host country (see Khwaja and Mian, 2008). These include the macroeconomic and financial market developments of the host country, such as the movements in its sovereign yield. Thus, β isolates the effect of changes in the *home* sovereign yield, $S_{i,t-1}$, on the lending activity of bank $b(i)$ in the host country j, controlling for group-level characteristics, and for the correlation between the home and the host sovereign yields. The coefficient

β thus reflects changes in the domestic sovereign yield due only to the loan supply channel.

Let us provide a concrete example: suppose that bank $b(i)$ is a foreign subsidiary of BNP Paribas, whose head institution resides in France, and which operates in Italy. In this case, $\alpha_{j,t}$ refer to Italy-specific fixed effects and thus capture the variation in bank $b(i)$'s lending caused by developments that are specific to the borrower country (Italy). In turn, $S_{i,t-1}$ refers to the sovereign yield on the 10-year French bond, and thus to the sovereign stress generated in the home country (France) of BNP Paribas. This approach is substantially different from that which is typically proposed in the literature, in that we allow the shock to be generated in a different country from the one in which the bank operates. Thus, we isolate a pure supply effect deriving by the worsening of the funding conditions at the banking group level. In this way, the identification of the loan supply channel of the sovereign stress transmission is sharper.

In order to identify the loan demand channel of sovereign stress transmission, we use the following equation:

$$L_{b(i),j,t} = \alpha_{i,t} + \beta S_{j,t-1} + \gamma X_{j,t-1} + \xi_{b(i),j,t} \tag{2}$$

where again $L_{b(i),j,t}$ is the lending of bank b from home country i which operates in host country j, $\alpha_{i,t}$ are the home country-time fixed effects, $S_{j,t-1}$ is the 10-year sovereign yield of the host country, and $X_{j,t-1}$ includes industrial production and unemployment as macro-level controls of the host country to capture any business cycle developments which may affect local demand conditions. We also consider a more restrictive specification in which we include head bank-time fixed effects, defined as $\alpha_{h(i),t}$, replacing $\alpha_{i,t}$. This allows us to isolate directly the head bank-specific characteristics and thus track more precisely any changes in the funding conditions of the banking group of bank b. The fixed effects $\alpha_{i,t}$ (and $\alpha_{h(i),t}$) capture all observable and unobservable time-varying home country-specific (head bank-specific) characteristics. Thus, they control for the lender specific factors affecting the lending of bank $b(i)$ in the host country j, including the deterioration of funding conditions at the banking group level as a consequence of sovereign stress in the home country. Therefore, β isolates the effect of a change in the sovereign yield of the *host* country, $S_{j,t-1}$, on lending activity of bank $b(i)$ in the host country j, controlling for the loan supply channel and the potential correlation between the home and the the host yield.

5 Results

This section presents the main results of our empirical analysis. It is divided into two subsections which illustrate the effects of the sovereign stress transmission on the growth rates of loan volumes to non-financial corporations through, respectively, the loan supply and the loan demand channel.[5]

5.1 Loan supply channel

In Table 3, we present the baseline results for the regression (1). Estimation is carried out through a fixed-effects panel regression approach, where standard errors are clustered at the host country and time level. The first column includes host country-time fixed effects and a lag of the dependent variable as the only control. The second column adds capital and liquidity ratios as further controls, and the third column restricts the sample to cross-border banks only. The number of observations is very high. Even in the most restrictive case (Column 3), we have more than five thousands data points.

Table 3: Supply channel effects on growth rates of loans

	(1)	(2)	(3)
	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$
$S_{i,t-1}$	-0.440***	-0.446***	-0.403***
	(-4.78)	(-4.84)	(-3.55)
Only cross-border banks	no	no	yes
Controls	no	yes	yes
R^2	0.150	0.161	0.269
Adjusted R^2	0.0851	0.0830	0.0742
F	39.64	22.25	6.922
N	23343	18605	5388

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable $L_{b(i),j,t}$ is the annualised 3-month growth rate of loan volumes to non-financial corporations of bank $b(i)$ that operates in country j in month t. $S_{i,t-1}$ is the three-months moving average of the 10-year sovereign yield of country i in month $t-1$. Column (1) includes a lag of the dependent variable as unique control, whereas Columns (2) and (3) include, additionally, the capital ratio and the liquidity ratio at the consolidated level in month $t-1$ as additional controls. Standard errors are clustered at the host country and time level.

We find a negative and statistically significant effect of an increase in sovereign stress on lending volumes through the loan supply channel, which is also fairly stable across

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[5]In Appendix A, we also report our findings on the effects of the sovereign stress on the (bank-specific) lending rates to non-financial corporations, as driven by the two channels.

the different specifications. The magnitude of this effect is economically relevant. A 100 basis points increase in the domestic sovereign yield leads to an average decrease in loan growth of about 40-45 basis points, depending on the specification. This channel accounts for about 20% of the standard deviation of the loan growth, suggesting that the loan supply channel is an important determinant of credit volatility.

