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Small Firms and Domestic Bank Dependence in Europe's Great Recession

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Abstract

After the inception of the euro, the real economy in most member countries remained dependent on credit by domestic banks, which increasingly funded themselves through cross-border interbank funding. We find that this pattern of 'double-decker' banking integration exposed domestic banks to sharp declines in cross-border interbank lending during the eurozone crisis. As a result, domestic banks reduced lending which led to large declines in output in sectors with many small (bank-dependent) firms. We propose a quantitative small open economy model to account for these patterns and conclude that a global banking shock leading to a sudden stop in cross-border interbank lending in the eurozone is required to account for them.

Keywords: small and medium enterprises, sme access to finance, banking integration, domestic bank dependence, interbank dependence, international transmission, eurozone crisis
JEL-Codes: F30, F36, F40, F45

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1 Introduction

Since the inception of the euro until 2008, cross-border lending to banks in the eurozone increased considerably, while cross-border lending to the non-bank sector hardly increased. Thus, the real economy in most member countries remained dependent on the provision of credit by domestic banks, which in turn funded themselves through cross-border interbank borrowing. This pattern of 'double-decker' banking integration—'domestic bank dependence' coupled with a dependence of domestic banks on interbank funding ('interbank dependence'), left economies and sectors that were reliant on domestic banks for finance exposed during the the eurozone crisis when cross-border interbank lending declined sharply, while cross-border bank lending to the real sector remained relatively stable.[1] In this paper, we provide empirical evidence consistent with this mechanism and propose a model which explains how the global retrenchment in cross-border interbank flows disproportionately affects countries with a high share of domestic banks and sectors with many small and medium-sized firms (SMEs). We show that the predictions of the model qualitatively and quantitatively match the empirical patterns while reasonable alternative scenarios cannot by themselves replicate these findings.

Sectors and countries with many SMEs are particularly dependent on domestic banks for the provision of credit because SMEs are too small and opaque to borrow from banks in other countries or from the bond market. Domestic banks have better information about local small firms and often engage in long-term relationships with their borrowers, which allows SMEs to satisfy their demand for funds that are not easily available from large foreign banks that mainly lend at arms-length. However, domestic bank dependence makes small firms vulnerable to shocks that affect the domestic banking sector because they can only imperfectly substitute other sources of credit for domestic bank loans.

Consistent with this firm-borrowing channel, we document the following main empirical facts. First, using bank level data for eleven eurozone countries, we show that domestic banks that were more reliant on interbank funding reduced their lending more in response to the euro area-wide decline in interbank lending. Second, we construct an instrument for domestic lending supply from the granular responses of domestic banks to shocks in interbank markets to show that output in SME-intensive sectors declined more as a result of such shocks.

In order to provide a fully articulated interpretation of our findings, we build a dynamic stochastic general equilibrium (DSGE) model. The model allows for both global (foreign) and domestic ('local') banks and includes two sectors producing intermediate goods—one which is populated by 'large' firms, that borrow cross-border directly from global banks, and another one which is populated by 'small' firms, that borrow from local banks—as well

[1] The term 'double-decker banking integration' was first coined by Bruno and Shin (2015*b*). Brunnermeier and Reis (2019) discuss how European banks became more interbank dependent prior to the financial crisis and how liquidity dried up in the Great Recession and its aftermath.

as a final goods producer. Local banks collect deposits from their home country and also fund themselves in the European cross-border interbank market by borrowing cross-border from global banks, which in turn refinance themselves through wholesale funding in the global interbank market (interpreted as the U.S. money market).

The central assumption of our model is that global banks' cross-border lending to large firms is subject to higher intermediation frictions than cross-border lending to banks, making the supply of the latter more elastic than that of the former.[2] Therefore, cross-border lending to banks contracts more than cross-border lending to the real sector following a global deleveraging shock. The contraction in cross-border interbank lending reduces local banks' lending capacity and it disproportionately hurts SMEs because they depend on local banks. We perform simulations for a baseline case of a global banking shock leading to a sudden stop in cross-border interbank lending. Regressions run on data generated from the model quantitatively replicate the patterns we uncover in our empirical regressions. The model therefore provides a structural interpretation of our empirical regressions, suggesting that the global banking shock can quantitatively account for the patterns in the data.

We examine if this interpretation is robust to a number of plausible alternative shock scenarios that might explain the strong impact of the crisis on SME-intensive sectors. In these scenarios, we mute the global bank shock in the model and allow for either internationally synchronized drops of total factor productivity (TFP) for SMEs, or internationally synchronized deposit supply shocks for local banks (i.e., local banking shocks). These alternative model scenarios cannot explain the patterns in the data, because empirical regressions run on simulated data from these scenarios deliver statistically insignificant coefficients of interest. We conclude that a sudden stop in cross-border interbank lending is required to quantitatively account for the decline in economic output seen during the eurozone crisis, in the sectors most dependent on domestic banks.

The remainder of the paper is structured as follows: Section 2 provides a first look at the data and some initial stylized facts. Section 3 places our analysis in the context of the literature. Section 4 motivates our empirical specifications and discusses identification, while Section 5 presents our empirical results. Our DSGE model is laid out and brought to the data in Section 6, while Section 7 summarizes the quantitative results obtained from model simulations. Section 8 offers conclusions.

2 A look at the data

It is commonly observed that the European Monetary Union has given a boost to banking integration in Europe. Figure 1, which is based on locational banking statistics from the Bank for International Settlements (BIS), displays lending by foreign banks for a range of

[2]This assumption reflects, for example, the lower screening costs associated with interbank lending or regulatory constraints that attach a higher risk weight to cross-border direct than to interbank lending.

EMU countries, separately and combined. Flows of bank loans surged in the first decade of the EMU, but most of this growth was due to increased foreign bank lending to domestic banks—foreign bank lending to the domestic non-bank sector (which here includes the domestic private sector and government) increased less and has remained relatively flat.

We argue that foreign lending to domestic banks versus lending to the non-bank sector are not simple substitutes and, indeed, foreign lending to the non-bank sector generally proved resilient during the financial and sovereign debt crisis, while bank-to-bank lending virtually imploded. The synchronization of the collapse in cross-border bank-to-bank lending is noteworthy in this context. Even though the post-2008 experiences varied considerably across countries in terms of the severity of banking and sovereign crisis and in their real effects, the initial trigger (the U.S. subprime crisis spilling over to Europe and leading to a worldwide crisis in interbank markets) can be seen as a common factor which had differential impacts across countries, depending on their pre-existing vulnerabilities.

Figure 1 sets the scene for our empirical analysis. Banking sector integration in Europe was lopsided in the sense that there was too little real banking integration: the real sector was unable to diversify its sources of finance away from domestic banks. Domestic real-sector lending continued to be financed by domestic banks, which fund themselves by borrowing from foreign banks. This led to the pattern we observe in the data, with the growth in cross-border lending driven by bank-to-bank lending.[3] We illustrate these two different concepts of banking integration in Figure 2. There are two countries, one referred to as the core country, and the other one as the periphery country. The thick red arrow indicates the large cross-border banking flows in the data, whereas the thin gray arrows indicate the small flows of foreign bank lending from each country's banks to the other country's real sector. As was the case in the EMU before the crisis, net bank-to-bank flows were largely in the direction of the periphery country. The graph illustrates that, in the absence of direct cross-border real sector lending (thin or absent gray arrows), and in spite of high levels of bank-to-bank integration (thick red arrows between the two countries' banking sectors), the periphery remains vulnerable to both international liquidity shocks and domestic real shocks.[4] This happens for two reasons: first, domestic banks have domestically concentrated asset portfolios, which make them vulnerable to any real-sector shocks in the home economy. Second, an international world-wide funding shock to banks in the periphery country may cut off bank credit supply to the domestic real sector.[5]

Figure 2 suggests that the impact of a domestic banking sector shock on the domestic economy will depend on the extent to which real sector credit is provided by domestic

[3]Specifically, banks in the EMU periphery countries mainly borrowed from banks located in core economies which in turn borrowed in the U.S. money market (Hale and Obstfeld (2016)).

[4]As pointed out by Morgan, Rime and Strahan (2004), financial integration provides insurance against local liquidity shocks, because international lending quickly can replace local lending as long as the return to local investment remains high.

[5]For example, this could be the case in a global banking crisis when cross-border bank lending—which is arguably much more short-term than cross-border bank-to-real sector lending—dries up.

banks. As a measure of domestic bank dependence in country c—abbreviated as $\textsc{dbd}^c$—we propose the share of total real sector credit that is provided by domestic banks:

$$\textsc{dbd}^c = \frac{\text{Domestic bank lending to the real private sector in country } c}{\text{Total credit to the real private sector in country } c}, \tag{1}$$

which we construct using data from the Private Sector Credit Database (PSCD) compiled by the BIS.

Figures 3 and 4 illustrate that SMEs are particlarly dependent on finance from domestic banks and that SMEs were therefore more affected in countries with high domestic bank dependence during the crisis. Figure 3 uses data from the 2011 edition of the European Central Bank's and EU Commission's Survey of Access to Finance by Enterprises (SAFE) on sources of external finance of SMEs (defined as firms with fewer than 250 employees) to show that bank loans are by far the most important source of external finance for SMEs in most countries. Figure 4 provides *prima facie* evidence that SMEs in countries with high domestic bank dependence were more affected by the crisis. The first panel plots the share of SMEs that reported problems with obtaining external finance against country-level banking dependence ($\textsc{dbd}^c$). The second panel plots the share of firms reporting increased net interest expenses against $\textsc{dbd}^c$. The two plots deliver the same message: in countries with high levels of domestic bank dependence, the impact of the crisis on the financial situation of SMEs was worse.

To study how the reliance of domestic banks on cross-border interbank finance impacted SME-intensive sectors during the crisis, we define the 'global banking shock,' $\textsc{gbs}_t$, as the growth rate of aggregate cross-border interbank lending to the countries in our sample defined as

$$\textsc{gbs}_t \equiv \Delta \log \sum_c \textsc{b2b}_t^c, \tag{2}$$

where $\textsc{b2b}_t^c$ is cross-border interbank ('bank-to-bank') lending to domestic banks in country c from the BIS data shown in Figure 1. We use $\textsc{gbs}_t$ as our main shock variable in the empirical specifications throughout the paper. We compute time series of average growth rates of gross value added (GVA) for the most and least domestic-bank-dependent sectors across the countries in our sample—those with particularly high or low SME shares and, in Figure 5, plot $\textsc{gbs}_t$ along with these growth rates. The figure shows how the great financial crisis was associated with a sudden stop of cross-border interbank lending to eurozone countries. Not surprisingly, output contracted in all sectors, but the figure also shows that high-SME sectors contracted significantly more.

In the remainder of the paper, we examine in more detail the patterns outlined in this section. In particular, we estimate how cross-country variation in domestic bank dependence interacted with cross-country and cross-sectoral variation in SME shares in the international transmission of the common shock presented by the financial crisis.

3 Related literature

Our analysis draws on several strands of the literature. The first strand concerns the role of banking integration in the transmission of macroeconomic shocks. Here, we also connect to the literature on the global financial cycle, which examines how changes in global financial conditions lead to heterogeneous, but highly synchronized, real outcomes across countries. The second strand encompasses empirical work that emphasizes the financing constraints faced by SMEs during the European financial and sovereign debt crisis.

Regarding the empirical literature on the international transmission of banking sector shocks, we build on Peek and Rosengren (1997, 2000), who show how the burst of Japan's property bubble in the 1990s was reflected in contraction of ending by Japanese banks in the United States. Our paper is also related to work by Cetorelli and Goldberg (2012*a*,*b*) in its emphasis on the role of global banks' internal capital markets in international transmission and to Kalemli-Ozcan, Papaioannou and Peydro (2013), who show that the impact of banking integration on business cycle synchronization differs between crisis and tranquil periods. By illustrating how the international financing structure of an economy affects the transmission of global financial shocks, we also make contact with the literature on the global financial cycle (Rey (2015); Bruno and Shin (2015*a*)).

Recent papers that have recognized the role of the particular financing constraints faced by SMEs during the eurozone crisis include Ferrando and Mulier (2015), Ferrando, Popov and Udell (2019) and Bremus and Neugebauer (2018). Ferrando and Mulier (2015) match SMEs' survey responses to balance sheet information to check whether reported financial constraints line up with balance sheet facts. Ferrando, Popov and Udell (2019) use firm-level data to document that SME-financing constraints are exacerbated in countries which were under macroeconomic and sovereign risk 'stress' during the financial crisis. Using firm survey data, Bremus and Neugebauer (2018) show that the reduction in cross-border credit affected financing conditions for small firms. More generally, Chang, Gomez and Hong (2021) show using U.S. data that weaker banks contracted lending to riskier firms dramatically during the great recession and provide a structural model that explains this. Our model captures the gist of this mechanism in reduced form by assuming that, because of informational frictions, SMEs can only borrow from local banks.

Different from the studies discussed so far, our analysis of international transmission focuses on the interaction of SME prevalence and the nature of banking integration in the eurozone, with its focus on bank-to-bank integration as a key factor in the transmission of the crisis across countries, regions, and sectors.[6] A starting point for our analysis is the observation by Hale and Obstfeld (2016), that the inception of the euro changed the geography of international banking flows. Global European banks head-quartered in the northern

[6]We do not evaluate the benefits from integrated cross-border lending to banks relative to the more fragmented markets that existed before the introduction of the euro. See the survey of Sørensen and Villegas-Sanchez (2015) for the benefits of financial integration in the absence of market imperfections.

core countries started to intermediate funds from the global (dollar) interbank market to the European periphery. We focus on the fact that this lending boom mainly took the form of bank-to-bank lending while direct (bank-to-nonbank) lending from northern European core countries to the periphery increased much less.

Our emphasis on the differential impact of international and domestic bank lending on sector-level growth during the eurozone crisis closely connects our work to that of Schnabel and Seckinger (2019). While they focus on external finance dependence, we draw attention to the particular dependence of small firms on the local provision of credit and the interbank funding dependence of domestic banks as a key friction.

Our paper also relates closely to Schnabl (2012) and Baskaya et al. (2017), who document the role of wholesale funding dependence for the transmission of capital inflow shocks in Peruvian and Turkish data, respectively, and to work at the International Monetary Fund (2015), which emphasizes the different impacts that cross-border and direct local lending by foreign banks have on financial stability. We also connect to a paper by Martinez (2015), who documents the role of cross-border bank-to-bank lending in fueling boom and bust cycles. We add to these papers by focusing on how the mode of cross-border lending can explain sectoral real outcomes during the crisis in the eurozone and by offering a DSGE model that can quantitatively account for these empirical patterns.

Our DSGE model builds on Kalemli-Ozcan, Papaioannou and Perri (2013) and extends it along several dimensions. First, building on the setup in Uribe and Yue (2006), we introduce an interbank market to allow for a distinction between cross-border lending to domestic banks and the real sector. Second, we introduce a a sector populated by SMEs that is dependent on domestic banks, but allow large firms to borrow directly from global banks. Domestic banks, in turn, fund themselves from global banks in the interbank market and from domestic deposits. We use this model to replicate the stylized facts documented in the empirical analysis and to quantitatively evaluate plausible alternative interpretations of our empirical findings.

Our model also relates to Kollmann, Enders and Müller (2011), Kollmann (2013), Bruno and Shin (2015*b*) and Kerl and Niepmann (2015). Kollmann, Enders and Müller (2011) and Kollmann (2013) examine the role of global banks in global business cycle transmission. Our framework differs from theirs by allowing for different modalities of international bank lending—direct lending to firms by global banks vs. interbank lending—and by allowing for two sectors which differ in their financing needs. Bruno and Shin (2015*b*) formulate a model of 'double-decker' banking integration by allowing global banks to interact with local banks, while Kerl and Niepmann (2015) explain the choice between direct and interbank cross-border lending as a function of barriers to entry into foreign banking markets. In our model, entry barriers take the form of frictions which give local banks an advantage in lending to SMEs and, because we embed direct and interbank cross-border bank lending into a fully dynamic model, we can study how the modality of cross-border bank lending affects the dynamics and transmission of macroeconomic shocks.

The idea that small firms rely on relationship lending and therefore require local access to credit is well-established in the banking literature. Starting with Berger and Udell (1995) a large literature shows that small firms are more likely to borrow from small, local banks which have a comparative advantage in relationship lending. Degryse and Ongena (2005) emphasize the role of distance for the intensity of banking relationships and for the intensity of banking competition. Mian (2006) provides empirical evidence on the role of foreign vs domestic banks in lending to small firms in the context of a developing economy. While long-standing banking relationships may help a firm to obtain credit more easily when facing adverse firm-specific shocks (Petersen and Rajan (1994)), relationship lending also creates a hold-up problem if a negative shock affects the lender. In this situation it may be difficult to turn to alternative sources of finance (Sharpe (1990)) and Giannetti and Ongena (2007) show that the presence of foreign banks improves small firms' access to credit. Our macroeconomic model captures these mechanisms in reduced form.

Starting with Khwaja and Mian (2008), the micro-banking literature has begun to explore the real effects of banking shocks in matched bank-firm-level data. In this paper, our interest is in understanding the macroeconomic relevance of the above mechanisms for the EMU as a whole. In particular, we are interested in how the structure of cross-border lending (interbank vs. direct lending to firms) affects the transmission of macroeconomic shocks. We are not aware of matched bank-firm level data sets that would allow us to study this nexus, i.e., that would be (a) representative at the level of individual countries (and in particular, would also cover small firms); (b) would allow us to distinguish between direct and indirect (via the impact of the interbank market on domestic banks) exposures of firms; and (c) at the same time would cover sufficiently many EMU countries.[7] We proceed in three steps. First, we use micro (bank-level) data from the countries in our sample to show that more interbank dependent domestic banks reduced lending more in response to the shock in interbank markets. Second, we exploit the granular structure of the bank-level data to construct an instrument and additional controls for our empirical analysis at the sector-country level, discussing identification assumptions and potential challenges in detail. Third, building on the approach in Kalemli-Ozcan, Papaioannou and Perri (2013), we use a DSGE model to target the empirical country-sector level specifications and as a laboratory in which we simulate the impact of confounding factors on our empirical results. This allows us to strike a balance between the high levels of internal validity achieved by the literature using bank-firm level data and the external validity of a more macroeconomic approach.

[7] To our knowledge, Hale, Kapan and Minoiu (2019) is the first paper to examine the role of cross-border interbank exposures for firm-level lending, but their evidence is based on syndicated loan data and thus on large firms.

4 Empirical framework

Econometric specifications As starting point for our empirical analysis, we posit the following reduced-form link between fluctuations in domestic real sector credit and output growth:

$$\Delta \log \text{GVA}_t^{c,s} = \gamma^{c,s} \times \text{CreditGrowth}_t^c + \eta_t^{c,s}, \tag{3}$$

where $\Delta \log \text{GVA}_t^{c,s}$ is the growth rate of gross valued added in country c, sector s, CreditGrowth_t^c is the growth of domestic credit to the real sector in country c, and $\eta_t^{c,s}$ is a productivity shock. This specification acknowledges that firms are heterogeneous in their ability to substitute fluctuations in the availability of bank credit for other forms of funding.[8] We can think of the coefficient $\gamma^{c,s}$ as capturing this ability, which is likely to vary by sector and/or country. For instance, if $\gamma^{c,s} = 0$, firms can fully offset variations in bank loan supply by turning to internal or non-bank finance (e.g., by issuing bonds). If $\gamma^{c,s} > 0$, fluctuations in bank finance cannot be fully offset and will have real effects. Based on our earlier discussion, we conjecture that country-sectors with higher SME shares will be more sensitive to variation in lending growth, so that

$$\gamma^{c,s} = \kappa + \gamma \times \text{SME}^{c,s}, \tag{4}$$

where $\text{SME}^{c,s}$ stands for the share of SMEs with less than 250 employees in value added in country c, sector s, in 2008, and where we expect $\gamma > 0$.

