What determines the Composition of International Bank Flows?*

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Abstract

Several recent studies document that the extent to which shocks are transmitted through banks across borders depends on the type of foreign activities these banks engage in. This paper proposes a model to explain the composition of banks' foreign activities, distinguishing between international interbank lending, intrabank lending and cross-border lending to foreign firms. The model shows that the different activities are jointly determined and depend on the efficiencies of countries' banking sectors, differences in the return on loans across countries and impediments to foreign bank operations. Specifically, the model predicts that international interbank lending increases whereas lending to foreign non-banking firms declines when bank entry barriers rise, a hypothesis that is supported by German bank-level data. This suggests that policies that restrict the operations of foreign banks in a country may move activity onto international interbank markets, with the potential to make domestic credit overall less resilient to financial distress.

Keywords: global banks, interbank market, international bank flows, transmission of shocks
JEL-Codes: F30, F21, F23, G21

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1 Introduction

The recent financial crisis has highlighted that international bank linkages are pivotal for the transmission of shocks across borders. When banks' financial conditions or macroeconomic factors in the home or the host country change, banks adjust their lending on international interbank markets (see, for example, Afonso et al. (2011)), their cross-border lending to and borrowing from foreign firms and depositors (see, for example, Bruno and Shin (2013), de Haas and van Horen (2013)) and they reallocate funds through their internal capital markets (see, for example, Cetorelli and Goldberg (2011), de Haas and van Lelyveld (2010)). Research suggests that adjustments are not uniform but that banks reduce their foreign activities by varying degrees. One common finding in the literature is that lending by foreign affiliates tends to be more stable during financial crises than cross-border lending by the parent, for example.[1]

Despite the apparent relevance of the composition of foreign bank activities for the transmission of shocks, there is no theory to jointly explain why banks engage in international interbank lending, cross-border lending (from home) to foreign firms or establish internal capital markets. While the theoretical literature on international banking is growing, different types of bank flows are often isomorphic in existing models or are analyzed separately.[2] Building on Niepmann (2012) and Niepmann (2013), this paper provides a simple model of banking across borders to explain why banks engage in cross-border lending to firms, international interbank lending or establish internal capital markets.

To motivate the analysis and the modeling choices, the paper starts by providing empirical facts on the composition of international bank flows using bank-level data available at Deutsche Bundesbank. First, we document that both lending to and borrowing from banks as well as from the non-bank private sector are important components of international capital flows. As the German example shows, a country can be a net borrower from foreign banks and a net lender to the foreign non-bank private sector. Second, banks differ substantially in the sectoral composition of their domestic and foreign activities. The larger and more efficient banks borrow from the smaller and less efficient banks to grow their loan portfolios.

In line with these facts, the interbank market in the model is a means to reallocate funds from the less efficient banks to the more efficient banks.[3] Banks have to monitor firms when they extend a loan and monitoring is costly. Because banks have equal amounts of deposits but face different monitoring costs, it is optimal that the banks with the lower monitoring costs obtain funds from the banks with the higher monitoring costs to extend additional loans to firms. In the open economy model, banks can lend and borrow on international interbank markets and they can engage in cross-border lending to firms or establish foreign affiliates abroad for a fixed cost. A foreign affiliate allows the bank to decrease variable transaction costs from operating abroad and to raise additional funds from foreign depositors. In equilibrium, banks lend to

[1] We discuss the empirical evidence in Section 2.2.

[2] In Bruno and Shin (2013), intra-bank and interbank lending are isomorphic. In Niepmann (2012), interbank funding, cross-border deposit taking and borrowing from foreign affiliates are isomorphic. Niepmann (2013) abstracts from interbank lending. In de Blas and Russ (2013), cross-border lending and lending through foreign affiliates are considered as separate scenarios.

[3] This in line with in Boissay (2011), for example.

and borrow from each other as well as to and from foreign and domestic firms/depositors so that financial intermediation costs are minimized and the return on loans is maximized in the open economy. The lower the frictions to foreign bank operations are, the lower are aggregate monitoring costs and the larger is world output. The model shows that the composition of equilibrium capital flows (into cross-border loans to firms, international interbank lending, intrabank lending and foreign private sector borrowing) depends, in general, on barriers to bank entry and transactions costs from operating across borders, banking sector efficiencies and returns to capital at home and abroad.