The loan supply channel of sovereign stress transmission may depend on whether the head bank (or the banking group) is highly exposed to domestic sovereign debt (see, e.g., Altavilla et al., 2017; Bottero et al., 2020) or whether the subsidiary (or branch) is domestic or foreign. In Table 4, we augment the baseline specification - as reflected in Column (2) of Table 3, which includes all banks, and Column (3), which includes only cross-border banks - in order to account for sovereign exposure and (domestic vs. foreign) lenders' origin. To this end, we add the following set of controls to the baseline specification of Table 3: the first set of controls includes a dummy that takes value one if the home and host countries of bank $b(i)$ are the same, i.e., $I(i = j)$, and its interaction with the home 10-year sovereign yield $S_{i,t-1}$. The second set of controls includes the domestic sovereign exposure of the head bank of bank $b(i)$, $E^i_{h(i),t-1}$, its interaction with $I(i = j)$, and a three-way interaction between $S_{i,t-1}$, $I(i = j)$ and $E^i_{h(i),t-1}$. Specifically, we estimate the following equation:

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\begin{aligned}
L_{b(i),j,t} =& \alpha_{j,t} + \beta_1 S_{i,t-1} + \beta_2 I(i = j) + \beta_3 S_{i,t-1} * I(i = j) + \\
& + \beta_4 E^i_{h(i),t-1} + \beta_5 S_{i,t-1} * E^i_{h(i),t-1} + \\
& + \beta_6 I(i = j) * E^i_{h(i),t-1} + \\
& + \beta_7 S_{i,t-1} * I(i = j) * E^i_{h(i),t-1} + \gamma X_{i,j,t-1} + \xi_{b(i),j,t} \ ,
\end{aligned}
\tag{3}
$$

The first two columns of Table 4 add only $I(i = j)$ and its interaction with $S_{i,t-1}$ to the specifications of Columns (2) and (3) of Table 3. We observe a more negative coefficient associated to the home sovereign yield. However, $\hat{\beta}_1$ has a different interpretation than $\hat{\beta}$ of equation (1): it is the coefficient associated to an increase in domestic sovereign stress conditional on bank $b(i)$ operating in a foreign country. For the sample including only cross-border banks (Column 2), we observe a positive and significant $\hat{\beta}_3$. This means that foreign banks cut lending much more than domestic ones, for which we observe a smaller effect, as reflected by the sum of the coefficients $\hat{\beta}_1$ and $\hat{\beta}_3$. Put differently, this suggests that when cross-border banks deleverage due to a worsening of funding conditions in their home country, they do so in particular in foreign countries. While international spillovers of sovereign stress have already been emphasised in some papers (e.g. Correa et al., 2016), the stronger deleveraging operated on foreign assets

Table 4: Supply channel effects conditional on sovereign exposure and domestic vs. foreign origin of the head bank

	(1)	(2)	(3)	(4)	(5)	(6)
	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$
$S_{i,t-1}$	-0.503***	-0.599***	-0.477***	-0.355**	-0.879***	-1.045***
	(-4.04)	(-4.26)	(-4.05)	(-2.42)	(-3.20)	(-3.76)
$I(i=j)$	-0.144	-1.972***			-1.695**	-3.185***
	(-0.47)	(-3.76)			(-2.50)	(-3.88)
$S_{i,t-1} * I(i=j)$	0.0703	0.551***			0.575**	1.042***
	(0.66)	(2.93)			(2.32)	(3.83)
$E^i_{h(i),t-1}$			-3.794*	-1.821	-25.01**	-41.21***
			(-1.88)	(-0.26)	(-2.26)	(-3.24)
$S_{i,t-1} * E^i_{h(i),t-1}$			0.0475	-0.255	10.31**	16.94***
			(0.18)	(-0.18)	(2.36)	(3.69)
$I(i=j) * E^i_{h(i),t-1}$					22.73**	53.91***
					(2.06)	(3.91)
$S_{i,t-1} * I(i=j) * E^i_{h(i),t-1}$					-10.48**	-20.51***
					(-2.39)	(-4.50)
Only cross-border banks	no	yes	no	yes	no	yes
Controls	yes	yes	yes	yes	yes	yes
R^2	0.161	0.271	0.176	0.232	0.177	0.236
Adjusted R^2	0.0829	0.0766	0.0790	0.0510	0.0801	0.0557
F	15.87	8.299	7.000	3.413	4.606	5.609
N	18605	5388	12888	4718	12888	4718

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable $L_{b(i),j,t}$ is the annualised 3-month growth rate of loan volumes to non-financial corporations of bank $b(i)$ that operates in country j in month t. $S_{i,t-1}$ is the three-months moving average of the 10-year sovereign yield of country i in month $t-1$. $I(i=j)$ is a dummy that equals 1 if bank $b(i)$ is domestic in country j (i.e. $i=j$) and 0 otherwise. $E^i_{h(i),t-1}$ is the domestic (country i) sovereign exposure of the head bank $h(i)$ of bank $b(i)$. Columns (1) to (7) include a lag of the dependent variable, the capital ratio and the liquidity ratio in month $t-1$ as controls. Standard errors are clustered at the host country and time level.

is novel in the literature.