Our focus is on understanding how the collapse in cross-border interbank lending apparent from Figure 1 affected private sector credit and thus real outcomes across the eurozone. We interpret the eurozone crisis as a common shock to interbank funding that was common to all eurozone countries, but affected countries differentially according to their respective banks' dependence on wholesale borrowing and their respective dependence on domestic banks.

We model the link between domestic credit supply to the private sector and shocks to cross-border bank lending using granular bank-level data for all dometic banks in the eleven countries of our sample. Specifically, we conjecture that domestic banks that were particularly reliant on wholesale funding were also particularly exposed to the drop in cross-border interbank lending. To evaluate the strenght of this mechanism, we run bank-level regressions of the form

$$\text{LendingGrowth}_t^b = \alpha \times \underbrace{\text{IBD}_{t-1}^b \times \text{GBS}_t}_{=:G_t^b} + \mu^b + f_t^c + \text{CONTROLS}_t^b + \zeta_t^b, \tag{5}$$

[8]This is in the spirit of the literature on the firm-borrowing channel (e.g., Khwaja and Mian (2008)). However, unlike in most of that literature, for the reasons discussed in the previous section our focus here is on the country-sector rather than the bank-firm level.

where IBD^b_{t-1} is interbank dependence of bank b at time $t-1$ and GBS_t is the global banking sector shock.

The coefficient α captures the causal effect of funding conditions in the European interbank market on the bank's credit supply. We provide several justifications for this interpretation: first, GBS_t is an aggregate (global) variable that is clearly exogenous with respect to individual banks' credit supply because any common time-varying factors are absorbed into country-time fixed effects, f^c_t, which also absorb country-specific shocks to credit demand or credit supply. Second, the bank-level specification allows us to control for permanent unobserved heterogeneity of banks—via the inclusion of bank fixed effects μ^b—as well as for observed time-varying bank-level characteristics; in particular, deposit growth and bank size.

Having documented our mechanism at the bank level, we exploit the granular structure of our data to achieve identification in the estimation of our sector-country-level regression (3). Specifically, we construct the contribution of the global banking shock to aggregate domestic credit growth, $\mathcal{G}^c_t$, by aggregating the exposures of individual banks to the global banking shock, $G^b_t = \text{IBD}^b_{t-1} \times \text{GBS}_t$, across all domestic banks within the country:

$$\mathcal{G}^c_t = \sum_{b \in \mathcal{B}(c)} \omega^b_{t-1} \times G^b_t, \tag{6}$$

where $\mathcal{B}(c)$ is the set of banks domiciled in country c and ω^b_{t-1} is the share of total private sector credit in country c issued by bank b. Note that the global banking shocks affect $\mathcal{G}^c_t$ in a way that varies by country and time: first, via G^b_t, which is a function of the bank's dependence on wholesale funding (and thus its exposure to GBS_t) and, second, via the bank's time-varying share of the domestic credit market. Note also that our definition of ω^b_{t-1} as the bank's share in domestic credit implies that $\sum \omega^b_{t-1} = \text{DBD}_{t-1}$, so that $\mathcal{G}^c_t$ is a function of domestic bank dependence.[9]

We propose to use $\mathcal{G}^c_t$ as an instrumental variable for private-sector credit growth. Specifically, plugging in for $\gamma^{c,s}$ from (4), we obtain the following consolidated version of equation (3):

$$\Delta \log \text{GVA}^{c,s}_t = \gamma \times \text{SME}^{c,s} \times \text{CreditGrowth}^c_t + \text{CONTROLS}^{c,s}_t + \eta^{c,s}_t\,, \tag{7}$$

which we estimate using $\text{SME}^{c,s} \times \mathcal{G}^c_t$ as an instrument for $\text{SME}^{c,s} \times \text{CreditGrowth}^c_t$. Our vector of controls includes a saturated set of fixed effects (country-sector, sector-time, country-time), which allows us to absorb lower-order terms of CreditGrowth^c_t, so that these do not figure separately in regression (7).

[9] If all banks in the country had the same dependence $\overline{\text{IBD}}^c_{t-1}$ on wholesale funding, we would have $\mathcal{G}^c_t = \text{DBD}^c_{t-1} \times \overline{\text{IBD}}^c_{t-1} \times \text{GBS}_t$. Our construction of the instrument as the granular sum of bank-level responses follows Hoffmann and Stewen (2020). For the role of granularity in banking markets more generally, see Amiti and Weinstein (2018); Bremus et al. (2018).

Identification The inclusion of a saturated set of fixed effects in the country-sector regression (7) allows us to control for any violation of the exclusion restriction that could arise from purely sector- or country-specific variables that could be correlated with the instrument ('confounders'). For example, variations in private-sector credit demand or in credit supply (e.g., due to a bank-run) that affect all sectors in a country equally would be absorbed by the country-time effects, while sector-time effects would absorb variation in credit demand and supply in particular sectors, irrespective of the country.

One remaining challenge to identification is that we may have neglected some source of country-sector-time variation that is correlated with the instrument. Our data does not allow us to deal with this in the most general way, because we cannot include country-sector-time effects, but we can address the possibility that there are unobserved common factors that affect sectors differently. If such factors are correlated with GBS_t, then our coefficient of interest would be biased in case these factors differ in their impact on sectoral output in a way that is correlated with $\text{SME}^{c,s}$.[10] For example, this could happen if the general decline in the demand for loans during the global financial crisis was particularly strong in SME-intensive sectors.

Our granular bank-level analysis above allows us to control for such confounders because it provides us with estimates $\widehat{f_t^c}$ of country-time effects that absorb any country-specific influences on bank lending. By including the interaction $\text{SME}^{c,s} \times \widehat{f_t^c}$ in our country-sector panel regressions, we can therefore control for the potential correlation of $\text{SME}^{c,s} \times \text{GBS}_t$ with unobserved country-specific factors that load differently on different country-sectors in a way that is cross-sectionally correlated with $\text{SME}^{c,s}$.[11]

Data To implement the bank-level regression (5), we compile annual bank-level balance sheet data from Fitch Connect. In our empirical analysis, we distinguish between domestic and foreign banks, because affiliates or subsidiaries of foreign banks will be affected less as they may tap into the internal capital markets of their bank holding company.[12] To make this distinction between domestic and foreign banks operational, we use the ultimate parent ID in the Fitch Connect data base. For each country, a bank is classified as domestic if its ultimate parent resides in the country, and it is classified as foreign if the ultimate parent resides in another country in our sample. We drop those banks whose ultimate parent resides in a country outside our sample. We measure a bank's interbank dependence, IBD, as

[10] More formally, let $\mathcal{F}_t^{(c)}$ be such an unmodelled (and potentially country-specific) factor which loads on output in country-sector c, s with loading $\delta^{c,s}$. Then, whenever $\mathcal{F}_t^{(c)}$ is correlated with $\mathcal{G}_t^c$ such that $\text{cov}(\mathcal{F}_t^{(c)}, \mathcal{G}_t^c) \neq 0$, identification would require us to assume that the *cross-sectional* covariance $\text{cov}(\delta^{c,s},\ \text{SME}^{c,s})$ equals zero. See Hoffmann and Okubo (2017) for a detailed discussion.

[11] Our approach builds on Cingano, Manaresi and Sette (2016); Jimènez et al. (2020); Hoffmann and Stewen (2020). Cingano, Manaresi and Sette (2016)and Jimènez et al. (2020) suggest to include estimated firm-year effects from loan-level data to control for credit demand in firm-level regressions. Hoffmann and Stewen (2020) use county-time effects estimated from bank-county-level data to control for local credit demand in county-level regressions.

[12] Schnabl (2012) provides evidence on this using Peruvian data.

the share of short-term wholesale funding in the bank's total funding.[13] Ivashina, Scharfstein and Stein (2015), Baskaya et al. (2017) and Bremus and Neugebauer (2018) measure bank-level exposures to international bank-funding shocks in a similar way.

To estimate the country-sector level regression (7), we compute output growth using annual data from each of the countries in our sample on gross value added at the sectoral level from Eurostat, while country-level credit growth refers to a sum of outstanding loans on the liability side of the balance sheets of the private non-bank sector (corporate sector and housholds).[14] For all output measures, we obtain real per capita values by deflating with the respective sectoral deflators and using population data from the same source.

SME importance is from the 2018 issue of the annual database accompanying the European Commissions' SME performance review. Specifically, we construct our measure $\text{SME}^{c,s}$ as the share in value added at factor costs (million euros at current prices) at the country-sector level of firms with fewer than 250 employees. Data on the value added of small businesses is not generally available before 2008 and we therefore use the 2008 values to construct $\text{SME}^{c,s}$.

Domestic banking dependence, DBD, is constructed using data from the Private Sector Credit Database (PSCD) compiled by the BIS, where the private sector comprises private non-financial corporations, households, and non-profit institutions serving households.

The sample period covered by all the data in our analysis is 1999–2013 and covers eleven EMU countries—Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain—as well as eleven 1-digit NACE rev. 2 sectors: Manufacturing (C); Electricity, Gas, Steam and Air Conditioning Supply (D); Water Supply; Sewerage, Waste Management and Remediation Activities (E); Construction (F); Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles (G); Transportation and Storage (H); Accommodation and Food Service Activities (I); Information and Communication (J); Real Estate Activities (L); Professional, Scientific and Technical Activities (M); and Administrative and Support Service Activities (N).

5 Main empirical results

Bank-level regressions Table 1 presents estimates of the bank-level regression (5) on the sample of domestic banks. The results show that the global banking shock disproportionately affects banks that are relatively more dependent on wholesale funding as the coefficient

[13] Bank level lending growth is constructed using the Fitch Connect variable FC_NET_LOANS_BNK. Short-term wholesale funding is defined as a difference between Fitch Connect variables FC_TOTAL_DEPOSITS_MM_ST_FUNDING_BNK (Customer Deposits and Short-Term Funding) and FC_TOTAL_CUSTOMER_DEPOSITS_BNK (Total Customer Deposits). Total funding refers to the Fitch Connect variable FC_TOTAL_FUNDING_BNK.

[14] Sectoral gross value added is obtained from Eurostat's *Gross value added and income A*64 industry breakdowns* file (nama_10_a64), while outstanding loans are obtained from Eurostat's *Financial balance sheets* file (nasa_10_f_bs).

α on the interaction term $\text{IBD}_{t-1}^{b} \times \text{GBS}_t$ is positive and significant in all our specifications. In column (1), we display results when no controls are included besides bank and country-time fixed effects and the stand-alone term IBD_{t-1}^{b}. We add bank-level controls in columns (2)-(4); the logarithm of lagged assets as a measure of bank size in column (2), the growth of customer deposits in column (3), and both controls together in column (4). Neither set of controls affects the magnitude of our coefficient of interest nor its significance. All our specifications include bank and country-time effects, so that we can rule out that our results are driven by country-specific factors that might, for example, have affected the credit demand differently in different countries.

Our measure of interbank dependence IBD_{t-1}^{b} is the share of short-term wholesale funding of a bank. Our conjectured mechanism would imply that interbank dependent banks would see a particularly large decline in their short-term funding during the crisis, which is exactly what we observe in the data. In Table A.1 in the appendix we re-run regression (5) for domestic banks, but with short-term funding as the dependent variable. In line with our conjecture, the coefficient on the interaction $\text{IBD}_{t-1}^{b} \times \text{GBS}_t$ is positively significant in all specifications.

During the eurozone crisis, cross-border interbank lending decreased by 18 percent, so that $\text{GBS} = 0.18$. Our estimate of α of around 0.5 in Table 1 implies that the sensitivity of a bank's lending to changes in IBD was $\alpha \times \text{GBS} = 0.5 \times 0.18 = 0.09$. The interbank dependence of the average bank in our sample is 0.2, which happens to be virtually identical to the standard deviation of IBD across banks. Hence, the average bank would have seen a decline in lending of 1.8 percent due to the collapse in interbank markets. Increasing the interbank dependence of the average bank by one standard deviation would have decreased its lending by another 1.8 percent, which suggests that there was considerable heterogeneity in the responses to the global banking shock.

To appreciate the economic significance of our estimates of α, we compare their magnitude to earlier estimates in the literature. Baskaya et al. (2017) study the impact of international capital inflows on bank lending in Turkish loan-level data. They measure bank-level exposures as the share of non-core liabilities in bank total assets, which is similar to what we do. We can therefore compare the sensitivities of lending to variation in bank exposures, i.e., the product $\alpha \times \text{GBS}$, to their estimates, although we are not able to compare the impact on aggregate lending, because we do not have access to the distribution of bank exposures in their data set. The specification that conceptually is closest to ours is given in Table 7 of Baskaya et al. (2017) and focuses on the role of 'other' capital inflows (which includes interbank flows) relative to GDP. Their Figure 2 shows that, during the global financial crisis, this inflow measure decreased by 2 percentage points, which together with their point estimate of 4.6 implies a sensitivity to variation in bank-level exposures of 0.09, virtually identical to our estimate.[15]

[15]The specific value of this sensitivity will depend on the size of the capital inflow shock and may be different

The results in Table 1 and Table A.1 capture an essential cog in our argument by showing that the collapse in cross-border interbank lending during the eurozone crisis disproportionately affected domestic banks that were dependent on wholesale funding. As we have argued above, we would expect the impact of this collapse in interbank lending to be less pronounced for foreign banks. We provide evidence to this effect in Tables A.2 and A.3 in the appendix, where we re-run the analysis in Tables 1 and A.1, but now using the sample of foreign instead of domestic banks. The coefficient of interest is generally much smaller in absolute value than in the corresponding coefficient for domestic banks in Tables 1 and A.1 and never significant. This finding lends further support to our conjectured mechanism, namely that domestic banks were particularly exposed to the freeze in cross-border interbank lending during the eurozone crisis and that those that were more dependent on interbank funding had to reduce their lending more.

Country-sector level results Tables 2 and 3 explore the aggregate implications of the interbank shock on sectoral output growth in the eleven EMU countries in our sample.

The two top panels of Table 2 present our country-sector level regression (7) using $\mathcal{G}_t^c$ as instrument for country-level lending growth, with the second stage of the IV estimation shown in the upper one and the first stage below.[16]

In column (1), we present results of our baseline specification which is already fully-saturated because it includes country-sector, country-time and sector-time effects. Our coefficient of interest on the interaction term $\text{SME}^{c,s} \times \widehat{\text{CreditGrowth}_t^c}$ is positive and significant, in line with our conjectured mechanism. The first-stage F-statistics far exceeds the conventional critical value of 10 (Stock and Yogo (2005)), suggesting that the instrument is relevant. In column (2), we report a specification, in which we also include the interaction of the estimated country-time effects $\widehat{f_t^c}$ with the sectoral SME share, $\text{SME}^{c,s}$. The estimate of our coefficient of interest and the relevance of the instrument in the first stage both remain unchanged. In column (3), we further tighten our specification by allowing the loading on $\widehat{f_t^c}$ to vary by sector. This allows for the possibility that the confounding factors affected certain sectors (e.g., construction and real estate) particularly strongly in all countries, irrespective of the SME share that this sector may have in a particular country. Again, our results are not affected by this. The estimate of α is quite stable at around 0.55. The cross-sectional standard deviation of $\text{SME}^{c,s}$ is 0.22, while the mean is 0.64. This implies that, after a one percent decline in lending, a sector with a one standard deviation higher SME share will have output growth that is $0.55 \times 0.22 = 0.12$ percent lower than that of the average sector.

The lower panel of Table 2 presents estimates of equation (7) in reduced form; i.e., we

for different crises, even for the same sample of banks. But our considerations here show that the orders of magnitude are very similar.

[16] More specifically, we instrument $\text{SME}^{c,s} \times \text{CreditGrowth}_t^c$ with $\text{SME}^{c,s} \times \mathcal{G}_t^c$.

directly substitute CreditGrowth_t^c with $\mathcal{G}_t^c$ and estimate

$$\Delta \log \text{GVA}_t^{c,s} = \gamma \times \text{SME}^{c,s} \times \mathcal{G}_t^c + \text{CONTROLS}_t^{c,s} + \eta_t^{c,s} \,. \tag{8}$$

Our findings remain robust and confirm the general conclusion that the collapse in interbank funding affected high-SME sectors (that are more dependent on domestic banks) more strongly.

To provide a simpler quantitative interpretation of our results, we consider an alternative specification where we classify a country-sector as generally domestic-bank dependent ('high SME') or not ('low SME'). Table 3 presents IV and reduced form estimates, where the variable $\text{HiSME}^{c,s}$ is coded as a dummy variable that is unity whenever the SME share of a country-sector is above the European median and zero otherwise. Our results remain qualitatively unchanged relative to Table 2. Also, the first stage in the middle and the reduced-form estimates in the lower panels confirm the relevance of our instrument. The coefficient of interest is significant, positive, and stable across all three specifications, and the first-stages remain strong. The estimate of 0.34 in the IV-specifications implies that a one percent decline in lending reduces output growth in high-SME sectors by 0.34 percentage points more than in low-SME sectors. We target these IV estimates in our quantitative-theoretical model below.

Graphical evidence Figure 6 graphically illustrates the role of sectoral variation in SME shares for the transmission of the global banking shock. Here, we plot the 2008 sectoral SME share in sectoral value added against estimates of the country-sector specific coefficients $\gamma^{c,s}$ obtained from the regression

$$\Delta \log \text{GVA}_t^{c,s} = \gamma^{c,s} \times \mathbf{1}^{c,s} \times \mathcal{G}_t^c + \text{fixed effects} + \eta_t^{c,s}, \tag{9}$$

where $\mathbf{1}^{c,s}$ is an indicator variable for country-sector c, s.[17] Consistent with our key conjecture, the cross-sectional link between $\gamma^{c,s}$ and $\text{SME}^{c,s}$ is positive and significant; i.e., sectors with higher SME shares are more exposed to the global banking shock.

Dynamic responses We study the dynamic response of real activity to the global banking sector shock by estimating local linear projections (LLP), which capture the dynamics of the dependent variable over longer time-horizons.[18] We split the sample in two groups: country-sectors with above-median shares of SMEs and country-sectors with low SME shares. For each group, we then estimate LLPs of the form:

[17] The panel specification (9) is virtually equivalent to running a separate time-series regression for each country-sector, with the difference that (9) also allows us to control for country-time and sector-time fixed effects.

[18] LLPs, proposed by Jordà (2005), are conceptually similar to impulse responses, but do not require the underlying data generating process to be linear.

$$\log \text{GVA}^{c,s}_{t+h} - \log \text{GVA}^{c,s}_{t-1} = \alpha_h \times \text{CreditGrowth}^c_t + \tau^s_t + \mu^{c,s} + \varepsilon^{c,s}_{t+h}, \tag{10}$$

at horizons of $h = 0, 1, ..., 4$ years using $\mathcal{G}^c_t$ as an instrument. This estimation equation for $h = 0$ is similar to equation (7) except we do not interact with SME shares but rather run the regression on each of the two groups separately.

Figure 7 plots the coefficients α_h up to a horizon of 4 years, for cumulative GVA growth, separately for high (red lines) and low (blue lines) SME country-sectors. Shaded areas indicate corresponding 90% confidence bands, constructed with standard errors clustered by country and time. For the high-SME sectors, the instrument impact of lending growth is statistically significant and persistent for 2–3 years. For low-SME sectors, there is no significant effect.

6 A theoretical model

To interpret our empirical findings, we propose a tractable model of a small open economy with two sectors—SMEs and large firms—as well as a final goods producer. The model features a domestic ('local') bank which lends to small firms and a (foreign) global bank, which lends cross-border to large firms and domestic banks. We show that this simple model is able to capture important features of our data and in this section we provide the setup of the model as well as details of the calibration. The full set of model equations is given in Appendix B, and we provide a synopsis of the model structure in Figure 8.

Firms Firms in sectors $s = \{\text{BF}, \text{SME}\}$ (BF refers to large ('big') firms and SME to SMEs) produce output according to the production function:

$$Y^s_t = \theta^s_t (K^s_{t-1})^{\alpha} (N^s_t)^{1-\alpha}, \tag{11}$$

where Y^s_t ,θ^s_t, K^s_{t-1}, N^s_t denote output, total factor productivity, capital (at the end of the previous period), and labor in sector s, while α denotes capital intensity.

Firms operate in perfectly competitive environments and maximize the present discounted value of dividends (DIV^s_t) for their owners. Both large and small firms are owned by domestic households, so that firms discount future dividends using the household's discount factor. With these assumptions, firms' maximization problem becomes

$$\max_{\{N^s_t,\, K^s_t,\, L^s_t\}^{\infty}_{t=0}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \Lambda_{0:t} \text{DIV}^s_t \right], \tag{12}$$

where $\Lambda_{0:t}$ is the household stochastic discount factor at horizon t. Firms do not accumulate savings, so dividends are given by

$$\text{DIV}^s_t = P^s_t Y^s_t - W_t N^s_t - P_t \left(I^s_t + \varphi^{I,s}_t \right) + L^s_t - R^s_{t-1} L^s_{t-1} , \tag{13}$$

where P_t^s denotes the price of output and I_t^s denotes investment in sector s. P_t is the price index of the final good introduced below, while W_t is the wage rate which is equal across sectors because labor is perfectly mobile within the country. Furthermore, L_t^s denotes total sector s bank borrowing at (gross) interest rate R_t^s. The law of motion for capital is given by $K_t^s = (1-\delta)K_{t-1}^s + I_t^s$, and both capital and investment are produced out of the final good subject to a sector-specific adjustment cost in investment, $\varphi_t^{I,s}$.

The key financial friction in the model is that firms need to borrow in order to finance their wage bill. This setup builds on Neumeyer and Perri (2005) and Uribe and Yue (2006), who rationalize this assumption by the timing structure of wage contracts and firm production. Specifically, we assume that firms borrow the amount $L_t^s = W_t N_t^s$ after shocks for the current period are realized but before production takes place. Firms repay loans from the last period (plus interest) out of their cash flow after output has been sold.[19]

Final goods producer The goods produced by SMEs and large firms are used as intermediate inputs for a final good used for consumption, investment, and net exports. The final good is internationally tradeable at price P_t which is determined in international markets and which we normalize to $P_t = 1$. This good is produced in perfectly competitive markets according to the following technology:

$$Y_t = \left(\omega^{\frac{1}{\epsilon}} {Y_t^{\text{BF}}}^{\frac{\epsilon-1}{\epsilon}} + (1-\omega)^{\frac{1}{\epsilon}} {Y_t^{\text{SME}}}^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}}, \tag{14}$$

where ω is the share of large firm goods in the final good production—the relative size of the large firms sector in GDP—and ϵ is the intratemporal elasticity of substitution between the SME and large firm goods.

The final goods producer maximizes the value of its output by minimizing the cost of the inputs, which yields the following demand functions:

$$Y_t^{\text{BF}} = \omega \left(\frac{P_t^{\text{BF}}}{P_t} \right)^{-\epsilon} Y_t \quad \text{and} \quad Y_t^{\text{SME}} = (1-\omega) \left(\frac{P_t^{\text{SME}}}{P_t} \right)^{-\epsilon} Y_t\,. \tag{15}$$

Households Households consume C_t of the final good, supply labor N_t to firms, and receive dividends and profits from the firms and banks they own. They maximize the lifetime utility

$$\max_{\{C_t,\, N_t,\, D_t\}_{t=0}^{\infty}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{{C_t}^{1-\sigma} - 1}{1-\sigma} - \Psi \frac{N_t^{1+\psi}}{1+\psi} \right) \right], \tag{16}$$

where β is the discount factor, σ is the coefficient of risk aversion, ψ is the inverse Frisch elasticity, and Ψ is the weight of labor disutility.

[19] An alternative rationalization is that of Mendoza and Yue (2012), who assume intra-period loans to pay for a fraction of intermediate inputs, suggesting the rationale that some inputs can be financed via trade-credit, which is collateralized by the goods themselves. In our model, workers cannot be used for collateral and need to be paid before production is realized.

Each period, households receive wage income $W_t N_t$, dividends from firms, profits Π_t from the domestic banks, and hold deposits D_t that earn (gross) interest R^d_t. Households' flow budget constraint is thus given by

$$P_t C_t + D_t = W_t N_t + R^d_{t-1} D_{t-1} + \text{DIV}^{\text{BF}}_t + \text{DIV}^{\text{SME}}_t + \Pi_t. \tag{17}$$

The banking sector The banking sector features a domestic ('local') and a global bank. The domestic bank lends to small firms and finances itself by raising deposits from domestic households and by borrowing from the global bank. The global bank borrows funds in the global wholesale market and lends cross-border to large firms and to the domestic bank. This setup captures the double-decker nature of banking integration in the eurozone documented by Bruno and Shin (2015*b*) and Hale and Obstfeld (2016).

The domestic bank is more efficient in intermediating funds to small firms while the global bank is more efficient in lending to large firms. We formalize this idea by assuming that the global bank fully concentrates its cross-border real-sector lending on large firms while the local bank concentrates on small firms. Cross-border lending is subject to convex intermediation costs. These assumptions are consistent with empirical research showing that distance is a major determinant of the strength of a banking relationship (Petersen and Rajan (1994) and Degryse and Ongena (2005)), and that local banks have a comparative advantage in screening small, relatively opaque borrowers (Berger and Udell (1995)).

To pin down the global bank's choice of direct and interbank cross-border lending, we follow Buch, Koch and Koetter (2011) and Kerl and Niepmann (2015) and assume that intermediation costs for direct cross-border lending are higher than for interbank lending.[20] This effectively implies a pecking order of the mode of international bank lending in which the global bank trades off direct lending to firms at high screening costs (and high margins) against low-margin interbank lending and makes the latter more elastic than the former.

Local bank With the assumptions from the previous paragraph, the balance sheet of the local bank is given by

$$L^{\text{SME}}_t = M_t + D_t\,, \tag{18}$$

where M_t is cross-border interbank borrowing, D_t is domestic deposits, and L^{SME}_t is local bank lending to small firms. Local banks maximize profits (accruing in period $t+1$, after loans made in period t have been repaid)

$$\max_{L^{\text{SME}}_t,\, M_t,\, D_t} \quad \Pi_{t+1}\,, \tag{19}$$

[20]We are agnostic about the exact nature of these costs. For example, loans to the foreign non-bank sector have higher regulatory risk weights than interbank loans. So a given amount of lending to foreign firms would tie up more regulatory capital than the same amount of interbank lending.

where profits are given by

$$\Pi_{t+1} = R_t^{\text{SME}} \times (1-\iota)\, L_t^{\text{SME}} - R_t^m \times M_t - \left(R_t^d + \zeta_t^{lbs}\right) \times D_t - \varphi^d\left(D_t\right), \tag{20}$$

and where R_t^{SME} , R_t^m, and R_t^d are the (gross) interest rates on small firm lending, interbank borrowing, and deposits, respectively, ι is a fixed intermediation margin for lending to the real sector, ζ_t^{lbs} is a mean-zero local bank deposit liquidity shock, and $\varphi^d\left(D_t\right)$ is a convex cost of raising deposits.[21]The optimality conditions of the local bank are given by

$$R_t^{\text{SME}} = \frac{R_t^m}{1-\iota} \text{ and } R_t^d + \zeta_t^{lbs} + \varphi^{d\prime}\left(D_t\right) = R_t^m\,. \tag{21}$$

Global bank We build on Schmitt-Grohé and Uribe (2003) and Uribe and Yue (2006) and assume international borrowing takes place through a global bank that captures wholesale funds in the global money market and lends cross-border to large domestic firms and to domestic banks in the interbank market.[22] The global bank's balance sheet is

$$L_t^{\text{BF}} + M_t = F_t, \tag{22}$$

where L_t^{BF} is cross-border lending to large firms, M_t is interbank lending, and F_t is wholesale funding. The global bank maximizes profits (accruing in period $t+1$, after loans made in period t have been repaid)

$$\max_{L_t^{\text{BF}},\, M_t,\, F_t} \quad \Pi_{t+1}^{\text{GB}}\,, \tag{23}$$

where profits are given by

$$\Pi_{t+1}^{\text{GB}} = R_t^{\text{BF}} \times \left((1-\iota)\, L_t^{\text{BF}} - \varphi(L_t^{\text{BF}})\right) + R_t^m \times \left(M_t - \kappa\varphi\left(M_t\right)\right) - R_t^w \times F_t\,, \tag{24}$$

and where R_t^{BF} is the (gross) interest rate on large firm lending, R_t^w is an exogenous world interest rate which we could think of, for example, as the federal funds rate, $\varphi\left(.\right)$ is a convex function increasing in the amount of category cross-border lending, and the constant $0 < \kappa < 1$ captures relatively lower intermediation costs of interbank lending. To model stress in global wholesale funding markets, we assume that there is an exogenous limit on the global bank's balance sheet, which imposes a shadow cost on the global bank that it passes on to domestic banks and large firms. With these assumptions, we can write the first-order conditions of the global bank as

$$R_t^{\text{BF}} = \frac{R_t^w + \lambda_t}{1-\iota-\varphi'\left(L_t^{\text{BF}}\right)} \text{ and } R_t^m = \frac{R_t^w + \lambda_t}{1-\kappa\varphi'\left(M_t\right)}\,, \tag{25}$$

[21]One possible interpretation of ι is as a loan default rate, as in Kollmann, Enders and Müller (2011). In our model, $\iota > 0$ induces a constant positive spread between lending rates and banks refinancing rates that also prevails in the steady state and that makes firms' borrowing constraints bind.

[22]Importantly, the global bank resides outside the small open economy being modeled, and we assume it is owned and funded by residents of the rest of the world. Its profits therefore do not feature in the budget constraints of domestic residents.

where λ_t is the spread that reflects the shadow price of balance sheet capacity for the global bank. We assume λ_t is exogenous to the domestic economy and interpret it as capturing the effect of the global banking shock on the small open economy.

Market clearing The market for the final good clears according to:

$$Y_t = C + I_t + \frac{\Gamma_t + NX_t}{P_t}, \tag{26}$$

where Γ_t is total domestic net costs (which can be thought of as part of gross investment), $\Gamma_t = \iota \times L_{t-1}^{\text{SME}} + \zeta_{t-1}^{lbs} \times D_{t-1} + \varphi^d \left(D_{t-1}\right) + P_t \varphi_t^I$, and where net exports are given by

$$NX_t = R_{t-1}^m M_{t-1} - M_t + R_{t-1}^{\text{BF}} L_{t-1}^{\text{BF}} - L_t^{\text{BF}}. \tag{27}$$

Market clearing conditions for the factor markets are given by $K_t = K_t^{\text{BF}} + K_t^{\text{SME}}$, $I_t = I_t^{\text{BF}} + I_t^{\text{SME}}$ and $N_t = N_t^{\text{BF}} + N_t^{\text{SME}}$.

Forcing variables There are three sources of shocks in the model: shocks to total factor productivity θ_{ct}^s for SMEs and large firms, shocks to the global bank λ_t, and shocks to local banks ζ_{ct}^{lbs}.

The TFP processes for any country c (one for each sector s) are given by

$$\log \theta_{cst} = \rho^\theta \log \theta_{cst-1} - \sigma^\theta \eta_{cst}. \tag{28}$$

The stochastic process for the global banking shock has the same realization for every country c and is given by

$$\lambda_t = \left(1 - \rho^{gbs}\right) \lambda + \rho^{gbs} \lambda_{t-1} + \sigma^{gbs} \eta_t^{gbs}. \tag{29}$$

The local bank shocks for any country c are given by

$$\zeta_{ct}^{lbs} = \rho^{lbs} \zeta_{ct-1}^{lbs} + \sigma^{lbs} \eta_{ct}^{lbs}. \tag{30}$$

In the setup above, the innovations η_{cst}, η_t^{gbs}, ζ_{ct}^{lbs} to idiosyncratic country sectoral TFP, global banking, and idiosyncratic local banking shocks, respectively, are independent draws from a standard normal distribution. In the baseline specification, TFP and deposit shocks are uncorrelated across countries.

A simplified version of the model for interpretation Consider a simplified version of the model, where consumers make no decisions, but accept a fixed exogenous wage rate and deposit a fixed amount in the local bank. Firms only use labor as input and pre-finance wage payments through loans at the beginning of the period and repay principal plus interest at the end of the period as in Neumeyer and Perri (2005).

With these assumptions, we can write the profit function of the firm in sector s as

$$\theta\left(\frac{L^s}{W}\right)^{1-\alpha} - R^s L^s \,, \tag{31}$$

for $s = \{\text{SME}, \text{BF}\}$, which implies a sector-level loan demand function of the form

$$L^s = K\left(R^s\right)^{-\frac{1}{\alpha}} \,, \tag{32}$$

where K is a constant. At the end of the period, after firms have repaid their loans and produced, consumers receive income, withdraw deposits, and consume.

We assume that the global banks' marginal intermediation costs for each category of cross-border lending are linear in percentage deviations from initial values (here indicated by bars) so that $\varphi'(X) = \overline{\varphi} \times \left(\frac{X-\overline{X}}{\overline{X}}\right)$ for $X = \{L, M\}$, where $\overline{\varphi}$ is some positive constant, and we normalize the intermediation margin to the real sector, ι, to zero. The global bank's supply functions for cross-border interbank and direct lending are determined by the first-order conditions

$$R^m = \frac{R^w + \lambda}{1 - \kappa\overline{\varphi} \times \left(\frac{M-\overline{M}}{\overline{M}}\right)} \quad \text{and} \quad R^{\text{BF}} = \frac{R^w + \lambda}{1 - \overline{\varphi} \times \left(\frac{L^{\text{BF}}-\overline{L^{\text{BF}}}}{\overline{L^{\text{BF}}}}\right)} \,. \tag{33}$$

Because deposits in the simplified model are fixed at $\overline{D}$, the growth in local bank lending is directly proportional to growth in interbank lending:

$$\frac{L^{\text{SME}} - \overline{L^{\text{SME}}}}{\overline{L^{\text{SME}}}} = \underbrace{\left[\frac{\overline{M}}{\overline{M} + \overline{D}}\right]}_{=\overline{\text{IBD}}} \times \frac{M - \overline{M}}{\overline{M}} \,, \tag{34}$$

where the elasticity here corresponds to the initial value of interbank dependence, $\overline{\text{IBD}}$. The local bank's marginal costs of funding is given by the interbank rate R^m, which must equal the lending rate, so that $R^{\text{SME}} = R^m$.

Figure 9 illustrates this stylized model graphically. Assume first that there are no deposits, so that all small firm lending is financed by interbank borrowing, $\overline{\text{IBD}} = 1$. Large and small firms have identical demand functions and, initially, both banks supply funds at the world interest rate R^w, where we normalize the initial value of the spread λ to zero. Both firms initially borrow $\overline{L^{\text{BF}}}$ and $\overline{L^{\text{SME}}} = \overline{M} + \overline{D}$ such that intermediation costs are zero for both banks. A spread shock λ shifts both banks' supply curves upwards. Because the local bank's supply of funds is fully exposed to the stress in interbank markets ($\overline{\text{IBD}} = 1$), lending supply to small firms 'inherits' the elasticity of the supply of interbank funds by the global banks, which by assumption ($0 < \kappa < 1$) is higher than that of direct bank lending. Thus, given identical demand curves of large and small firms, local bank lending to SMEs will fall more than cross-border lending to big firms.

To see how $\overline{\text{IBD}}$ scales the transmission of the shock, note from (34) that $\overline{\text{IBD}}$ is the elasticity of local bank lending to interbank funding. Lower levels of $\overline{\text{IBD}}$ therefore mitigate the impact of the spread shock λ on the the local bank's lending supply. This makes the local bank's lending supply curve steeper in Figure 9, dampening the impact of the shock on lending to small firms and thus on output.[23]

The results in the simplified model depend on the assumption that deposits are fixed; however, the basic intuition carries over to the full model as long as deposit supply is relatively inelastic compared to wholesale funding supply, an assumption that is backed up by the empirical literature (see, e.g., Chiu and Hill (2018)).

Mapping the model to the data

Definitions Aggregate real GDP in the model is given by Y_t. Total credit corresponds to the sum of loans to both sectors: $L_t^{\text{BF}} + L_t^{\text{SME}}$ and the growth rate of this variable corresponds to the variable CreditGrowth_t^c in our empirical specifications.

Domestic bank dependence is defined in the model as the ratio of locally originated loans to total credit in the economy:

$$\text{DBD}_t = \frac{L_t^{\text{SME}}}{L_t^{\text{SME}} + L_t^{\text{BF}}}. \tag{35}$$

Interbank dependence is defined in the model as the ratio of cross-border interbank borrowing to the total funding of the local banks:

$$\text{IBD}_t = \frac{M_t}{M_t + D_t}. \tag{36}$$

Letting letters without time subscript denote steady-state values of the respective variable, the steady-state values of domestic and interbank dependence are given by $\text{DBD} = \frac{L^{\text{SME}}}{L^{\text{SME}}+L^{\text{BF}}} \approx 1 - \omega$ and $\text{IBD} = \frac{M}{M+D}$, and we calibrate these values separately for each country.

The model counterpart to the global banking shock in our regressions, GBS_t, is constructed as follows. We simulate the model for all eleven countries in our sample to obtain artificial data on cross-border bank-to-bank lending, M_t^c, where c indexes a country, and we aggregate the country-specific interbank lending values to get the EMU-wide variable $M_t^{\text{EMU}} = \sum_{c=1}^{11} M_t^c$. The global banking shock is the growth rate of this variable:

$$\text{GBS}_t = \Delta \log M_t^{\text{EMU}} . \tag{37}$$

[23] It is straightforward to show that the elasticity of the local bank's supply curve is given by $\overline{\text{IBD}}/(\kappa\overline{\varphi})$, while that of the the global bank to large firms has elasticity $1/\overline{\varphi}$. Hence, our results regarding the relative impact of the shock on large and small firms would reverse if $\overline{\text{IBD}} < \kappa$. However, as long as interbank markets are sufficiently elastic, so that κ is sufficiently low, this case is unlikely to be empirically relevant. Even then it would still be true that higher levels of $\overline{\text{IBD}}$ increase the exposure of small firms to the shock.