Columns (3) and (4) of Table 4 add sovereign exposure at the head bank level $E^i_{h(i),t-1}$ and its interaction with $S_{i,t-1}$ to the baseline specification. In this case, $\hat{\beta}_1$ represents the effects of sovereign stress on lending conditional on the head bank having no home sovereign exposure. We do not find *prima facie* evidence of a strengthening of the loan supply channel if sovereign exposure is higher, as reflected in a $\hat{\beta}_5$ coefficient not statistically different from zero. This refers to the overall sample of banks, without distinguishing between domestic and foreign banks. However, the picture substantially changes when we distinguish between the two groups of banks. In practice, we add the dummy $I(i = j)$, its interaction with $S_{i,t-1}$ and a three-way interaction term between $E^i_{h(i),t-1}$, $S_{i,t-1}$ and $I(i = j)$. Results are presented in Columns (5) and (6). In this case, the interpretation of the coefficients and the overall effect of sovereign stress on lending is less trivial. The coefficient $\hat{\beta}_1$ reflects the effect of the sovereign stress conditional on being a foreign subsidiary (or branch) and the head bank having no home sovereign exposures. In line with the findings reported in Columns (1) to (4), the coefficient is negative and significant across the different specifications. The estimated coefficients of the interaction between the domestic bank dummy and sovereign yields, i.e., $\hat{\beta}_3$, and of interaction between sovereign exposures and sovereign yields, i.e., $\hat{\beta}_5$, are positive and significant. The former coefficient shows that, in response to an increase in home sovereign stress, and conditional on the head banks having no sovereign exposure, domestic lenders cut their lending in the home country less than foreign ones. This is consistent with the findings of Column (2). The latter coefficient suggests that a higher home sovereign exposure of the head bank of foreign subsidiaries reduces the contraction in lending volumes in the host country when home sovereign stress increases. Finally, we observe a negative and significant coefficient for the three-way interaction term $\hat{\beta}_7$, especially for the sample with only cross-border banks (Column 6). This shows that domestic lenders contract lending more in the home country the higher their home sovereign exposure.

We summarize these results in Figure 1, where we report the overall effect of an increase in sovereign stress through the loan supply channel for domestic and foreign lenders by varying their exposure to domestic (i.e., home) sovereign debt. This effect depends on the domestic sovereign exposure of the head bank. We construct $\hat{\gamma}^f$ and $\hat{\gamma}^d$, based on the estimated coefficients reported in Column (6) of Table 4:

$$\hat{\gamma}^f = \hat{\beta}_1 + \hat{\beta}_5 E^i_{h(i),t-1}$$
$$\hat{\gamma}^d = \hat{\beta}_1 + \hat{\beta}_3 + (\hat{\beta}_5 + \hat{\beta}_7) E^i_{h(i),t-1}$$

Figure 1: Effect of the loan supply channel depending on home sovereign exposure.

Foreign banks | Domestic banks
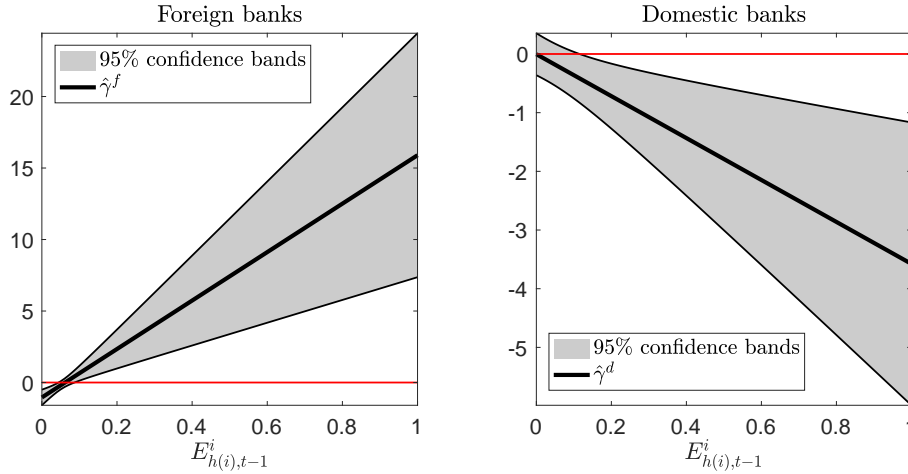
Note: The figure shows the percentage point effect on lending in the host country of a 100 b.p. increase in the home sovereign yield, depending on the degree of exposure to the home sovereign ($E^i_{h(i),t-1}$). The coefficient $\hat{\gamma}^f$ (left chart) captures lending by foreign banks, while the coefficient $\hat{\gamma}^d$ (right chart) lending by domestic banks.

and make domestic sovereign exposures $E^i_{h(i),t-1}$ vary in the range $[0,1]$, where 0 represents no exposure and 1 indicates full exposure to domestic sovereign debt relative to main assets. The coefficient $\hat{\gamma}^f$ represents the percentage points effect on lending in the host country by foreign banks, following a 100 basis points increase in the home sovereign yield. The coefficient $\hat{\gamma}^d$ represents the effect on the lending by domestic banks. The two charts display substantially different patterns. The left chart suggests that, when the home sovereign exposure of foreign banks is relatively low (less than 10%), there is a slight contraction of lending in the host country following an increase in the sovereign stress in the home country. However, if home sovereign exposure is higher, we observe a strong, positive, and significant expansion of lending in the host country. For example, for an exposure of around 30%, our findings suggest that the growth rate of lending in the host country rises by about 4 percentage points. This effect is stronger, the higher the exposure to the home sovereign. This result might reveal evidence of a "flight-to-quality" motive. The picture is substantially different when we focus on domestic banks only (right chart), for which the coefficient is always negative and significant for levels of domestic sovereign exposure higher than 10%.