Calibration The model is solved by log-linearizing around the deterministic steady-state, and we calibrate the baseline model at the quarterly frequency using parameter values displayed in Table 4. We additionally calibrate steady-state nominal GDP (GDP), domestic bank dependence (DBD), and interbank dependence (IBD) for the countries in our sample as shown in Table 5.

Most of the parameters are calibrated to standard values common in the literature. Households' discount factor β is set to 0.99, to match the steady-state quarterly net deposit rate of 1 percent, and households' coefficient of relative risk aversion σ is set to 1, such that its instantaneous utility function is logarithmic with respect to the consumption bundle. The inverse of the Frisch elasticity, ψ, in the utility function is set to 2 while the scale parameter, Ψ, is determined by the steady-state restrictions. The elasticity of intratemporal substitution between the SME and large-firm goods, ϵ, is set to 0.4, which is between the value of 0.44 reported in Stockman and Tesar (1995) and the range of values for the periphery European countries estimated in Siena (2021). The household preference parameter, ω, is then pinned down by the domestic bank dependence, DBD, in a given economy.

The production functions of large and small firms are Cobb-Douglas with the capital intensity parameter, α, equal to 0.35 for each firm, which corresponds to a long-term share of capital in production in advanced economies. We set the capital depreciation parameter, δ, to 0.025 and define the investment cost adjustment function as $\varphi_t^{I,s} = \frac{1}{2}\varphi^I K_{t-1}^s \left(\frac{I_t^s}{K_{t-1}^s} - \delta\right)^2$, with the parameter φ^I to 22, in order to match the volatility of investment growth rate in the model to that in the data.

The next step in our calibration is defining the functional forms and choosing values for adjustment cost parameters for global bank direct lending, interbank lending and local bank deposit adjustment cost. We assume the following functional forms for the adjustment costs: $\varphi_t^d\left(D_t\right) = \frac{1}{2}\varphi^d D \left(\frac{D_t - D}{D}\right)^2$ and $\varphi_t\left(L_t^{\text{BF}}\right) = \frac{1}{2}\bar{\varphi} L^{\text{BF}} \left(\frac{L_t^{\text{BF}} - L^{\text{BF}}}{L^{\text{BF}}}\right)^2$. We set $\varphi^d = \bar{\varphi} = 2$ and the scaling parameter of intermediation cost of interbank lending to $\kappa = 2.5\%$. Using these values, we match the relative volatilities of the growth rates of total firm loans, interbank loans, and deposits in the model to those in the data. The fixed loan intermediation cost parameter, ι, is set to 0.02, which is the average interest rate spread in the model, and we normalize the world interest rate R_t^w to 1 at all times.

All exogenous processes follow AR(1) processes with persistence parameters $\rho^\theta = \rho^{gbs} = \rho^{lbs} = 0.95$. We set the standard deviation of the global banking shock, σ^{gbs}, to 0.025 and that of the local deposit shocks, σ^{lbs}, to 0.04. We do so in order to match the volatility of the interbank lending, loan, and deposit growth rates. The standard deviation of the TFP shocks σ^θ is set to 0.0091 to match the standard deviation of the growth rates of real GDP.

As mentioned previously, we calibrate the steady-state nominal GDP and ratios DBD and IBD separately for each country using the real data values reported in Table 5.

Business cycle properties The business cycle properties of the calibrated model are given in Table 6. The first two columns present statistics for model simulations calibrated to 'Austria,' which is typical for the countries in our sample in terms of IBD and DBD, while the last two columns contain the respective data-counterparts, calculated as an average over the countries in the sample using data from Eurostat and BIS. We present the statistics for the following variables: GDP, consumption, investment, employment, deposits, total firm loans, interbank loans, and net exports-to-lagged-GDP ratio. All variables refer to the respective growth rates (log-differences) except for net exports, which are in proportion to last-year nominal GDP. For each variable in the table, we present the standard deviations relative to the standard deviation of GDP and the correlation with domestic GDP. The standard deviation of GDP, marked with an asterisk, is an absolute value. All model statistics are obtained from 1000 model simulations with sectoral TFP and the global banking shocks over 250 quarters (with the first 50 quarters dropped). Empirical moments are obtained from the pre-crisis sample 1997Q1–2007Q4.

7 Quantitative results

Impulse responses To shed more light on the economic mechanisms that drive our results, Figure 10 displays model impulse responses to the global banking shock. The first three rows present responses of aggregate variables, while the fourth and fifth rows present sector-level results for SMEs and large firms respectively: output, bank lending, and interest rates. Each panel provides impulse responses for three different calibrations of the model: the baseline calibration—which we take to be Austria, as described in the previous section—a low-interbank-dependence scenario in which IBD in steady state is set to 50 percent of the baseline level, and a scenario in which domestic bank dependence (effectively: the size of the SME sector) in steady state is set to 50 percent of the baseline level, while all other parametrizations are as in the baseline case.

The impulse responses in the first row of Figure 10 show that a global banking shock leads to a protracted reduction of GDP, wages, and employment. There is also a marked reduction in consumption (see the panel in the third row). Consistent with our central hypothesis, all these real effects are attenuated when local banks are less dependent on interbank funding and when domestic bank dependence is lower. The panels in the second row show that global banking shock leads to a reduction in aggregate global bank lending and, consistent with our basic mechanism, this reduction falls mainly on cross-border interbank lending, while direct lending to big firms (second panel in the fifth row) declines much less. The sudden stop in cross-border lending leads to an increase in net exports. Because cross-border interbank lending falls markedly, local banks try to make up for this funding shortfall by attracting additional deposits (see the third row of Figure 10). Note that lower interbank dependence mutes the response of deposits but leads to a larger (percentage) decline in cross-border interbank lending.[24]

Turning to the responses of sector-level variables (rows 4 and 5), we find that both sectors see marked declines in lending (by global banks to large firms and by local banks to SMEs) and an increase in the associated interest rates, but the drop in lending and the increase in interest rates is stronger for the SME sector. Output also declines more in the SME sector.[25]

Higher levels of interbank dependence attenuate the differences between sectors. Low IBD benefits SME output, but deteriorates the output response to the global banking shock for large firms. The explanation for this can be found from inspecting the responses of sectoral lending to the global banking shock. Consistent with Figure 9 above, lending to small firms reacts more to the global banking shock than lending to large firms, but while the elasticity of lending to large firms is unaffected, lending to small firms becomes less elastic with respect to the global banking shock as IBD declines. This means that the reduction of lending now effectively falls more equally on both sectors, attenuating the difference in real sectoral outcomes.

To understand the impact of lowering domestic bank dependence, recall that domestic bank dependence in our model corresponds to the size of the SME sector and reducing the size of this sector therefore attenuates the impact of a global banking shock on aggregate variables such as GDP and wages via compositional effects. By contrast, lower domestic bank dependence has virtually no effect on sector-level outcomes nor on how the shock affects local bank funding.

From the impulse responses of consumption, it seems that lowering interbank dependence is relatively more important in insuring the household against global banking shocks than lower domestic bank dependence. But we are cautious not to draw conclusions concerning welfare from the log-linearized solution to the stylized model.[26]

Figures A.1 and A.2 show the impulse responses to (negative) sectoral TFP shocks. Lowering domestic bank dependence mutes the response of aggregate output and wages to a TFP shock in the SME sector while it amplifies that of the large firm sector. This mainly reflects compositional effects because lowering domestic bank dependence is equivalent to decreasing the size of the SME sector in the model. Differently from what we saw for the global banking shock, variation in interbank dependence hardly affects the responses of sectoral

[24]This is a basis effect: in an otherwise identical economy, a given reduction of cross-border interbank lending will have a larger percentage impact on cross-border lending in the economy with lower interbank dependence.

[25]In the baseline scenario, large firm output falls over time but only after an initial increase. To understand this feature of the model, recall that the global banking sector shock drives down wages. To the extent that the reduction in wages is inititally larger than the reduction in credit supply to large firms, this allows the large firms to hire more labor and produce more output. Furthermore, the drop in SME output temporarily increases the relative price of the SME good, leading consumers (or the intermediate goods producer) to demand relatively more large firm output.

[26]Consumption in the steady state is virtually the same across the three scenarios. This suggests that IBD and DBD mainly affect the responses of consumption to shocks. See Hoffmann et al. (2019) for a detailed analysis of the impact of interbank lending on consumption risk sharing during the euro crisis.

and aggregate outputs or wages.

Figure A.3 shows the impulse responses to an exogenous increase in the deposit rate (i.e., a local banking shock). This shock makes deposit funding expensive for local banks, who try to substitute deposits for interbank credit. The global bank partly accommodates this increased demand but initially at the expense of large firm lending. On impact, lending to both sectors, employment, wages, and GDP fall, while higher deposit interest rates depress consumption. However, labor supply rises over time, leading to increased employment and hence higher sectoral output and net exports (which fall initially as a result of the sudden stop). Opposite to what we find for the global banking shock, lower interbank dependence worsens the responses of real aggregate and sectoral outcomes, because interbank dependence effectively shields the economy from local banking shocks (while increasing the exposure to global banking shocks). Similar to the transmission of the TFP shocks, changes in DBD mainly lead to compositional changes in the aggregate responses.

Matching the IV regressions We further evaluate the ability of the model to fit the data by asking whether it can replicate the sector-country level IV regressions presented in Table 3. Having verified this, we use the model to assess to what extent alternative configurations of shocks—other than the global banking sector shock—could explain our empirical findings.

We calibrate the model to our sample, for each country matching domestic bank dependence and interbank dependence as described in the subsection on calibration above. For each country, we simulate the data for 60 quarters by drawing a common (for all countries) realization of the global banking shock and by drawing separate realizations for each country of the local banking shock and the sectoral TFP shocks. From these model-generated data, we calculate annual growth rates of real output by sector and country, ($\Delta \log \text{GVA}_t^{c,s}$) and country-level bank lending (CreditGrowth_t^c), and we construct the counterpart of GBS by computing the growth rate of aggregate (across countries) model-simulated interbank lending. Our model does not feature heterogeneous domestic banks and the analog of the granular instrumental variable in the model-generated data is $\mathcal{G}_t^c = \text{DBD}_{t-1}^c \times \text{IBD}_{t-1}^c \times \text{GBS}_t^c$. We then run the IV regression (7) and its reduced form (8) on this artificial panel of 22 country-sectors (eleven countries with one SME and one large firm sector each).[27]

Table 7 presents results, obtained from averaging regression coefficients and constructing t-statistics from the distribution of 1000 simulations as described in the previous paragraph, for various other model scenarios that we describe shortly. The first row of the table presents the IV estimate, on which we focus here, because it is our main coefficient of inter-

[27]As in the empirical regressions, we include country-sector and country-time fixed effects. We do not include sector-time effects, because doing so effectively absorbs the variation on which the identification in the model-generated data is based. This is because in our stylized model sectors are only distinguished by whether they are high-SME or not. By contrast, in the real data, sector-time effects account for heterogeneity across sectors that is not fully accounted for by the SME share.

est that captures the causal link between loan supply and sectoral outputs but, to show the relevance of the instrument $\mathcal{G}_t^c$ in the model-simulated data, we also report first-stage and reduced form results in the second and third rows.

The average model-simulated IV regression coefficient in the baseline scenario reported in the first row of column (1) is 0.33, which almost exactly matches our IV estimate of 0.34 from Table 3 above. The first stage and reduced-form estimates are significant, albeit smaller than those found for the empirical data.

In columns (2)–(5), we examine whether our results can be ascribed to global banking sector shocks. To do so, we simulate the model under different scenarios. In column (2), we switch off all shocks other than the global banking shock when simulating the data and rerun our regression. The estimates of the coefficient of interest remain virtually unchanged from the baseline specification in column (1), where all shocks were switched on. We draw two conclusions from column (2). First, the global banking shock on its own seems sufficient to quantitatively account for the size of the IV coefficient in the real data. Second, the comparison between columns (1) and (2) reveals that the IV regression correctly identifies the magnitudes of the coefficient, even in the presence of a range of other structural shocks—at least if these shocks are uncorrelated with the global banking sector shock, as is the case in the baseline simulations.

Columns (3) and (4) examine whether other plausible shock-scenarios might confound these conclusions. For example, it is conceivable that the European sovereign debt crisis was a run on domestic banks by domestic depositors that was synchronized across countries; e.g., because of contagion. We simulate such a scenario in column (3), by switching off the global banking shock and by allowing local banking shocks to be correlated across countries. Estimating our main regression on model-simulated data reveals that this scenario cannot account for the effect of GBS on high-SME sectors: the IV coefficient is clearly insignificant, as are the first stage and the reduced form estimates.

The eurozone crisis could also have reflected a sudden and synchronized deterioration of fundamentals (and a drop in credit demand) that particularly affected small-firm intensive sectors. In column (4), we therefore consider a scenario in which we allow TFP shocks in the SME sector to be correlated across countries while switching off the global banking shock. Again, the IV coefficient is clearly insignificant, along with the first-stage and reduced-form estimates.

Taken together, the results in columns (1)–(4) show that plausible alternative shock scenarios alone cannot account for the patterns we observe in our IV regressions, and that a global banking shock is required to explain them. However, it is still conceivable that our conclusions regarding the quantitative importance of the global banking shock could be confounded by the simultaneous occurrence of local banking crises or by a sudden drop in local credit demand that happened at the same time as global banks started to retrench from cross-border interbank lending to eurozone countries.

To account for these possibilities, in columns (5) and (6), we reconsider the scenarios from columns (3) and (4), but now by switching the global banking shock back on, and allowing it to be correlated with the local banking shocks or the country-specific TFP shocks in the SME sector, respectively. Column (5), with correlated local and global banking shocks, shows that our main coefficient of interest remains unaffected, while the first-stage and the reduced-form estimates now are closer to the empirical estimates. This suggests that local banking sector shocks—which are likely to have occurred during the crisis—could have affected our first stage, but that they do not bias the IV estimate. By contrast, in column (6), where the global banking shock is correlated with local TFP shocks in the SME sector, the IV coefficient doubles relative to the baseline while the first stages remain almost unchanged. This makes the coefficient of interest implausibly large when compared to the estimates obtained from real data, allowing us to effectively rule out this scenario.[28]

We conclude that, although these alternative scenarios could lead to bias in our coefficient of interest, none of them fits the data. Only when we include a shock to the global banking sector do we find a large significant differential effect on growth of sectoral value added between SME-intensive and other sectors.

Matching dynamic responses Figure A.4 displays LLPs which are estimated on simulated data at horizons of $h = 0, 1, ..., 4$ years using $\mathcal{G}_t^c$ as an instrument and are to be compared to the corresponding empirical Figure 7. The dynamic pattern from the simulated data is very similar to what we found for the empirical data, in that for high-SME sectors, the instrumented impact of lending growth is statistically significant and persistent for 2–3 years while there is no significant impact on high-SME sectors at any horizon.

8 Conclusion

After the inception of the euro, the real economy in most member countries remained dependent on the provision of credit by domestic banks, which increasingly funded themselves through cross-border interbank borrowing. This pattern of 'double-decker' banking integration exposed economies and sectors that were reliant on domestic banks to the sharp declines in cross-border interbank lending during the eurozone crisis. We show that domestic banks that were more reliant on interbank finance reduced lending more in response to this sudden stop in European interbank markets, and that sectors with many SMEs (that are particularly dependent on domestic banks for finance) saw the biggest declines in output as a

[28] In the empirical section above, we obtained proxies of country-level credit-demand shocks from the bank-level regressions. We interacted them with sector-dummies in the sector-country level regressions to control for the potential confounding from sector-country specific shocks that could be correlated with GBS. In Table A.4 in the appendix, we show versions of the regressions in Table 7 in which we do something equivalent on the model-generated data. In the model, we have the benefit of directly observing shocks that could be correlated with GBS, and we include these in the regressions directly, allowing them to have sector-specific slopes. The table shows that doing so eliminates bias in our coefficient of interest.

result. To explain these patterns in the data, we propose a quantitative small open economy model that allows us to explore whether alternative shock scenarios such as local banking crises or synchronized negative credit demand shocks could explain our empirical findings. The upshot from the model is that they cannot, and that a global deleveraging shock leading to a sudden stop in cross-border interbank lending in the eurozone is required to quantitatively account for the protracted decline in economic output in the sectors most dependent on domestic banks.

Our findings have some interesting policy implications. They suggest that banking integration in the eurozone in the years before 2008 was of the 'wrong' kind, in the sense that it was driven by lending from international banks to domestic banks, rather than by lending from international banks to the real economy. This left firms highly exposed to global banking shocks without shielding them from shocks to the domestic banking sector. Banking integration in Europe may require a 'reset' that involves cross-border mergers between banks and consolidation of branch networks by retail banks across country-borders in the eurozone, as happened in the United States after the state liberalization of state-level banking in the 1980s. This would enable international banks to operate genuine internal capital markets, allowing them to respond to the financing needs of small firms by reallocating credit across borders.

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Table 1: Bank-level regressions: domestic bank lending and interbank dependence

	(1)	(2)	(3)	(4)
$\text{GBS}_t \times \text{IBD}^b_{t-1}$	0.43***	0.44***	0.56***	0.56***
	(3.46)	(5.24)	(14.42)	(51.93)
IBD^b_{t-1}	-0.06**	0.01	-0.22***	-0.16***
	(-2.63)	(0.28)	(-5.59)	(-4.42)
$\log \text{ASSETS}^b_{t-1}$		-0.23***		-0.15***
		(-9.20)		(-7.19)
$\Delta \log \text{DEPOSITS}^b_t$			0.29***	0.27***
			(7.20)	(6.74)
Num.Obs.	32855	32855	32781	32781
R2 Adj.	0.07	0.11	0.19	0.21
$FE : bank$	X	X	X	X
$FE : country \times date$	X	X	X	X

NOTES: The table shows estimates of the bank-level regression (5)

$$\text{LendingGrowth}^b_t = \alpha \times \text{IBD}^b_{t-1} \times \text{GBS}_t + \mu^b + f^c_t + \text{CONTROLS}^b_t + \zeta^b_t \ ,$$

where the dependent variable is bank lending growth. All regressions are saturated with fixed effects as indicated at the bottom of the table. The sample includes domestic banks from the eleven EMU countries in our sample over the years 1999–2013. Standard errors are clustered by country and year. Statistical significance at the 1/5/10 percent level is denoted by ***, **, and *.