All in all, we document an important role of the loan supply channel of sovereign stress transmission for lending activity, which also depends on sovereign exposure and on the (domestic vs. foreign) lenders' origin.

5.2 Loan demand channel

Here, we report the results on the loan demand channel as a driver of lending activity. Table 5 presents the results for the baseline regression (2). The first column includes home country-time fixed effects and a lag of the dependent variable as the only control. Columns (2) to (4) also include industrial production and the unemployment rate as additional controls to capture business cycle developments. The third column restricts the sample to only cross-border banks. The fourth column replaces the home country-time fixed effects used in the third column with head bank time fixed effects (i.e., $\alpha_{h(i),t}$).

Table 5: Demand channel effects on growth rates of loans

	(1)	(2)	(3)	(4)
	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$
$S_{j,t-1}$	-0.259***	-0.411***	-0.371***	-0.376***
	(-3.50)	(-4.66)	(-3.08)	(-2.81)
$\alpha_{i,t}$	yes	yes	yes	no
$\alpha_{h(i),t}$	no	no	no	yes
Only cross-border banks	no	no	yes	yes
Controls	no	yes	yes	yes
R^2	0.146	0.147	0.176	0.263
Adjusted R^2	0.0717	0.0720	0.0172	0.00842
F	38.31	21.03	2.602	3.333
N	23702	23702	5775	5137

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable $L_{b(i),j,t}$ is the annualised 3-month growth rate of loan volume to non-financial corporations of bank $b(i)$ that operates in country j in month t. $S_{j,t-1}$ is the three months moving average of the 10-year sovereign yield of country j in month $t-1$. Column (1) includes a lag of the dependent variable as unique control. Columns (2), (3) and (4) include industrial production and unemployment in month $t-1$ as additional controls, Column (1) has home-country fixed-effects, while Columns (2) to (4) fixed-effects at the head-bank level. Standard errors are clustered at the host country and time level.

We find a negative and statistically significant effect of an increase in sovereign stress on lending growth through this channel across the different specifications. In particular, the estimated coefficients are very similar when macroeconomic controls are included (Columns 2 to 4), regardless if we focus on cross-border banks only or use head bank-specific fixed effects.

In terms of the size of this channel, we note that a 100 basis points increase in the 10-year sovereign yield of the host country leads to an average decrease in loan growth of around 0.4 percentage points (when controls are included, i.e., in Columns 2 to 4).

This accounts for approximately 17% of the standard deviation of loan growth, slightly less than for the loan supply channel (i.e., about 20%).[6]

Similarly to the loan supply channel, the loan demand channel of sovereign stress transmission could depend on the fact that lenders are domestic or foreign. In addition, sovereign exposures might play an important role. However, in this context, the sovereign exposures that are relevant are the ones to the *host* country where the bank operates. This channel is likely to be not very powerful as banks, and especially subsidiaries, tend to hold relatively few sovereign securities (for instance, Altavilla et al. (2017) show that sovereign debt, be it domestic or foreign, is basically entirely held by the head bank). Finally, the loan demand channel could depend on whether the host country was under stress in the sovereign debt market, or not. Specifically, we divide the sample and include in the "stressed" group the following countries: Cyprus, Greece, Ireland, Italy, Portugal, Slovenia, and Spain. These are the countries which are generally considered to have been affected the most by the European sovereign debt crisis of 2011-2012 (see, e.g., Lane, 2012). To account for these different factors, we extend the baseline specification (2) as follows:

$$
\begin{aligned}
L_{b(i),j,t} =& \alpha_{i,t} + \beta_1 S_{j,t-1} + \beta_2 I(i=j) + \beta_3 S_{j,t-1} * I(i=j) + \\
& + \beta_4 E^j_{b(i),t-1} + \beta_5 S_{i,t-1} * E^j_{b(i),t-1} + \\
& + \beta_6 I(i=j) * E^j_{b(i),t-1} + \\
& + \beta_7 S_{j,t-1} * I(i=j) * E^j_{b(i),t-1} + \gamma X_{i,j,t-1} + \xi_{b(i),j,t},
\end{aligned}
\tag{4}
$$

where $I(i=j)$ is a local lender dummy that takes value one if the home and host countries of bank $b(i)$ are the same. We then include its interaction with the *host* 10-year sovereign yield $S_{j,t-1}$, the host sovereign exposure of the bank $b(i)$, $E^j_{b(i),t-1}$, its interaction with $S_{j,t-1}$ and $I(i=j)$, and a three way interaction between $S_{j,t-1}$, $I(i=j)$ and $E^j_{b(i),t-1}$.

The first column of Table 6 presents the estimation results in which we include only the local lender dummy, $I(i=j)$, and its interaction with the host country sovereign yield, $S_{j,t-1}$. The second column focuses on cross-border banks that operate only in stressed countries. The interaction coefficient $\hat{\beta}_3$ is positive and significant across specifications. This suggests that local lenders decrease credit less than foreign ones when sovereign stress in the host country increases. Quantitatively, these results suggests that following a 100 basis points increase in the host sovereign yield, lending via foreign banks contracts by 0.4 percentage points and by 0.1 percentage points via

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[6]In Appendix B, we perform an IV regression to assess the robustness of the loan demand channel of sovereign stress transmission.

Table 6: Demand channel effects conditional on sovereign exposure and domestic vs. foreign origin of the head bank

	(1)	(2)	(3)	(4)	(5)	(6)
	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$
$S_{j,t-1}$	-0.406***	-2.349***	-0.318**	-2.312***	-0.409***	-2.138***
	(-3.09)	(-4.15)	(-2.50)	(-4.06)	(-2.60)	(-3.68)
$I(i=j)$	-0.814**	-3.162*			-1.209*	-2.410
	(-2.04)	(-1.81)			(-1.93)	(-0.97)
$S_{j,t-1} * I(i=j)$	0.306**	0.935**			0.416**	0.450
	(2.29)	(2.18)			(2.19)	(0.72)
$E_{b(i),t-1}^{j}$			16.47***	-1.267	7.413	5.830
			(4.75)	(-0.18)	(1.19)	(0.26)
$S_{j,t-1} * E_{b(i),t-1}^{j}$			-3.275**	-3.298**	-0.900	-8.626
			(-2.35)	(-2.07)	(-0.36)	(-1.43)
$I(i=j) * E_{b(i),t-1}^{j}$					16.71**	-13.99
					(2.37)	(-0.59)
$S_{j,t-1} * I(i=j) * E_{b(i),t-1}^{j}$					-4.166	7.759
					(-1.50)	(1.22)
Stressed j	no	yes	no	yes	no	yes
R^2	0.177	0.263	0.179	0.286	0.181	0.290
Adjusted R^2	0.0178	0.00806	0.0203	0.0558	0.0213	0.0582
F	2.467	2.265	6.958	7.568	5.317	5.003
N	5775	5137	5775	2514	5775	2514

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable $L_{b(i),j,t}$ is the annualised 3-months growth rate of loan volumes to non-financial corporations of bank $b(i)$ that operates in country j in month t. $S_{j,t-1}$ is the three months moving average of the 10-year sovereign yield of country j in month $t-1$. $I(i=j)$ takes value 1 if the lender is local and 0 if the lender is foreign. $E_{b(i),t-1}^{j}$ is the host (country j) sovereign exposure of bank $b(i)$ in month $t-1$. All regressions include a lag of the dependent variable, industrial production and unemployment in month $t-1$ as additional controls. Standard errors are clustered at the host country and time level.

domestic banks (Column 1). Interestingly, if we focus on the sample of cross-border banks that operate in only stressed host countries, we observe a larger positive and significant $\hat{\beta}_3$ and a more negative coefficient $\hat{\beta}_1$ (Column 2). It seems therefore that foreign banks cut lending strongly in response to host country stress, even more so if the borrower country is stressed. This result confirms the view prevailing in international finance that foreign investors tend to be more flighty (see, e.g., Caballero and Simsek, 2020).

Columns (3) and (4) of Table 6 present the results when we extend the baseline specification to account for the host country sovereign exposure of the particular bank $b(i)$ and its interaction with the sovereign yield of the host country j. Column (3)

includes all banks, while Column (4) only the stressed borrower countries. $\hat{\beta}_1$ represents the effects of sovereign stress on lending conditional on the bank holding no sovereign exposures of the host country. We observe a negative and significant coefficient for the different specifications. The magnitude of the estimated coefficient in the third column is similar to the one of Table 5. This is not surprising, however, as host sovereign exposure is expected to play a small role in the transmission. As before, the magnitude of the effects of the sovereign stress through the loan demand channel turns out to be bigger when we focus on the stressed host countries (Column 4). The interaction coefficient $\hat{\beta}_5$ is negative and significant: the higher the exposure in host sovereign bonds, the stronger the lending cut in response to the sovereign stress in that country.

In the last two columns, we also include the local lender dummy, the interaction term with $S_{j,t-1}$ and, additionally, a three-way interaction term between the host sovereign exposure of the bank, the sovereign yield and the dummy $I(i = j)$. By introducing all the interaction terms, we observe, again, a negative and significant $\hat{\beta}_1$ across the different specifications. In this context, $\hat{\beta}_1$ is the effect of an increase in sovereign stress conditional on being a foreign lender with no sovereign exposure in the host country. The effect of the host sovereign yield is again stronger for stressed countries (Column 6). The local lender interaction term is positive and significant only when both stressed and non-stressed countries are included, while $\hat{\beta}_5$ becomes insignificant for both specifications. In general, these results suggest that, when local lender dummies are introduced, the role of host sovereign exposure becomes negligible.

6   Is a diversified banking system overall beneficial?

The overall assessment on the role of foreign banks in stabilising the domestic banking sector in the presence of sovereign stress needs two elements. One is the set of elasticities to the sovereign shocks, which is provided in the previous analysis. One general result is that foreign lenders tend to react more strongly to sovereign yield shocks, both in terms of lending supply when the shock originates in their home country, and in terms of reaction to local demand shocks in the host country. At the same time, funding conditions for foreign banks are not affected by shocks occurring in the host sovereign debt market, and thus the loan supply channel is inactive in the presence of such shocks.

A second element is a model for the stochastic processes underlying the realisation of the sovereign shocks in each economy. A stylised mean-variance model, calibrated

with the parameters from the empirical analysis, is proposed here to show under which conditions a higher share of foreign banks is preferable, depending on the relative variance of domestic vs. foreign sovereign shocks.