Table 2: Country-sector level regressions (continuous $\text{SME}^{c,s}$)

	(1)	(2)	(3)	(4)
IV results				
$(\text{fit})\text{CreditGrowth}_t^c \times \text{SME}^{c,s}$	0.50**	0.50**	0.55**	0.50**
	(2.38)	(2.74)	(2.98)	(2.37)
$\widehat{f}_t^c \times \text{SME}^{c,s}$		-0.01		
		(-0.12)		
1st stage results				
$\mathcal{G}_t^c \times \text{SME}^{c,s}$	2.57***	2.48***	2.54***	2.57***
	(5.09)	(4.82)	(4.97)	(5.07)
$\widehat{f}_t^c \times \text{SME}^{c,s}$		0.07		
		(1.49)		
Num.Obs.	1672	1672	1672	1672
R2 Adj.	0.28	0.28	0.28	0.27
Weak inst. test	25.91 (0.00)	23.23 (0.00)	24.66 (0.00)	25.74 (0.00)
Reduced form				
$\mathcal{G}_t^c \times \text{SME}^{c,s}$	1.31*	1.27*	1.43*	1.31*
	(1.82)	(1.94)	(2.09)	(1.82)
$\widehat{f}_t^c \times \text{SME}^{c,s}$		0.03		
		(0.46)		
Num.Obs.	1694	1694	1694	1694
R2 Adj.	0.28	0.28	0.28	0.27
$FE : date \times sector$	X	X	X	X
$FE : date \times country$	X	X	X	X
$FE : country \times sector$	X	X	X	X
$Slopes : sector \times \widehat{f}_t^c$			X	
$Slopes : country \times \widehat{f}_t^c$				X

NOTES: The upper and middle panels of the table show IV and first-stage estimates of the country-sector panel IV regression (7)

$$\Delta \log \text{GVA}_t^{c,s} = \gamma \times \text{SME}^{c,s} \times \text{CreditGrowth}_t^c + \text{CONTROLS}_t^{c,s} + \eta_t^{c,s} ,$$

using $\text{SME}^{c,s} \times \mathcal{G}_t^c$ as an instrument for $\text{SME}^{c,s} \times \text{CreditGrowth}_t^c$, where $\text{SME}^{c,s}$ is the SME share in value added in country-sector c, s in 2008. The lower panel reports estimates of the corresponding reduced-form regression (8)

$$\Delta \log \text{GVA}_t^{c,s} = \gamma \times \text{SME}^{c,s} \times \mathcal{G}_t^c + \text{CONTROLS}_t^{c,s} + \eta_t^{c,s}.$$

All regressions are saturated with fixed effects as indicated at the bottom of the table. In columns (3) and (4), we allow for sector- and country-specfic slopes on the estimates of the country-time shocks $\widehat{f}_t^c$ obtained from the domestic bank-level regressions presented in Table 1. The sample covers our 11 EMU countries and 11 NACE rev. 2 1-digit sectors over the period 1999–2013. Standard errors are clustered by country and time. Statistical significance at the 1/5/10 percent level is denoted by ***, **, and *.

Table 3: Country-sector level regressions (discrete $\text{SME}^{c,s}$)

	(1)	(2)	(3)	(4)
IV results				
(fit)$\text{CreditGrowth}_t^c \times \text{HiSME}^{c,s}$	0.34**	0.34**	0.35**	0.34**
	(2.25)	(2.23)	(2.23)	(2.24)
$\widehat{f}_t^c \times \text{HiSME}^{c,s}$		-0.01		
		(-0.39)		
1st stage results				
$\mathcal{G}_t^c \times \text{HiSME}^{c,s}$	2.11***	2.11***	2.10***	2.11***
	(4.48)	(4.64)	(4.47)	(4.47)
$\widehat{f}_t^c \times \text{HiSME}^{c,s}$		0.04		
		(0.92)		
Num.Obs.	1672	1672	1672	1672
R2 Adj.	0.27	0.27	0.27	0.27
Weak inst. test	20.06 (0.00)	21.53 (0.00)	20.00 (0.00)	19.93 (0.00)
Reduced form				
$\mathcal{G}_t^c \times \text{HiSME}^{c,s}$	0.75*	0.75*	0.76*	0.75*
	(2.10)	(2.13)	(2.12)	(2.09)
$\widehat{f}_t^c \times \text{HiSME}^{c,s}$		0.01		
		(0.92)		
Num.Obs.	1694	1694	1694	1694
R2 Adj.	0.28	0.28	0.28	0.28
$FE: date \times sector$	X	X	X	X
$FE: date \times country$	X	X	X	X
$FE: country \times sector$	X	X	X	X
$Slopes: sector \times \widehat{f}_t^c$			X	
$Slopes: country \times \widehat{f}_t^c$				X

NOTES: The upper and middle panels of the table show IV and first-stage estimates of the country-sector panel IV regression (7)

$$\Delta \log \text{GVA}_t^{c,s} = \gamma \times \text{HiSME}^{c,s} \times \text{CreditGrowth}_t^c + \text{CONTROLS}_t^{c,s} + \eta_t^{c,s} ,$$

using $\text{HiSME}^{c,s c,s} \times \mathcal{G}_t^c$ as an instrument for $\text{HiSME}^{c,s} \times \text{CreditGrowth}_t^c$ where $\text{HiSME}^{c,s}$ is an indicator variable that is unity (zero) if country-sector c, s has a 2008 SME-share in value added above (below) the median of all country-sectors. The lower panel reports estimates of the corresponding reduced-form regression (8)

$$\Delta \log \text{GVA}_t^{c,s} = \gamma \times \text{HiSME}^{c,s} \times \mathcal{G}_t^c + \text{CONTROLS}_t^{c,s} + \eta_t^{c,s} ,$$

All regressions are saturated with fixed effects as indicated at the bottom of the table. In columns (3) and (4), we allow for sector- and country-specfic slopes on the estimates of the country-time shocks $\widehat{f}_t^c$ obtained from the domestic bank-level regressions presented in Table 1. The sample covers eleven EMU countries and eleven NACE rev. 2 1-digit sectors over the period 1999–2013. Standard errors are clustered by country and time. Statistical significance at the 1/5/10 percent level is denoted by ***, **, and *.

Table 4: Model calibration

Parameter	Value	Description
Households		
β	0.99	Households' discount factor
ψ	2	Inverse of Frisch elasticity
σ	1	Households' risk aversion
ϵ	0.4	Elasticity of substitution between consumption goods
Firms		
α	0.35	Capital intensity
φ^I	22	Investment adjustment cost parameter
δ	0.025	Capital depreciation
Banks		
φ^d	2	Deposits adjustment cost parameter
$\bar{\varphi}$	2	Global bank lending to firms intermediation cost parameter
κ	0.025	Global bank interbank lending intermediation scale parameter
ι	0.02	Average firm loans intermediation margin
R^w	1	Gross world interest rate
Shocks		
σ^θ	0.0091	Standard deviation of SME and BF TFP shocks
σ^{gbs}	0.025	Standard deviation of the global banking shock
σ^{lbs}	0.04	Standard deviation of the local banking shock
ρ^θ	0.95	Autocorrelation of SME and BF TFP shocks
ρ^{gbs}	0.95	Autocorrelation of the global banking shock
ρ^{lbs}	0.95	Autocorrelation of the local banking shock

NOTES: This table reports calibrated parameters, common for all EMU-11 countries in our sample. The country-specific values of GDP, IBD, and DBD shares are reported in Table 5. The values of model parameters ω and Ψ are determined from steady-state restrictions.

Table 5: Calibration targets for GDP, IBD and DBD by country

	GDP	IBD	DBD
Austria	0.57	0.26	0.68
Belgium	0.70	0.26	0.46
Finland	0.37	0.28	0.44
France	4.00	0.39	0.54
Germany	5.51	0.28	0.78
Greece	0.43	0.18	0.85
Ireland	0.33	0.22	0.62
Italy	3.36	0.25	0.73
Netherlands	1.22	0.21	0.51
Portugal	0.35	0.21	0.68
Spain	1.92	0.27	0.75

NOTES: This table reports country-specific values of GDP, IBD and DBD for the EMU-11 countries that we match in our calibration of the model for the respective country. Common calibration parameters are presented in Table 4. The values for GDP are constructed as pre-2008 within-country averages of nominal GDP in tens thousands of euros. The values for IBD are constructed as pre-2008 country averages of bank-level measures, IBD_t^b, which we aggregate to the country level using lagged bank-level net loans as weights. The values for DBD are constructed as pre-2008 country averages.

Table 6: Business cycle properties of the model

	Austria		Data	
	St.Dev	Corr.	St.Dev	Corr.
GDP	0.69*		0.69*	
Consumption	2.15	0.21	0.88	0.47
Investment	3.76	0.17	3.89	0.48
Employment	0.70	0.21	0.67	0.34
Deposits	2.70	0.09	2.62	–0.03
Loans	2.26	0.40	2.26	0.30
B2B lending	13.15	0.24	13.05	0.06
Net exports	1.53	–0.35	2.97	0.06

NOTES: The table reports theoretical and empirical standard deviations ('St.Dev.') and correlations ('Corr.') of main model variables. The theoretical moments are shown for Austria, which is the 'representative' country in our sample. The empirical moments are calculated as an average over EMU-11 countries using data from Eurostat and BIS. All variables refer to the respective growth rates (log-differences), except for net exports, which are in proportion to last-year nominal GDP. For each variable in the table, we present the standard deviations relative to the standard deviation of GDP and correlation with domestic GDP. The standard deviation of GDP, marked with an asterisk, is an absolute value. All model statistics are obtained from 1000 model simulations of the baseline scenario over 250 quarters (with the first 50 quarters dropped). Empirical moments are obtained from the pre-crisis sample 1997Q1–2007Q4.

Table 7: Model simulation results under counterfactuals

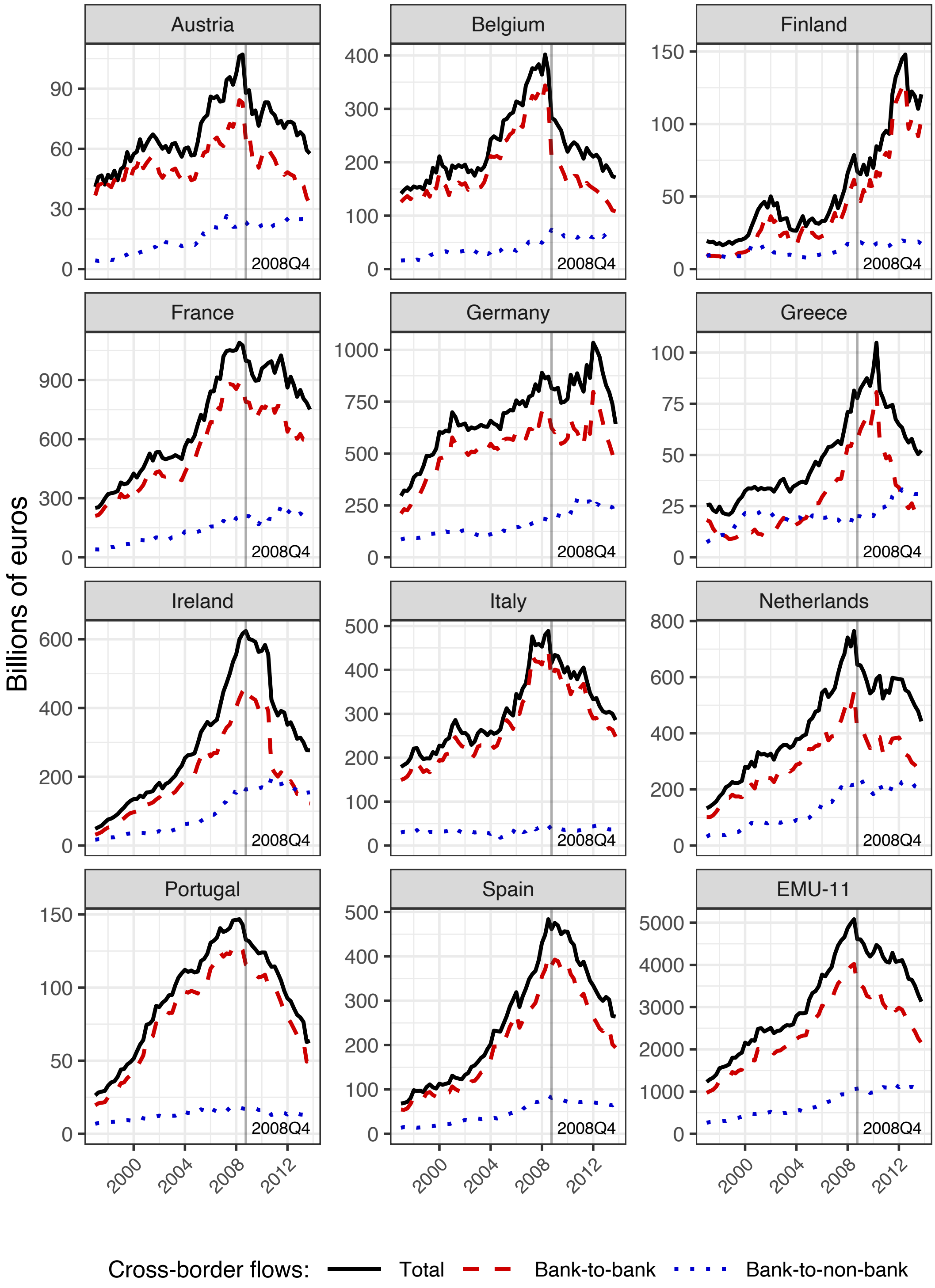
	(1)	(2)	(3)	(4)	(5)	(6)
			Synchronized, no GBS		Correlated with GBS	
	Baseline	Only GBS	LBS	SME	LBS	SME
IV	0.33***	0.33***	−0.55	1.12	0.36***	0.65***
	(5.21)	(147.95)	(−0.02)	(0.06)	(6.22)	(13.45)
IV 1st stage	0.88***	0.97***	0.06	0.24	1.70***	0.95***
	(4.32)	(4.71)	(0.55)	(1.19)	(8.20)	(4.04)
Reduced form	0.29***	0.32***	−0.06	0.29	0.61***	0.62***
	(3.27)	(4.65)	(−0.43)	(0.52)	(4.84)	(3.82)
N	286	286	286	286	286	286

NOTES: The table reports the estimates of the regression:

$$\Delta \log \text{GVA}_t^{c,s} = \gamma \times \text{SME}^s \times \text{CreditGrowth}_t^c + \tau_t^s + \mu^{c,s} + \varepsilon_t^{c,s}\,.$$

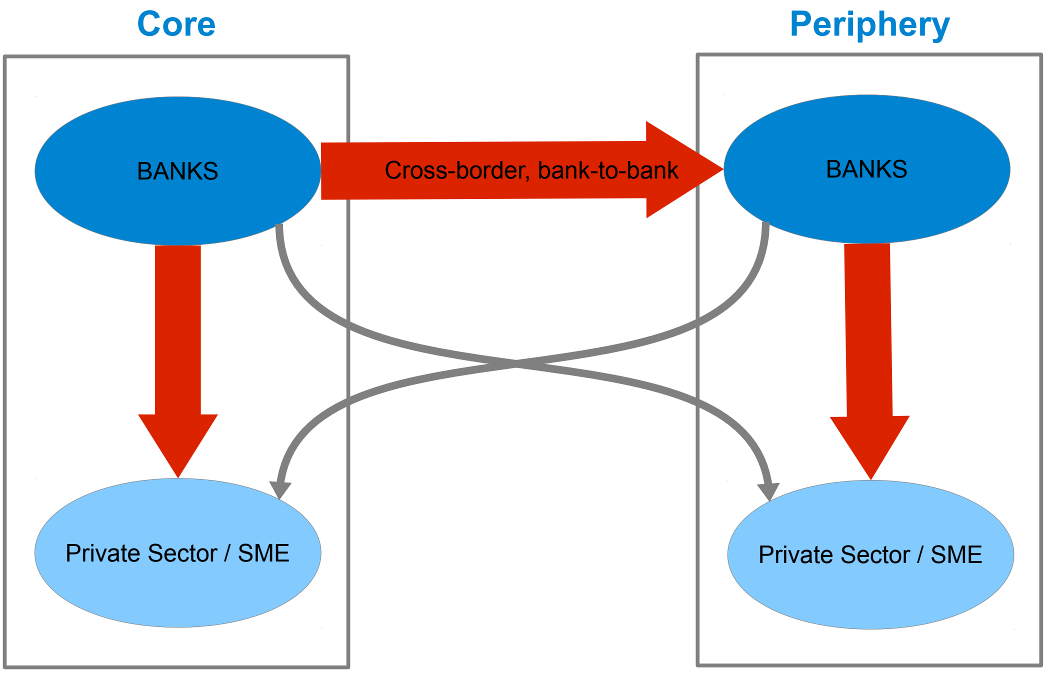
The rows correspond to different estimation approaches: row (1): IV, in which the term $\text{SME}^s \times \text{CreditGrowth}_t^c$ is instrumented with $\text{SME}^s \times \left(\text{GBS}_t \times \text{IBD}_{t-1}^c \times \text{DBD}_{t-1}^c\right)$; row (2): IV 1st stage; and row (3) : the reduced form.
Estimated coefficients and t-stats (in parentheses) are derived from sample means and standard deviations of the simulated regression coefficients. In particular, for every of 1000 simulations, we run the regressions, save the estimated coefficients, and use their distribution to construct the reported values. The data has been obtained and annualized for 1000 model simulations over 60 quarters, using 40 quarters of additional 'pre-sample' observations, such that the final sample spans 15 years representing the 1999–2013 period, for 11 model EMU countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain. Statistical significance at the 1/5/10 percent level is denoted by ***, **, and *.
The scenarios are as follows: 'Baseline:' all shocks (GBS, LBS, SME TFP, and BF TFP) are 'on' and random (GBS is the same for all countries, but different across simulations); 'Only GBS:' only GBS is 'on,' other shocks are 'off;' 'Synchronized LBS shocks, no GBS': all shocks are 'on' but GBS is 'off,' LBS shocks are synchronized across countries; 'Synchronized SME shocks, no GBS': all shocks are 'on,' but GBS is 'off,' SME TFP shocks are synchronized across countries; 'LBS shocks, correlated with GBS:' all shocks are 'on,' LBS shocks are correlated with GBS (and thus also synchronized across countries); 'SME shocks, correlated with GBS:' all shocks are 'on,' SME TFP shocks are correlated with GBS (and thus also synchronized across countries). The pairwise correlation coefficients are equal to 0.8.

Figure 1: Cross-border bank lending in the eurozone



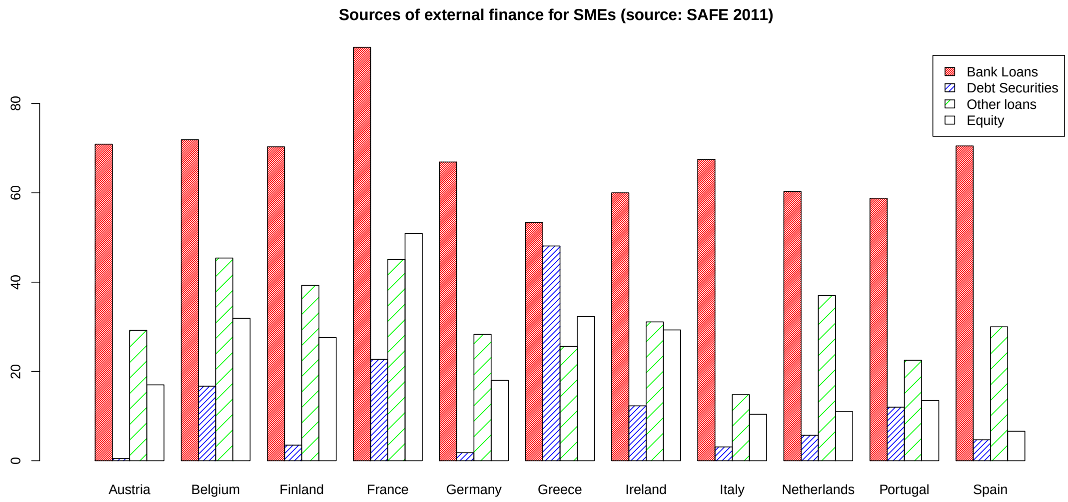
NOTES: The figure plots cross-border lending by foreign banks to each country. The last panel plots aggregate cross-border flows aggregated over the eleven countries in our sample. The black solid line shows total lending, the red dashed line shows lending by foreign banks to domestic banks, and the blue dotted line shows lending by foreign banks to the domestic non-bank sector (including governments). Source: BIS locational banking statistics database.