Let ϵ^d and ϵ^f be the sovereign stress shocks in the domestic and foreign country respectively, which can be interpreted as changes in the sovereign yield in the two countries. We assume that the shocks are normally distributed $\epsilon^d \sim N(0, \sigma_d^2)$ and $\epsilon^f \sim N(0, \sigma_f^2)$. The shocks are assumed to be uncorrelated, reflecting the conceptual framework of our empirical analysis, which controls for the correlation between shocks via fixed effects. Let ΔL be the lending change in the domestic country in response to sovereign stress that originated both in the domestic economy and abroad. It will depend on the share of foreign lenders operating in an economy, which is defined as ϕ, and on the elasticities to the sovereign shocks estimated in the empirical analysis. In particular, changes in lending will evolve according to:

$$\Delta L = \epsilon^d((1 - \phi)\alpha + \phi\beta) + \epsilon^f(\phi\gamma) \tag{5}$$

where α is the sum of supply and demand channel elasticity to a domestic shock by domestic banks (from Column (1) in Table 4 and Column (1) in Table 6, respectively), β is the demand channel elasticity to a domestic shock by foreign banks (from Column (1) in Table 6). Note that the supply channel is inactive for foreign banks, when the shock hits the host country. Finally, γ is the supply channel elasticity to a foreign shock by foreign banks (from Column (1) in Table 4).[7] The expected value of ΔL is then given by:

$$E(\Delta L) = E(\epsilon^d)((1 - \phi)\alpha + \phi\beta) + E(\epsilon^f)(\phi\gamma) \tag{6}$$

Notice that $E(\Delta L) = 0$ as we assume normality of the shocks.

The variance of ΔL is given by:

$$var(\Delta L) = \sigma_d^2((1 - \phi)\alpha + \phi\beta)^2 + \sigma_f^2(\phi\gamma)^2 \tag{7}$$

The objective is to maximise a utility function (minimise a loss function) for the share of foreign banks, ϕ. Similarly to other portfolio problems in finance (see, e.g., Markowitz and Todd, 2000), this function will depend positively on expected lending and negatively on the variance of lending. Specifically, we consider the following

---

[7]Note that estimation uncertainty from the regression results in Table 4 and 6 is not taken into account here.

problem:

$$\max_{\phi} \quad E(\Delta L) - a * var(\Delta L)$$

$$\text{subject to} \quad 0 \leq \phi \leq 1$$

(8)

for a given value a, which weights the relative importance of lending variance.[8]

We solve the problem above for the share of foreign banks in the domestic economy, ϕ, conditional to all combinations of σ_d^2 and σ_f^2 in the interval [0,1] and report in Figure 2 the optimal values ϕ^*. The yellow region in Figure 2 indicates a combination of variances for which an economy populated by only foreign banks is optimal. The figure suggests that, when the variance of the foreign sovereign shocks is low, a high share of foreign banks is preferable. In the extreme case in which the variance of such shocks is zero, it will always be optimal to have an economy populated by *only* foreign banks because they will be completely unaffected by shocks that originated in their own country. As long as the variance of foreign shocks increases relative to that of domestic shocks, it will be progressively less convenient to have a large share of foreign banks in the local economy.

Figure 2: Optimal ϕ^* with normally distributed sovereign shocks
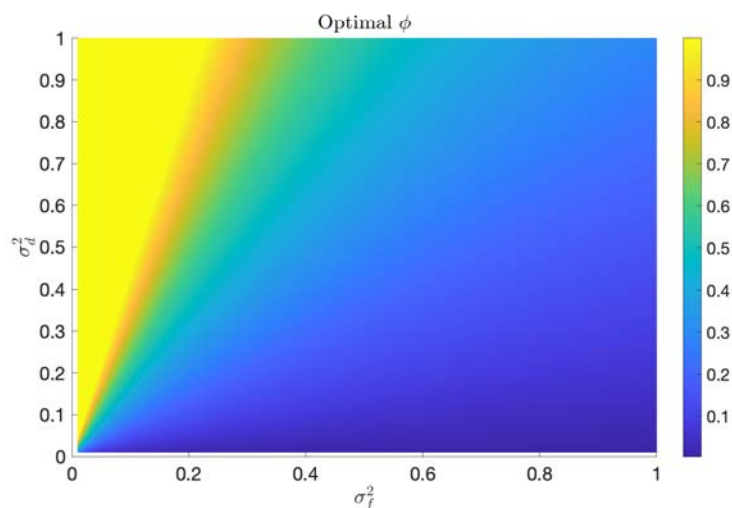
Note: The figure the optimal share of foreign banks in the local economy, ϕ^*, for given levels of the variance of domestic (σ_d^2) and foreign sovereign shocks (σ_f^2), where such shocks are assumed to be normally distributed and centered around zero. The yellow region indicates a combination of variances consistent with an environment populated by only foreign banks, while in the dark blue region it would be optimal to have only domestic banks.

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[8]The value of a is irrelevant for the exercise based on normally distributed shocks, because $E(\Delta L)$ in equation (8) is zero. In Appendix C, we show the robustness of the exercise to shocks distributed as binomial. In that case, the value of a will affect the optimisation problem. We choose in an ad-hoc way a to be equal to 0.5, the results are broadly robust to other values of that parameter.

7 Conclusions

This paper offers new insights into the transmission of sovereign stress to lending to non-financial corporations, focusing on the role of international banks. In contrast to existing research, we explore the implications of sovereign shocks originating both in the domestic economy and abroad, and how they transmit to lending in the domestic economy via local banks and foreign ones.

We identify two channels through which these shocks propagate: a loan supply channel, which affects the funding conditions of banks, and operates through their balance sheets; and a loan demand channel, which depends on borrower characteristics.

Our results indicate that both the loan supply and the loan demand channels of transmission are quantitatively relevant. First, an increase in the home sovereign yield entails a sizeable lending contraction by domestic banks via the loan supply channel. Second, cross-border banks respond to an increase in stress in their home country mostly by deleveraging foreign positions. Third, these banks cut lending considerably more than domestic ones if the host country is stressed. Yet, given that the supply channel is partially inactive for these banks, because their funding conditions are not affected by stress in the host country sovereign, a large presence of foreign lenders still mitigates the sovereign-bank nexus, thus resulting in a sustained provision of credit in the presence of domestic sovereign stress. In addition, a stylised mean-variance model, calibrated with the parameters from the empirical analysis, shows that the stabilisation role of foreign banks tends to be confirmed even considering that these lenders may import shocks from their own sovereign.

These findings suggest that a geographically diversified banking system might support the creation of a fully-fledged Banking Union for the Eurozone by alleviating the sovereign-bank nexus.

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Data Appendix

Data used in the empirical analysis

Variable	Unit	Transformation	Source
(1)	(2)	(3)	(4)
Loans to NFC	million of euro	3-months growth rate	IBSI
Loan rate to NFC	percent	3-months moving average	IMIR
Yield on 10-year govt. bond	percent	3-months moving average	Reuters
Capital ratio	percent	level	Van Dijk (Bankscope)
Liquidity ratio	percent	level	IBSI
Industrial production	index	3-months growth rate	Datastream
Unemployment	percent	level	Datastream

Note: Data are retrieved from the sources reported in Column (4), including two the ECB's confidential dataset: the Individual Balance Sheets Items dataset (IBSI) and the individual MFI interest rates (IMIR). In the IBSI dataset, bank-level loan growth rates are computed taking into account reclassifications and value adjustments. In the IMIR dataset, loan rates to NFC are bank-level averages for new loans. Before running the empirical analysis, data are transformed according to what reported in Column (3).

Additional results

A   Loan rates

A.1   Supply channel effects on loan rates

We report here our findings for the supply side regression (1), where we use as dependant variable the (bank-specific) loan rate to non-financial corporations. Table A1 reports results for the same specification as of Table 3.

Table A1: Supply channel effects of sovereign stress on loan rates to NFC

	(1)	(2)	(3)
	$R_{b(i),j,t}$	$R_{b(i),j,t}$	$R_{b(i),j,t}$
$S_{i,t-1}$	0.244***	0.206***	0.0646
	(3.30)	(2.72)	(0.67)
Cross-border banks only	no	no	yes
Controls	no	yes	yes
R^2	0.941	0.937	0.963
Adjusted R^2	0.936	0.931	0.953
F	7022.9	2539.5	3548.2
N	21500	16851	4691

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable $R_{b(i),j,t}$ is the annualised 3-months loan rate to non-financial corporations of bank $b(i)$ that operates in country j in month t. $S_{i,t-1}$ is the 3-months moving average of the 10-year sovereign yield of country i in month $t-1$. Column (1) includes a lag of the dependent variable as unique control, whereas Columns (2) and (3) include, additionally, the capital ratio and the liquidity ratio as additional controls. Standard errors are clustered at the host country and time level.

We find a positive and significant effect of a change in sovereign yields on loan rates for for the regressions reported in Column (1) and (2). Interestingly, the effect is still positive but not statistically significant once we control for host country-time fixed effects and restrict the focus on cross-border banks only.

A.2   Demand channel effects on loan rates

We also report our findings for the demand side regression (2), for loan rates to non-financial corporations. Table A2 reports results for the same specifications used in Table 5.

Across the different specifications, we find a strongly positive and significant effect of sovereign stress transmission to lending rates through the demand channel. Unlike the case of growth rates of loan volumes, the demand channel is significantly more important than the supply one when focusing on loan rates. Interestingly, the demand channel effect on loan

rates can be interpreted as driven by two components. On the one hand, according to the pure "demand" component of this channel, we would expect both loan volumes and loan rates to decrease when credit demand decreases due to an increase in sovereign stress. On the other, according to the "credit risk" component of this channel, we would expect loan volumes and loan rates to move in opposite directions, as this channel is driven by the supply of credit of banks (even though not through a deterioration of funding conditions). The positive and significant effect of an increase in sovereign stress of loan rates suggests that the risk component is relatively more important than the demand component. This could not be seen by simply looking at loan volumes, for which both channels imply a clear decrease.