Figure 2: Bank-to-bank integration vs. bank-to-real sector integration



NOTES: The figure conceptualizes the structure of banking integration in the eurozone in the years before the financial crisis. Cross-border integration mainly took place between banks (bank-to-bank integration) with net flows largely in the direction of the periphery country (big red arrow in the middle). Cross-border flows from banks to the real sector remained very limited (thin gray arrows). This left periphery economies vulnerable to sudden stops in banking flows (due to the global crisis), while keeping the domestic banking sector exposed to country-specific shocks due to its domestically concentrated loan portfolio.

Figure 3: Bank dependence of SMEs in the eurozone

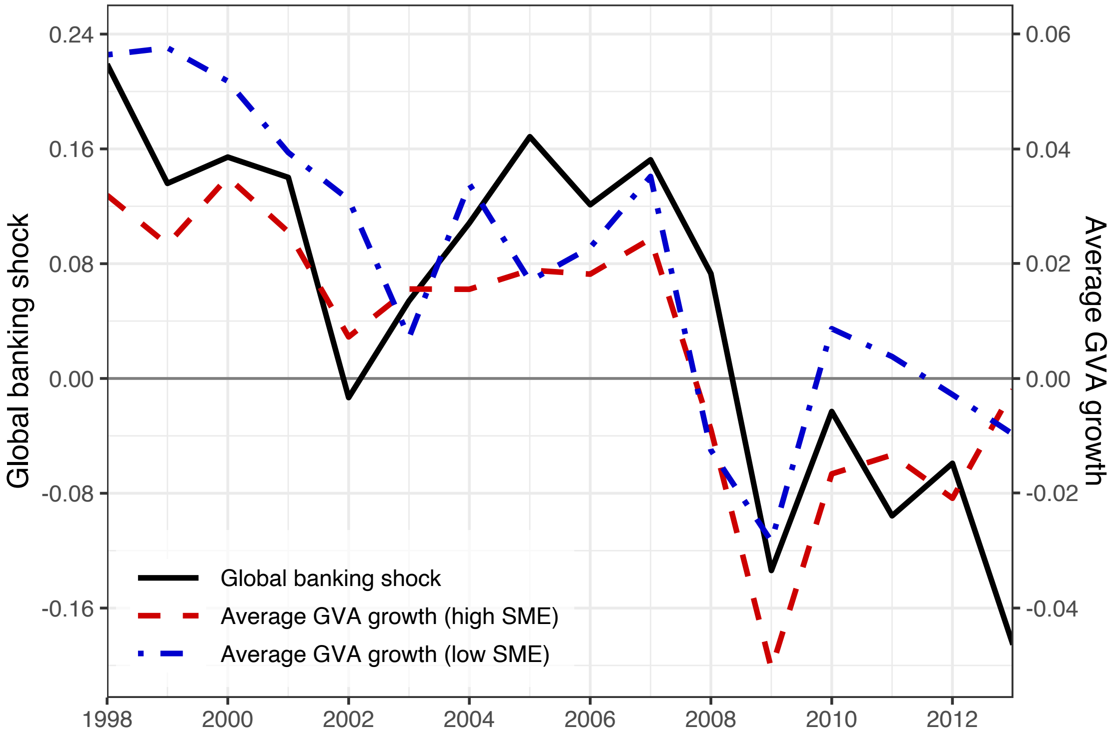


NOTES: The figure reports the fraction of SMEs (firms with fewer than 250 employees) reporting to have used or to be currently using the respective source of external finance. The data source is the European Central Bank's and EU Commission's Survey of Access to Finance by Enterprises (SAFE) 2011 for eleven eurozone countries.

Figure 4: Domestic bank dependence and SME financial conditions

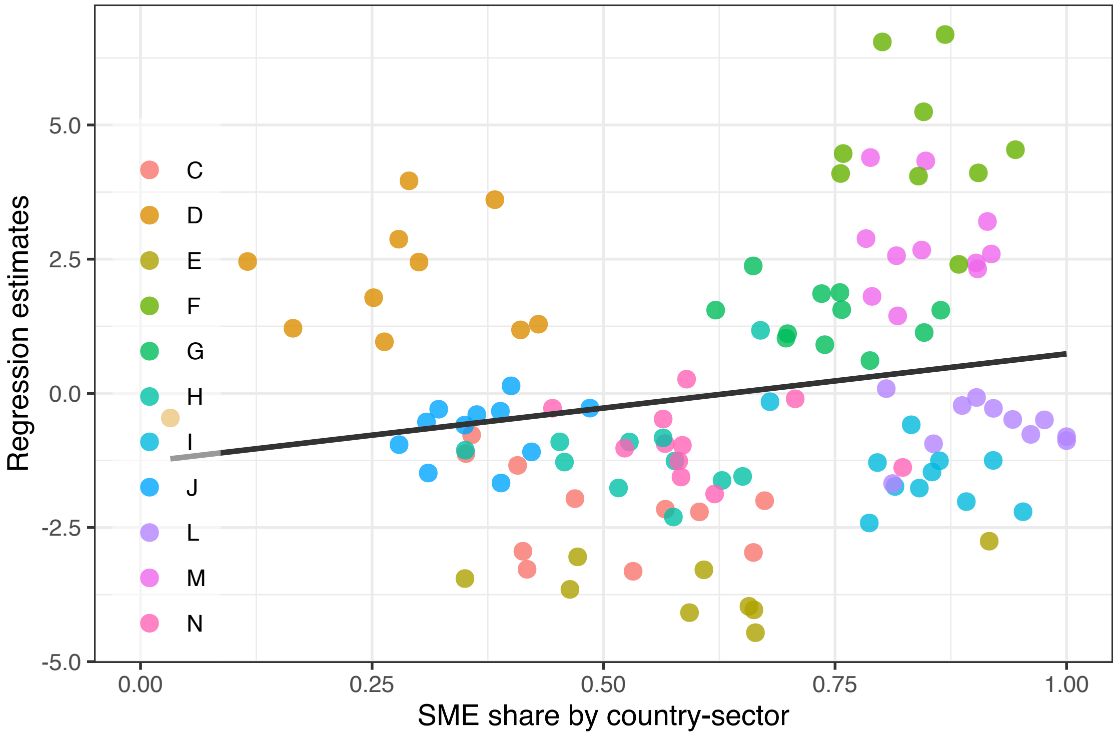
NOTES: The top panel plots the fraction of firms that reported any obstacles in obtaining finance in the ECB-EU Commission's Survey of Access to Finance of Enterprises (SAFE) 2011 against the pre-crisis average value of domestic bank dependence by country, DBD. The bottom panel plots the the fraction of firms that reported increased net interest expenses in SAFE 2011 against DBD. For the two regression lines, the slope (robust t-stat) $[R^2]$ in the top panel is 69.93 (1.72) [0.22], and in the bottom panel is 48.32 (1.79) [0.20].

Figure 5: Global banking shock and sectoral output growth



NOTES: The figure plots the global banking shock (black solid line, left y-axis), average growth rates of high (top tercile) SME country-sectors (red dashed line, right y-axis) and average growth rates of low (bottom tercile) SME country-sectors (blue dot-dashed line, right y-axis). The global banking shock is defined as the growth rate 1998–2013 of total yearly cross-border lending by foreign banks to the eleven EMU countries in our sample, $\text{GBS}_t = \Delta \log \sum_c \text{B2B}_t^c$, where c indexes Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain. Sources: BIS locational banking statistics database and Eurostat.

Figure 6: Exposures to global banking shock and SME shares by country-sector

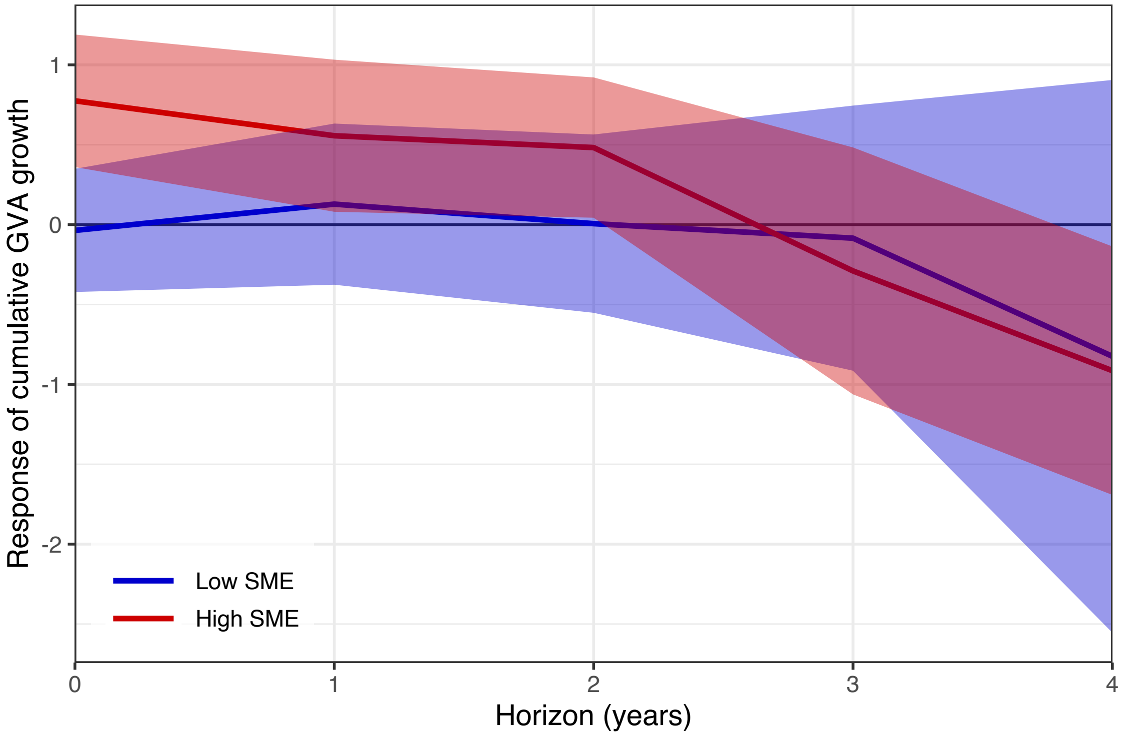


NOTES: The figure plots the estimates of $\gamma^{c,s}$ from the panel regression

$$\Delta \log \text{GVA}_t^{c,s} = \gamma^{c,s} \times \mathbf{1}^{c,s} \times \mathcal{G}_t^c + \text{fixed effects} + \eta_t^{c,s} \,,$$

against the 2008 sectoral SME share. The regression contains a saturated set of fixed effecs (country-sector, country-time, and sector-time). The cross-sectional regression of $\gamma^{c,s}$ on $\text{SME}^{c,s}$ is significant with coefficient 2.02 and t-statistic 2.13. The sectors are as follows: Manufacturing (C); Electricity, Gas, Steam and Air Conditioning Supply (D); Water Supply; Sewerage, Waste Management and Remediation Activities (E); Construction (F); Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles (G); Transportation and Storage (H); Accommodation and Food Service Activities (I); Information and Communication (J); Real Estate Activities (L); Professional, Scientific and Technical Activities (M); and Administrative and Support Service Activities (N). The observation period is 1999–2013 for the countries Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain.

Figure 7: Response to a global banking shock by SME sector— Local linear projections

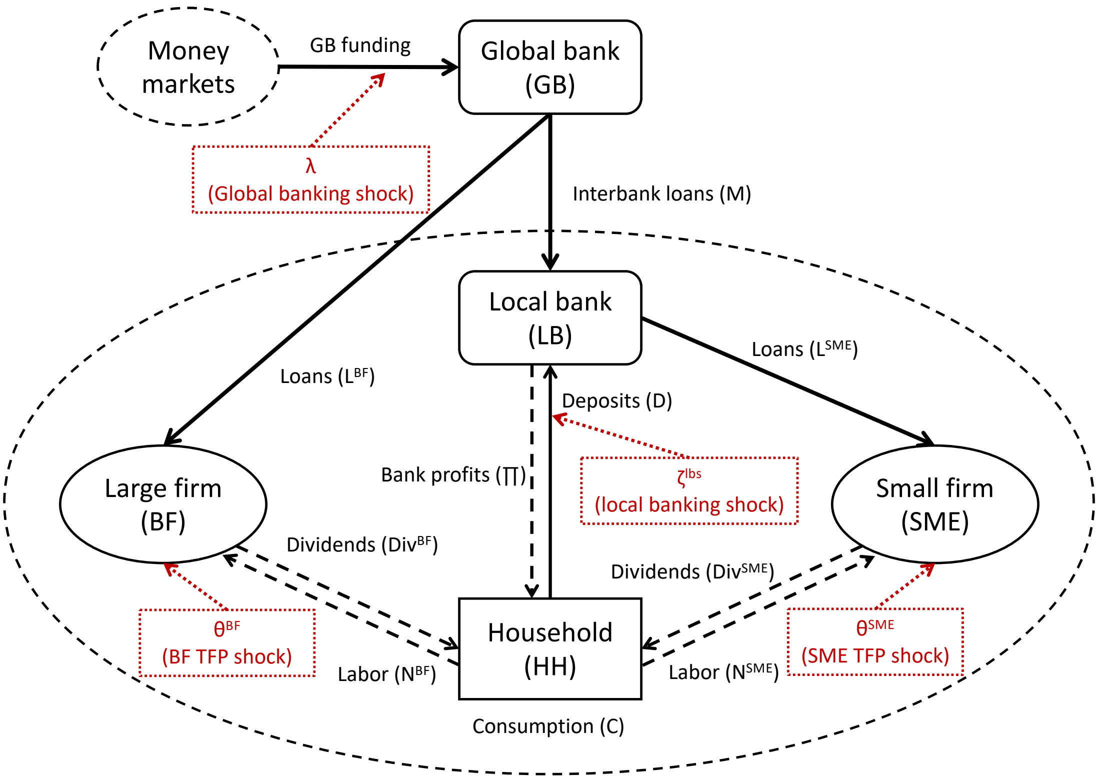


NOTES: The graph plots the IV estimates α_h from the following local linear projection regressions:

$$\log \text{GVA}_{t+h}^{c,s} - \log \text{GVA}_{t-1}^{c,s} = \alpha_h \times \text{CreditGrowth}_t^c + \tau_t^s + \mu^{c,s} + \varepsilon_{t+h}^{c,s} \,,$$

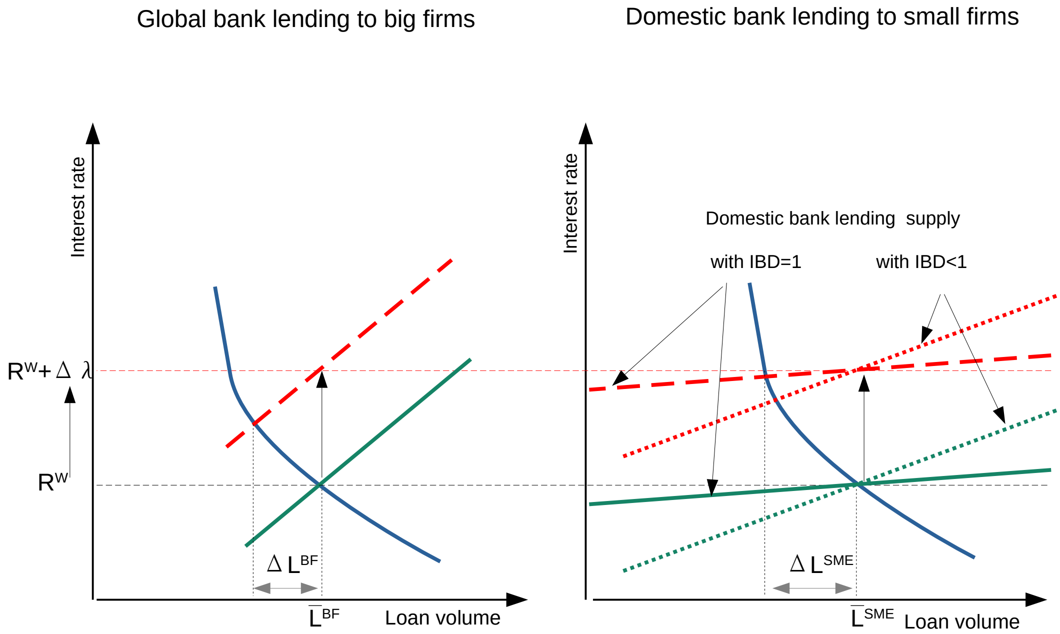
where the endogenous variable CreditGrowth_t^c is instrumented by the variable $\mathcal{G}_t^c$, and the controls include sector-time and country-sector fixed effects. The coefficients are estimated and plotted separately for high SME sectors (red) and low SME sectors (blue). Horizons (zero to four years) are on the x-axis, and the coefficients α_h are on the y-axis. Colored shaded areas correspond to the respective 90% confidence bands, constructed using the standard errors clustered by country and year. The observation period is 1999–2013 for the countries Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain.