Table A2: Demand channel effects of sovereign stress on loan rates to NFC

	(1) $R_{b(i),j,t}$	(2) $R_{b(i),j,t}$	(3) $R_{b(i),j,t}$	(4) $R_{b(i),j,t}$
$S_{j,t-1}$	0.495***	0.535***	0.393***	0.536***
	(6.31)	(5.01)	(3.27)	(3.84)
$\alpha_{i,t}$	yes	yes	yes	no
$\alpha_{h(i),t}$	no	no	no	yes
Cross-border banks only	no	no	yes	yes
Controls	no	yes	yes	yes
R^2	0.941	0.941	0.938	0.943
Adjusted R^2	0.935	0.935	0.926	0.921
F	6694.6	3464.2	1528.3	1634.7
N	21743	21743	5058	4526

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable $R_{b(i),j,t}$ is the annualised 3-month loan rate to non-financial corporations of bank $b(i)$ that operates in country j in month t. $S_{j,t-1}$ is the three months moving average of the 10-year sovereign yield of country j in month $t-1$. Column (1) includes a lag of the dependent variable as unique control, whereas Columns (2) to (4) include, additionally, industrial production and unemployment in month $t-1$ as additional controls. Standard errors are clustered at the host country and time level.

B IV regressions

Here, we present a robustness exercise for our loan demand channel equation (2), based on a simple IV regression. We focus on that channel only as our definition of the supply side is less affected by a possible reverse causality problem. In fact, in that framework, the shock originates in a different country than the one in which the bank operates and we believe this is largely rules out possible endogeneity problems.

As instrumental variable, we use the Greek sovereign yield interacted for a dummy with value 1 for the period from April 2010 to December 2011, which corresponds with the peak of

the Greek sovereign crisis, and 0 otherwise. The idea is to isolate more effectively exogenous movements in the sovereign yield of other European countries, which is arguably the case when we focus on the contagion from Greece to those countries in that period. We focus on stressed countries only (Cyprus, Greece, Ireland, Italy, Portugal, Slovenia and Spain) because the first stage coefficients would not be interpretable if using the whole set of 19 euro area countries. Indeed, due to flight to quality, one may expect that stress in the Greek sovereign market would reduce - rather than increase - the yields in the core countries. We perform four exercises, which are presented in Table B1.

Table B1: Demand channel effects in an IV regression

	(1)	(2)	(3)	(4)
	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$	$L_{b(i),j,t}$
$S_{j,t-1}$	-0.185**	-0.184***	-0.232***	-0.229***
	(-2.05)	(-2.02)	(-4.78)	(-5.08)
Cross-border banks only	yes	yes	no	no
$\alpha_{h(i)}$	no	yes	no	yes
N	2766	2766	9812	9812

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable $L_{b(i),j,t}$ is the annualised 3-months growth rate of loan volumes to non-financial corporations of bank $b(i)$ that operates in country j in month t. $S_{i,t-1}$ is the three months moving average of the 10-year sovereign yield of country i in month $t-1$, which is instrumented with the Greek yield for the same month. Regressions include a lag of the dependent variable as unique control. Standard errors are clustered at the host country and time level.

The first column presents a simple IV regression of the growth rate of loan volumes on the host country sovereign yield where the sample is restricted to stressed host countries and cross-border banks only. In line with our baseline results, the coefficient is negative and statically significant at the 99% level. In the second column, we add head-bank fixed effects in order to better control for the supply side.[9] Again, the coefficient turns out to be negative and highly significant. In columns three and four we perform the same exercise of the first two columns, but for the entire banking sample in stressed host countries (including cross border and non cross-border banks). Across different specifications, the coefficients of a sovereign stress increase are negative and always highly statistically significant.

## C   Diversification exercise with binomially distributed shocks

We report here a robustness exercise to the one of Section 6 where, instead of assuming that the sovereign shocks ϵ^d and ϵ^f are normally distributed and centered around zero, we assume

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[9]We cannot include head bank-time fixed effects, because in this case we could not use the Greek sovereign yield as an instrument, as it is varies over time.

that they follow binomial distribution, with values 0 and 1. The optimisation problem is identical to the one in (8), but now the term $E(\Delta L)$ is not zero.

Similarly to Figure 2, the yellow region in Figure C1 indicates a combination of variances for which an economy populated by only foreign banks is optimal. Consistently with the findings of Section 6, Figure C1 suggests that, when the variance of the foreign sovereign shocks is low (in this case, below 0.2), a high share of foreign banks is preferable.

Figure C1: Optimal ϕ^* with binomial shocks
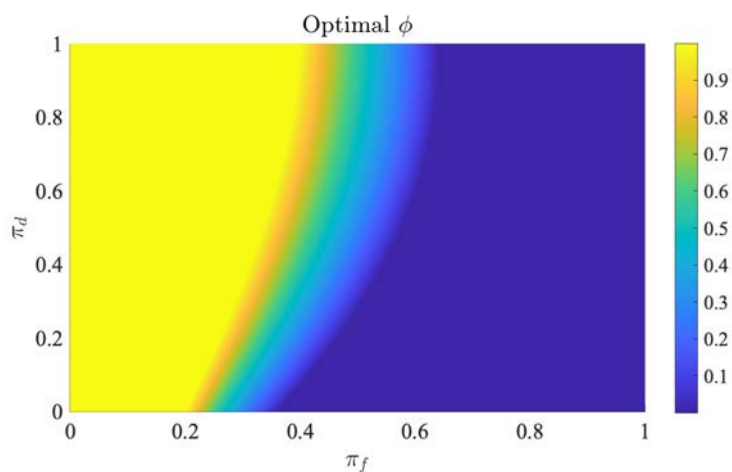
Note: The figure the optimal share of foreign banks in the local economy, ϕ^*, for given levels of the variance of domestic (σ_d^2) and foreign sovereign shocks (σ_f^2), where such shocks are assumed to be follow a binomial distribution with values 0 and 1.

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