Figure 8: Model economy



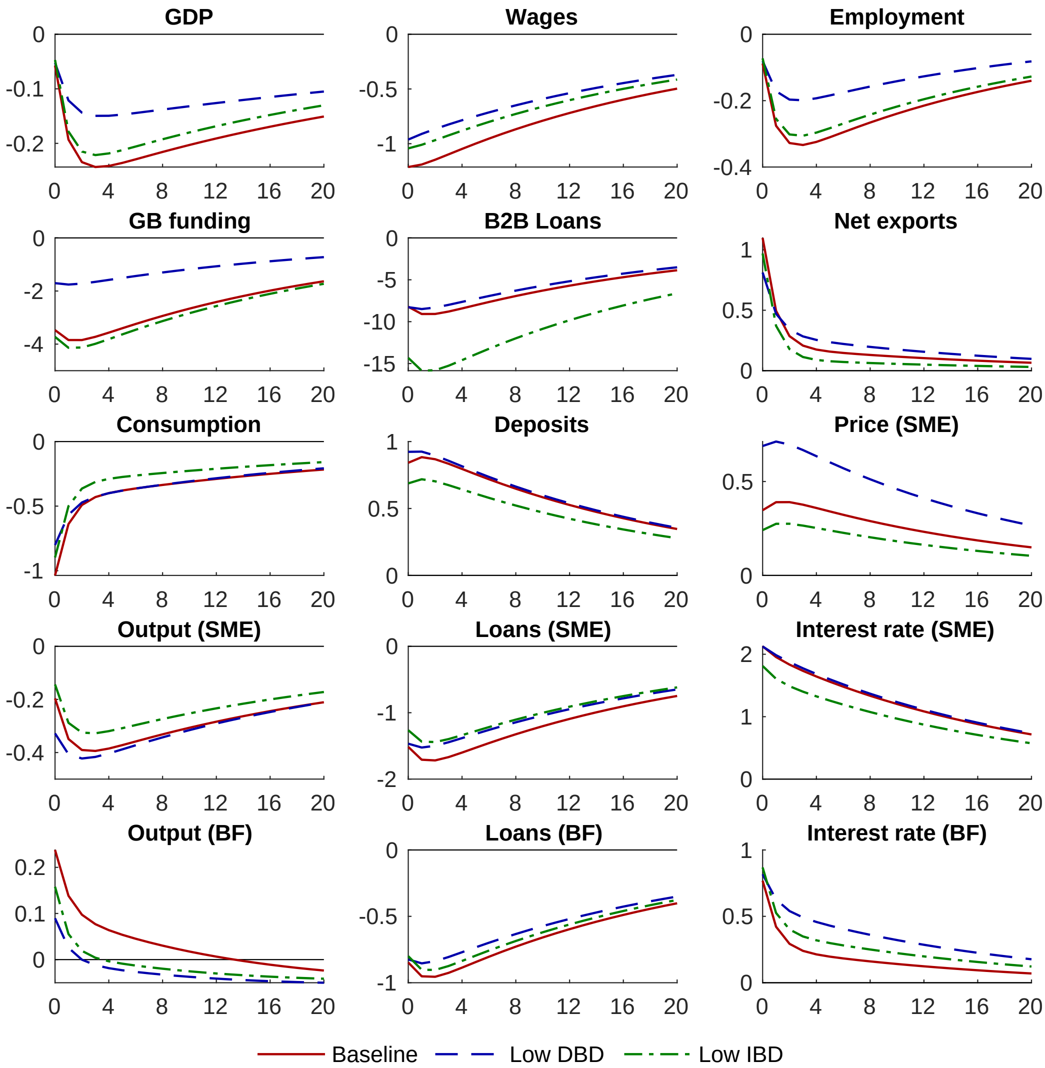
NOTES: The figure conceptualizes the structure of the model in Section 6. The model features a global (foreign) and a domestic ('local') bank, as well as two sectors producing intermediate goods—one which is populated by 'large' firms, that borrow cross-border directly from global banks, and another one which is populated by 'small' firms, that borrow from local banks. Large dashed circle denotes the boundaries of the economy. The local bank lends to small firms and finances itself by raising deposits from domestic households and by borrowing from the global bank. The global bank borrows funds in the global wholesale market and lends cross-border to large firms and to the domestic bank. Solid lines denote flows of loans and funding. Dashed lines denote flows of dividends, profits, and labor. Dashed circle around 'money markets' captures the idea that the funding source of the global bank lies outside the given economy and EMU-11 as a whole. Red dashed boxes include the description of exogenous shocks in the economy—the global banking shock, the local banking shock, and TFP shocks to large firms and SMEs—with arrows pointing at the origin of the shock in the model. For expositional clarity, we do not show graphically the flows of goods and the final goods producer. The latter combines intermediate output by large firms and SMEs into a final good which is used for consumption, investment, and net exports.

Figure 9: Model intuition



NOTES: The figure illustrates the differential impact of a deleveraging shock to the global bank on cross-border lending to large ('big') and small firms. The global bank's lending supply to large firms (solid green line in the left panel) is assumed to be less elastic than interbank lending supply to domestic banks. When the domestic bank is fully interbank dependent (IBD $= 1$) its lending supply to small firms is identical to the global bank's interbank lending supply (solid green line in the right panel). The deleveraging shock shifts lending supply for both firms upwards by $\Delta\lambda$ (dashed red lines) and the lower elasticity of lending supply to large firms implies that the reduction of lending to large firms (ΔL^{BF}) is smaller than that to small firms (ΔL^{SME}). Lowering interbank dependence, IBD, makes the supply of lending to small firms less elastic by rotating the domestic bank's supply curves left (dotted lines in the right panel). This dampens the impact of the shock on ΔL^{SME}.

Figure 10: Model impulse responses to a global banking shock



NOTES: The graph plots the model impulse response functions of various variables for 'Baseline' (red solid lines), 'Low DBD' (blue dashed lines), and 'Low IBD' (purple dot-dashed lines) scenarios to a one standard deviation global banking shock. The 'Baseline' impulse responses are generated from a model simulated for 'Austria,' using parameter values from Table 5. The 'Low DBD' scenario illustrates the counterfactual in which DBD is reduced by 50% compared to the 'Baseline' scenario, while the 'Low IBD' scenario illustrates the counterfactual in which IBD is reduced by 50% compared to the 'Baseline' scenario. All impulse responses are percentage deviations from steady state, except for the interest rates which are in percentage points, and net exports which are in proportion to the steady-state value of nominal GDP. Number of quarters following the shock is on the x-axis.

A Appendix: Supplementary tables and figures

Table A.1: Bank-level regressions: Short-term funding of domestic banks and interbank dependence

	(1)	(2)	(3)	(4)
$\text{GBS}_t \times \text{IBD}^b_{t-1}$	1.99*	2.02*	2.01*	2.03*
	(2.06)	(2.19)	(2.03)	(2.12)
IBD^b_{t-1}	-2.10***	-2.04***	-2.20***	-2.13***
	(-3.81)	(-3.59)	(-4.01)	(-3.82)
$\log \text{ASSETS}^b_{t-1}$		-0.25***		-0.19***
		(-8.68)		(-5.81)
$\Delta \log \text{DEPOSITS}^b_t$			0.20**	0.16*
			(2.41)	(2.04)
Num.Obs.	31267	31267	31193	31193
R2 Adj.	0.24	0.24	0.24	0.25
$FE : bank$	X	X	X	X
$FE : country \times date$	X	X	X	X

NOTES: The table shows estimates of the bank-level regression

$$\text{FundingGrowth}^b_t = \alpha \times \text{IBD}^b_{t-1} \times \text{GBS}_t + \mu^b + f^c_t + \text{CONTROLS}^b_t + \zeta^b_t \ ,$$

where the dependent variable is bank short-term funding growth. All regressions are saturated with fixed effects as indicated at the bottom of the table. The sample includes domestic banks from the eleven EMU countries in our sample over the years 1999–2013. Standard errors are clustered by country and year. Statistical significance at the 1/5/10 percent level is denoted by ***, **, and *.

Table A.2: Bank-level regressions: foreign bank lending and interbank dependence

	(1)	(2)	(3)	(4)
$\text{GBS}_t \times \text{IBD}_{t-1}^b$	0.28	0.07	0.48	0.27
	(0.48)	(0.12)	(0.86)	(0.48)
IBD_{t-1}^b	-0.23*	-0.14	-0.36**	-0.26*
	(-2.06)	(-1.35)	(-2.60)	(-2.29)
$\log \text{ASSETS}_{t-1}^b$		-0.21***		-0.20***
		(-3.68)		(-3.77)
$\Delta \log \text{DEPOSITS}_t^b$			0.10*	0.10*
			(2.01)	(2.00)
Num.Obs.	911	911	904	904
R2 Adj.	0.07	0.10	0.08	0.11
$FE : bank$	X	X	X	X
$FE : country \times date$	X	X	X	X

NOTES: The table shows estimates of the bank-level regression (5), i.e.

$$\text{LendingGrowth}_t^b = \alpha \times \text{IBD}_{t-1}^b \times \text{GBS}_t + \mu^b + f_t^c + \text{CONTROLS}_t^b + \zeta_t^b \ ,$$

where the dependent variable is bank lending growth. All regressions are saturated with fixed effects as indicated at the bottom of the table. The sample includes foreign banks from the eleven EMU countries in our sample over the years 1999–2013. Standard errors are clustered by country and year. Statistical significance at the 1/5/10 percent level is denoted by ***, **, and *.

Table A.3: Bank-level regressions: Short-term funding of foreign banks and interbank dependence

	(1)	(2)	(3)	(4)
$\text{GBS}_t \times \text{IBD}^b_{t-1}$	0.20	-0.04	0.19	-0.03
	(0.30)	(-0.05)	(0.28)	(-0.05)
IBD^b_{t-1}	-0.94***	-0.89***	-0.98***	-0.92***
	(-8.12)	(-9.63)	(-7.57)	(-8.27)
$\log \text{ASSETS}^b_{t-1}$		-0.15		-0.14
		(-1.52)		(-1.52)
$\Delta \log \text{DEPOSITS}^b_t$			-0.01	-0.01
			(-0.16)	(-0.22)
Num.Obs.	882	882	875	875
R2 Adj.	0.00	0.01	0.00	0.01
$FE : bank$	X	X	X	X
$FE : country \times date$	X	X	X	X

NOTES: The table shows estimates of the bank-level regression

$$\text{FundingGrowth}^b_t = \alpha \times \text{IBD}^b_{t-1} \times \text{GBS}_t + \mu^b + f^c_t + \text{CONTROLS}^b_t + \zeta^b_t \ ,$$

where the dependent variable is bank short-term funding growth. All regressions are saturated with fixed effects as indicated at the bottom of the table. The sample includes foreign banks from the eleven EMU countries in our sample over the years 1999–2013. Standard errors are clustered by country and year. Statistical significance at the 1/5/10 percent level is denoted by ***, **, and *.

Table A.4: Model counterfactuals with additional controls

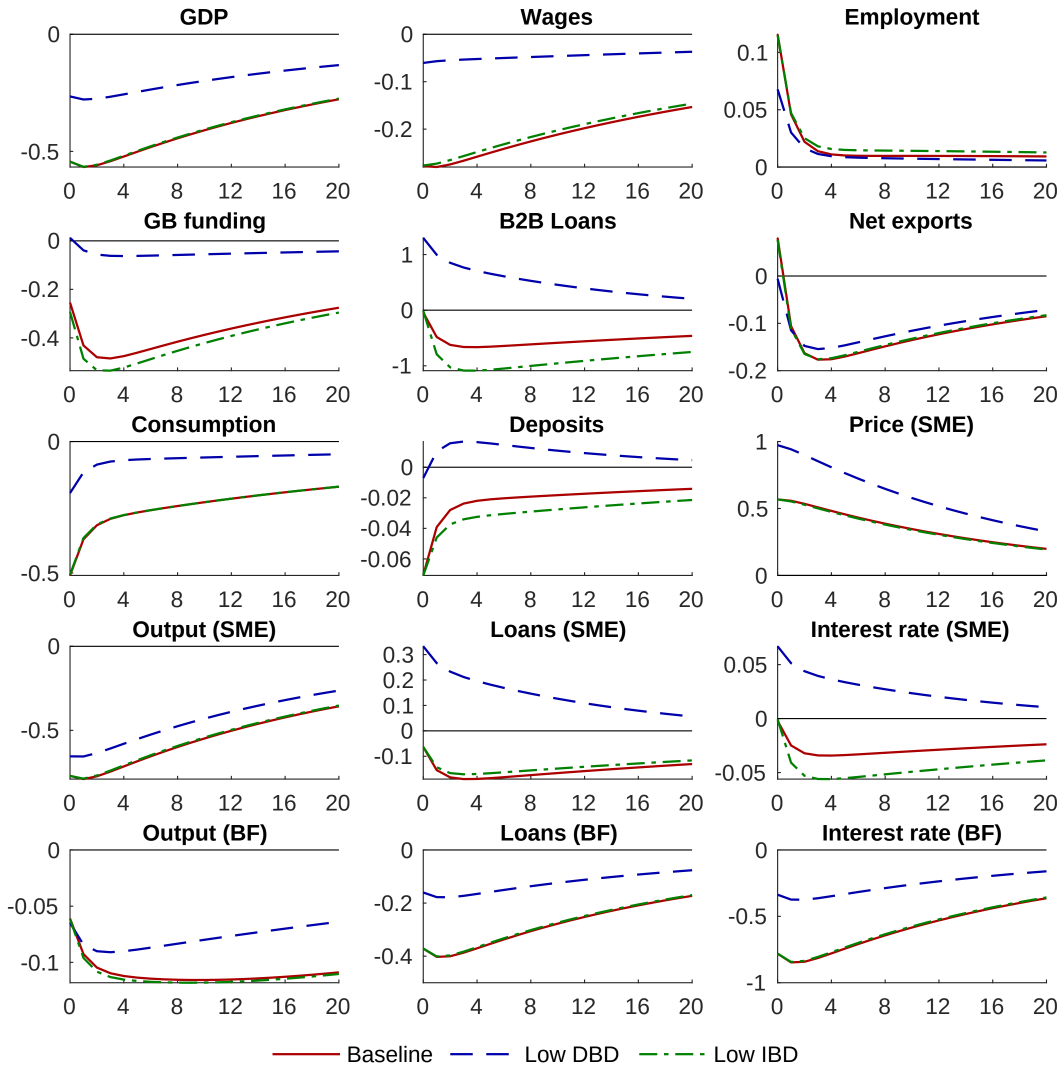
	(1)	(2)	(3)	(4)	(5)	(6)
			Synchronized, no GBS		Correlated with GBS	
	Baseline	Only GBS	LBS	SME	LBS	SME
IV	0.33***	0.33***	0.19	−1.18	0.30**	0.30***
	(5.21)	(147.95)	(0.11)	(−0.09)	(2.25)	(3.06)
IV 1st stage	0.88***	0.97***	0.44***	0.13	1.24***	0.63***
	(4.32)	(4.71)	(3.13)	(1.06)	(7.62)	(3.77)
Reduced form	0.29***	0.32***	0.12	−0.11	0.38**	0.19**
	(3.27)	(4.65)	(0.58)	(−0.72)	(2.11)	(2.38)
N	286	286	286	286	286	286

NOTES: The table reports the estimates of the regression:

$$\Delta \log \text{GVA}_t^{c,s} = \gamma \times \text{SME}^s \times \text{CreditGrowth}_t^c + \text{CONTROLS} + \tau_t^s + \mu^{c,s} + \varepsilon_t^{c,s} \,.$$

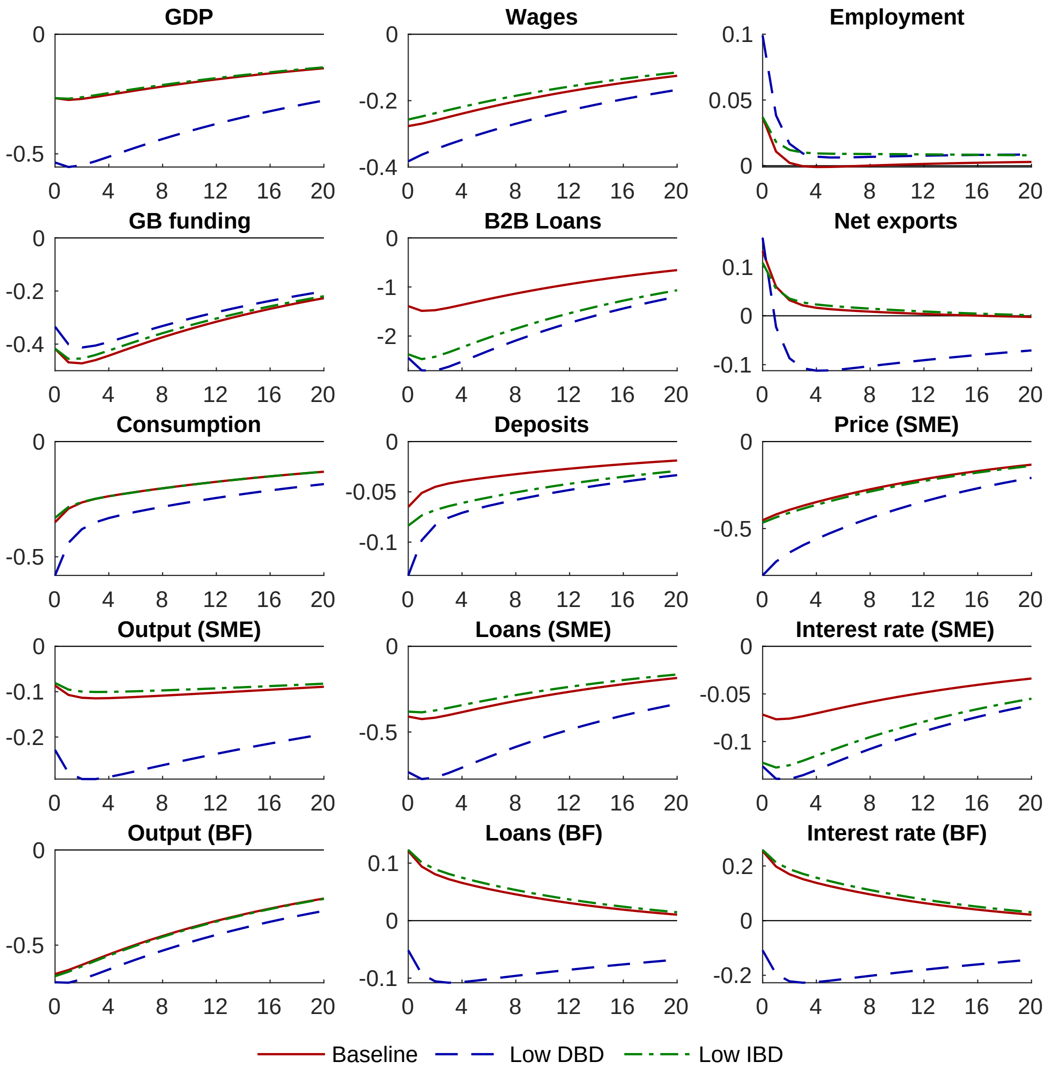
The rows correspond to different estimation approaches: row (1): IV, in which the term $\text{SME}^s \times \text{CreditGrowth}_t^c$ is instrumented with $\text{SME}^s \times \left(\text{GBS}_t \times \text{IBD}_{t-1}^c \times \text{DBD}_{t-1}^c\right)$; row (2): IV 1st stage; and row (3): the reduced form. Columns (1)–(2) do not have controls and are the same as in Table 7. In columns (3) and (5) controls include the growth rates of county-specific local banking shocks, interacted with sectoral SME share: $\text{CONTROLS} = \text{SME}^s \times \Delta \log \zeta_t^c$. In columns (4) and (6) controls include the growth rates of county-specific SME TFP shocks, interacted with sectoral SME share: $\text{CONTROLS} = \text{SME}^s \times \Delta \log \theta_t^{\text{SME},c}$.
Estimated coefficients and t-stats (in parentheses) are derived from sample means and standard deviations of the simulated regression coefficients. In particular, for every of 1000 simulations, we run the regressions, save the estimated coefficients, and use their distribution to construct the reported values. The data has been obtained and annualized for 1000 model simulations over 60 quarters, using 40 quarters of additional 'pre-sample' observations, such that the final sample spans 15 years representing the 1999–2013 period, for 11 model EMU countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain. Statistical significance at the 1/5/10 percent level is denoted by ***, **, and *.
The scenarios are as follows: 'Baseline:' all shocks (GBS, LBS, SME TFP, and BF TFP) are 'on' and random (GBS is the same for all countries, but different across simulations); 'Only GBS:' only GBS is 'on,' other shocks are 'off;' 'Synchronized LBS shocks, no GBS': all shocks are 'on' but GBS is 'off,' LBS shocks are synchronized across countries; 'Synchronized SME shocks, no GBS': all shocks are 'on,' but GBS is 'off,' SME TFP shocks are synchronized across countries; 'LBS shocks, correlated with GBS:' all shocks are 'on,' LBS shocks are correlated with GBS (and thus also synchronized across countries); 'SME shocks, correlated with GBS:' all shocks are 'on,' SME TFP shocks are correlated with GBS (and thus also synchronized across countries). The pairwise correlation coefficients are equal to 0.8.

Figure A.1: Model impulse responses to an SME TFP shock



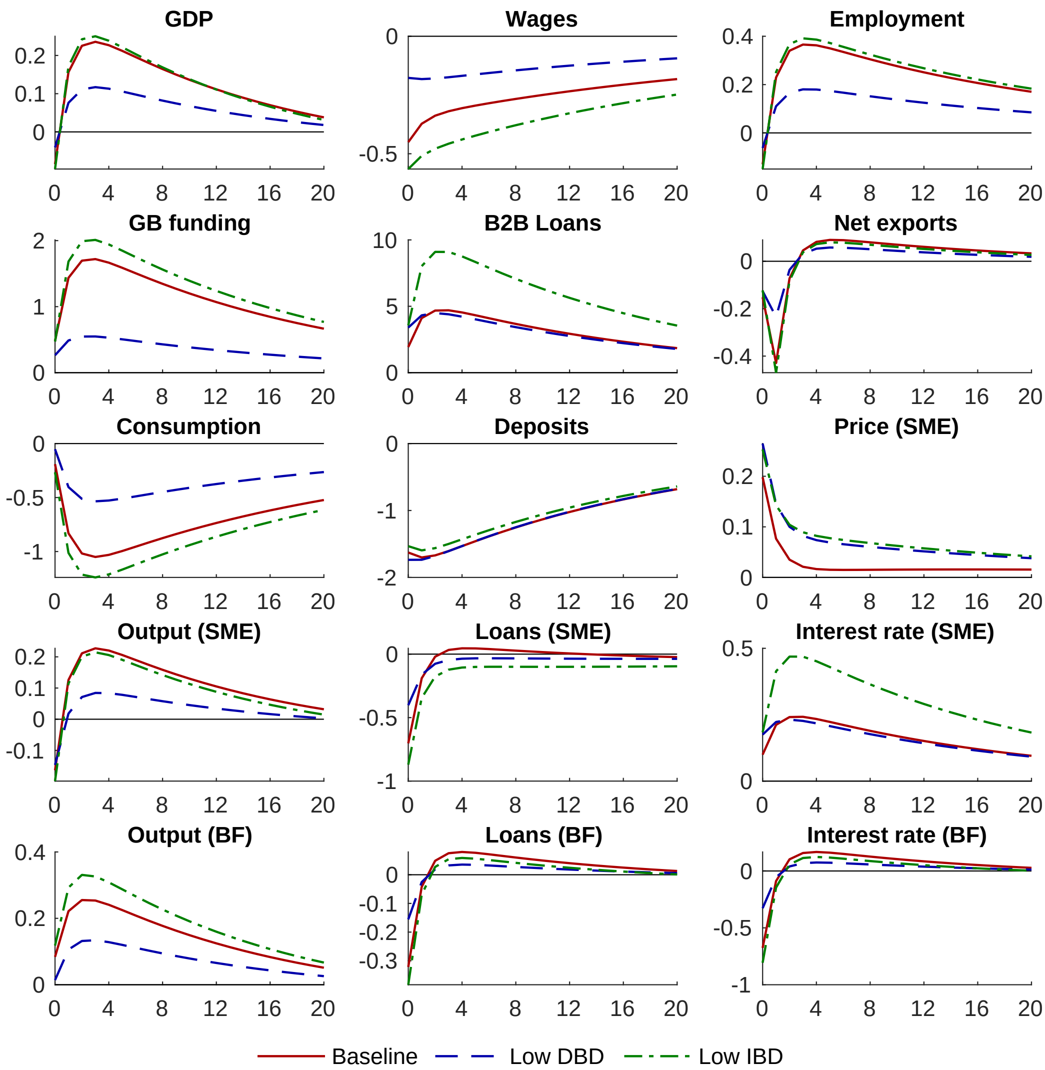
NOTES: The graph plots the model impulse response functions of various variables for 'Baseline' (red solid lines), 'Low DBD' (blue dashed lines), and 'Low IBD' (purple dot-dashed lines) scenarios to a one standard deviation TFP shock to the SME sector. The 'Baseline' impulse responses are generated from a model simulated for 'Austria,' using parameter values from Table 5. The 'Low DBD' scenario illustrates the counterfactual in which DBD is reduced by 50% compared to the 'Baseline' scenario, while the 'Low IBD' scenario illustrates the counterfactual in which IBD is reduced by 50% compared to the 'Baseline' scenario. All impulse responses are percentage deviations from steady state, except for the interest rates which are in percentage points, and net exports which are in proportion to the steady-state value of nominal GDP. Number of quarters following the shock is on the x-axis.

Figure A.2: Model impulse responses to a large-firm TFP shock



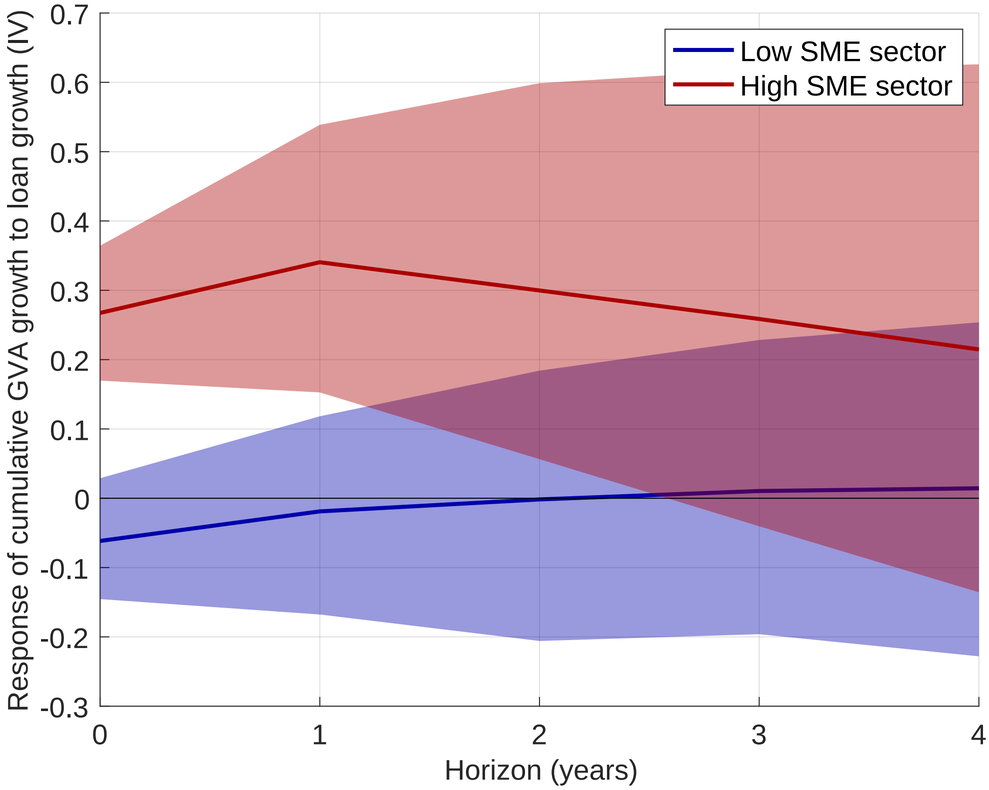
NOTES: The graph plots the model impulse response functions of various variables for 'Baseline' (red solid lines), 'Low DBD' (blue dashed lines), and 'Low IBD' (purple dot-dashed lines) scenarios to a one standard deviation TFP shock to the large firms sector. The 'Baseline' impulse responses are generated from a model simulated for 'Austria,' using parameter values from Table 5. The 'Low DBD' scenario illustrates the counterfactual in which DBD is reduced by 50% compared to the 'Baseline' scenario, while the 'Low IBD' scenario illustrates the counterfactual in which IBD is reduced by 50% compared to the 'Baseline' scenario. All impulse responses are percentage deviations from steady state, except for the interest rates which are in percentage points, and net exports which are in proportion to the steady-state value of nominal GDP. Number of quarters following the shock is on the x-axis.

Figure A.3: Model impulse responses to a local banking shock



NOTES: The graph plots the model impulse response functions of various variables for 'Baseline' (red solid lines), 'Low DBD' (blue dashed lines), and 'Low IBD' (purple dot-dashed lines) scenarios to a one standard deviation local banking shock. The 'Baseline' impulse responses are generated from a model simulated for 'Austria,' using parameter values from Table 5. The 'Low DBD' scenario illustrates the counterfactual in which DBD is reduced by 50% compared to the 'Baseline' scenario, while the 'Low IBD' scenario illustrates the counterfactual in which IBD is reduced by 50% compared to the 'Baseline' scenario. All impulse responses are percentage deviations from steady state, except for the interest rates which are in percentage points, and net exports which are in proportion to the steady-state value of nominal GDP. Number of quarters following the shock is on the x-axis.

Figure A.4: Response to a global banking shock by sector—local linear projections on model-generated data



NOTES: The graph plots the IV estimates α_h from the following local linear projection regressions using model-simulated data for the baseline scenario:

$$\log \text{GVA}^{c,s}_{t+h} - \log \text{GVA}^{c,s}_{t-1} = \alpha_h \times \text{CreditGrowth}^c_t + \mu^c + \varepsilon^{c,s}_{t+h} ,$$

where the endogenous variable CreditGrowth^c_t is instrumented by the variable $\text{GBS}_t \times \text{DBD}^c_{t-1} \times \text{IBD}^c_{t-1}$, and the controls include country fixed effects. The coefficients are estimated and plotted separately for high SME sectors (red) and low SME sectors (blue). Horizons (zero to four years) are on the x-axis, and the coefficients α_h is on the y-axis. Colored shaded areas correspond to the respective 90% confidence bands, constructed from the distribution of the estimated coefficients across simulations. The data has been obtained and annualized for 1000 model simulations over 60 quarters, using 40 quarters of additional 'pre-sample' observations, such that the final sample spans 15 years representing the 1999–2013 period, for 11 model EMU countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain.

B Appendix: Model equations

Household

Objective:

$$\max_{\{C_t,\, N_t,\, D_t\}_{t=0}^{\infty}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma} - 1}{1-\sigma} - \Psi \frac{N_t^{1+\psi}}{1+\psi} \right) \right] . \tag{B.1}$$

Intertemporal budget constraint:

$$P_t C_t + D_t = W_t N_t + R_{t-1}^d D_{t-1} + \text{DIV}_t^{\text{BF}} + \text{DIV}_t^{\text{SME}} + \Pi_t . \tag{B.2}$$

SDF (FOC w.r.t. C_t):

$$\Lambda_{t:t+1} = \mathbb{E}_t \left[\beta \frac{P_t}{P_{t+1}} \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} \right] . \tag{B.3}$$

FOC w.r.t. N_t:

$$\frac{W_t}{P_t} = \Psi N_t^{\psi} C_t^{\sigma} . \tag{B.4}$$

FOC w.r.t. D_t:

$$\mathbb{E}_t \left[\Lambda_{t:t+1} R_t^d \right] = 1 . \tag{B.5}$$

Final goods producer

Objective:

$$\min_{\{Y_t^{\text{BF}},\, Y_t^{\text{SME}}\}} P_t Y_t = P_t^{\text{SME}} Y_t^{\text{SME}} + P_t^{\text{BF}} Y_t^{\text{BF}} . \tag{B.6}$$

CES technology:

$$Y_t = \left(\omega^{\frac{1}{\epsilon}} {Y_t^{\text{BF}}}^{\frac{\epsilon-1}{\epsilon}} + (1-\omega)^{\frac{1}{\epsilon}} {Y_t^{\text{SME}}}^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}} . \tag{B.7}$$

Cost minimization w.r.t. Y_t^{BF}:

$$Y_t^{\text{BF}} = \omega \left(\frac{P_t^{\text{BF}}}{P_t} \right)^{-\epsilon} Y_t . \tag{B.8}$$

Cost minimization w.r.t. Y_t^{SME}:

$$Y_t^{\text{SME}} = (1-\omega) \left(\frac{P_t^{\text{SME}}}{P_t} \right)^{-\epsilon} Y_t . \tag{B.9}$$

Implied price index:

$$P_t = \left(\omega {P_t^{\text{SME}}}^{1-\epsilon} + (1-\omega) {P_t^{\text{SME}}}^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}} . \tag{B.10}$$

Firms

Objective:

$$\max_{\{N_t^s,\, K_t^s,\, L_t^s\}_{t=0}^{\infty}} \mathbb{E}_0\left[\sum_{t=0}^{\infty} \Lambda_{0:t}\text{DIV}_t^s\right] . \tag{B.11}$$

Dividends:

$$\text{DIV}_t^s = P_t^s Y_t^s - W_t N_t^s - P_t\left(I_t^s + \frac{1}{2}\varphi^I K_{t-1}^s\left(\frac{I_t^s}{K_{t-1}^s} - \delta\right)^2\right) + L_t^s - R_{t-1}^s L_{t-1}^s . \tag{B.12}$$

Production function:

$$Y_t^s = \theta_t^s (K_{t-1}^s)^{\alpha} (N_t^s)^{1-\alpha} . \tag{B.13}$$

Capital law of motion:

$$K_t^s = (1-\delta) K_{t-1}^s + I_t^s . \tag{B.14}$$

Wage pre-financing constraint (with Ξ_t^s as Lagrange multiplier):

$$L_t^s = W_t N_t^s . \tag{B.15}$$

FOC w.r.t. N_t:

$$W_t(1+\Xi_t^s) = P_t^s (1-\alpha)\frac{Y_t^s}{N_t^s} . \tag{B.16}$$

FOC w.r.t. K_t:

$$Q_t^s = \mathbb{E}_t\left[\Lambda_{t:t+1}\left(P_{t+1}^s \alpha \frac{Y_{t+1}^s}{K_t^s} + (1-\delta) Q_{t+1}^s - \frac{1}{2}\varphi^I\left(\frac{I_{t+1}^s}{K_t^s} - \delta\right)^2 + \varphi^I \frac{I_{t+1}^s}{K_t^s}\left(\frac{I_{t+1}^s}{K_t^s} - \delta\right)\right)\right] . \tag{B.17}$$

FOC w.r.t. I_t:

$$\frac{Q_t^s}{P_t} = 1 + \varphi^I\left(\frac{I_t^s}{K_{t-1}^s} - \delta\right) . \tag{B.18}$$

FOC w.r.t. L_t^s:

$$1 + \Xi_t^s = \mathbb{E}_t\left[\Lambda_{t:t+1} R_t^s\right] . \tag{B.19}$$

Local Bank

Objective:

$$\max_{L_t^{\text{SME}},\, M_t,\, D_t} \Pi_{t+1} . \tag{B.20}$$

Profits (accruing in the beginning of next period):

$$\Pi_{t+1} = R_t^{\text{SME}} \times (1-\iota) L_t^{\text{SME}} - R_t^m \times M_t - \left(R_t^d + \zeta_t^{lbs}\right) \times D_t - \varphi^d (D_t) .$$

Balance sheet:

$$L_t^{\text{SME}} = M_t + D_t\,. \tag{B.21}$$

FOC w.r.t. D_t (comb. with FOC w.r.t. M_t):

$$R_t^d + \zeta_t^{lbs} + \varphi^d \frac{D_t - D}{D} = R_t^m\,. \tag{B.22}$$

FOC w.r.t. L_t^{SME} (comb. with FOC w.r.t. M_t):

$$R_t^{\text{SME}} = \frac{R_t^m}{1-\iota}\,. \tag{B.23}$$

Global Bank

Objective:

$$\max_{L_t^{\text{BF}},\, M_t,\, F_t} \quad \Pi_{t+1}^{\text{GB}}\,. \tag{B.24}$$

Profits (accruing in the beginning of next period):

$$\begin{aligned}\Pi_{t+1}^{\text{GB}} = R_t^{\text{BF}} \times &\left((1-\iota)\, L_t^{\text{BF}} - \frac{1}{2}\bar{\varphi} L^{\text{BF}} \left(\frac{L_t^{\text{BF}} - L^{\text{BF}}}{L^{\text{BF}}} \right)^2 \right)\,. \\ &+ R_t^m \times \left(M_t - \frac{1}{2}\kappa\bar{\varphi} M \left(\frac{M_t - M}{M} \right)^2 \right) - R_t^w \times F_t\,. \end{aligned} \tag{B.25}$$

Balance sheet:

$$L_t^{\text{BF}} + M_t = F_t\,. \tag{B.26}$$

FOC w.r.t. L_t^{BF} (comb. with FOC w.r.t. F_t and Lagrange multiplier λ_t):

$$R_t^{\text{BF}} = \frac{R_t^w + \lambda_t}{1 - \iota - \bar{\varphi}\frac{L_t^{\text{BF}} - L^{\text{BF}}}{L^{\text{BF}}}}\,. \tag{B.27}$$

FOC w.r.t. M_t (comb. with FOC w.r.t. F_t and Lagrange multiplier λ_t):

$$R_t^m = \frac{R_t^w + \lambda_t}{1 - \iota - \kappa\bar{\varphi}\frac{M_t - M}{M}}\,. \tag{B.28}$$

Market Clearing and additional definitions

Final good market clearing:

$$Y_t = C + I_t + \frac{\Gamma_t + NX_t}{P_t}\,. \tag{B.29}$$

Labor market clearing:

$$N_t = N_t^{\text{BF}} + N_t^{\text{SME}}\,. \tag{B.30}$$

Investment market clearing:

$$I_t = I_t^{\text{BF}} + I_t^{\text{SME}} \,. \tag{B.31}$$

Capital market clearing:

$$K_t = K_t^{\text{BF}} + K_t^{\text{SME}} \,. \tag{B.32}$$

Final good price normalization:

$$P_t = 1 \,. \tag{B.33}$$

World interest rate:

$$R_t^w = R^w \,. \tag{B.34}$$

Net exports:

$$NX_t = R_{t-1}^m M_{t-1} - M_t + R_{t-1}^{\text{BF}} L_{t-1}^{\text{BF}} - L_t^{\text{BF}} \,. \tag{B.35}$$

Total net costs (within the economy):

$$\begin{aligned} \Gamma_t &= \iota \times R_{t-1}^{\text{SME}} L_{t-1}^{\text{SME}} + \zeta_{t-1}^{lbs} \times D_{t-1} \\ &+ \frac{1}{2}\varphi^d D \left(\frac{D_{t-1} - D}{D}\right)^2 + P_t \times \frac{1}{2}\varphi^I K_{t-1}^s \left(\frac{I_t^s}{K_{t-1}^s} - \delta\right)^2 . \end{aligned} \tag{B.36}$$

Domestic bank dependence:

$$\text{DBD}_t = \frac{L_t^{\text{SME}}}{L_t^{\text{SME}} + L_t^{\text{BF}}} \,. \tag{B.37}$$

International bank dependence:

$$\text{IBD}_t = \frac{M_t}{M_t + D_t} \,. \tag{B.38}$$

Exogenous Processes

TFP shocks for any country c (one for each sector s):

$$\log \theta_{cst} = \rho^\theta \log \theta_{cst-1} - \sigma^\theta \eta_{cst} \,. \tag{B.39}$$

Global banking shock (same for each country c):

$$\lambda_t = \left(1 - \rho^{gbs}\right)\lambda + \rho^{gbs}\lambda_{t-1} + \sigma^{gbs}\eta_t^{gbs} \,. \tag{B.40}$$

Local bank shocks for any country c:

$$\zeta_{ct}^{lbs} = \rho^{lbs}\zeta_{ct-1}^{lbs} + \sigma^{lbs}\eta_{ct}^{lbs} \,, \tag{B.41}$$

where $\eta_{cst},\ \eta_t^{gbs},\ \zeta_{ct}^{lbs} \overset{i.i.d.}{\sim} \mathcal{N}(0,\ 1)$.