The key result of the model is that impediments to foreign bank operations affect the composition of international bank flows. While international banking flows to the foreign non-bank private sector fall when bank entry barriers increase, interbank lending rises.[4] This theoretical result is supported by the empirical evidence presented toward the end of the paper. Again using German bank-level data, we find that the higher entry barriers are, the relatively more banks lend to other banks than to the non-bank private sector in a host country. We also show in the appendix that banks that use internal capital markets more intensively interact relatively more with firms than with banks in the host market. This suggests, that while aggregate cross-border bank flows may go down, the composition of bank flows shifts away from private sector lending toward more interbank lending when impediments to foreign bank operations increase.

This result has consequences for the current debate on global banking. It suggests that when a country raises the barriers to foreign bank entry, domestic lending may become less and not more resilient to foreign shocks. Because entry barriers harm lending between foreign banks and domestic firms more than interbank lending, lending by foreign banks may go down but the reliance of domestic banks on foreign bank funding may increase. Given that interbank lending appears to collapse more when foreign banks are in distress, an economy may become more vulnerable to foreign shocks overall aside from potentially higher costs of financial intermediation and a less efficient allocation of capital across countries.[5]

The model has two other relevant implications. First, when the impediments to foreign bank operations are lower, more capital flows across borders given the same differences in the return to capital across countries. While we do not extend the model to a dynamic setting, this finding implies that output can become less correlated while consumption can become more correlated across countries when bank entry barriers fall, reminiscent of the work by Backus et al. (1994). Second, similar to Niepmann (2012), the effect of changes in the cost of financial intermediation in a country on domestic lending depends on how open a country is to foreign bank operations. When a country is fairly open, foreign banks can step in as domestic banks shrink their balance sheets due to higher costs. This illustrates theoretically the finding in

[4]International interbank markets are often motivated by liquidity risk sharing motives. In frameworks in line with Allen and Gale (2000), interbank lending reduces the need to hold short-term assets and therefore increases (long-term) lending to firms. In this case interbank lending and lending to foreign firms are complements not substitutes.

[5]The finding by recent studies that global banks transmit shocks across borders through their internal capital market is sometimes perceived as a bad thing. However, global banks may have actually increased the resilience of an economy to foreign shocks compared to a world where capital can only flow through interbank markets or through other forms of short-term funding.

Aiyar et al. (2014a) that foreign-owned banks fill the gap when domestic banks reduce lending due to higher capital requirements.

This paper suggests several avenues for future research. While there is a growing theoretical literature that studies how financial frictions and globally active banks affect the transmission of shocks across countries, there is no work that studies how the structure of bank flows and barriers to bank entry (interbank lending, cross-border lending to firms, activities through foreign affiliates) affect the transmission of shocks and macro-economic fluctuations.[6] The model could be the basis to study these questions.[7] Moreover, a more explicit modeling of the demand for bank loans and the supply of deposits would be desirable as well as a further analysis of how well the model can match the data. The framework could also be used to study how monetary policy transmits across borders and can be effective depending on the openness of a country to foreign bank operations.

2 Motivating Facts

2.1 Empirical Facts

In this section, we highlight relevant features of banks' foreign activities to motivate our modeling choices, employing German bank-level data available at Deutsche Bundesbank. The data allow us to study the foreign activities of individual German banks across foreign countries, including their sectoral composition.

Figure 1 summarizes the conceptual framework that underlies the analysis in this paper. A parent bank can engage in operations abroad by borrowing from or lending to a foreign counterparty. This counter-party can either be a bank or a non-banking firm or household.[8] The parent bank can interact with the foreign counter-party either cross-border from home or through a foreign affiliate. In the German bank-level data, we can observe all of these dimensions: the lending versus the borrowing side of German banks' balance sheet, the sectoral composition of banks' foreign positions as well as the mode of their activities abroad. We will refer to the loans that the parent bank extends to foreign banks as *international interbank lending*. *Cross-border lending to firms* denotes loans that the parent bank issues from home to foreign non-banking firms. The terms *local lending* and *local borrowing* refer to positions on the balance sheets of affiliates vis-a-vis residents of the host country. *Intrabank lending* describes lending to the foreign affiliate by the parent bank.

Information on German banks' foreign activities comes mainly from the Foreign Positions Report, which banks file on a monthly basis with Deutsche Bundesbank.[9] We use data for 2005 and average positions over 12 months.[10] The sample includes roughly 2,000 German banks,

[6] See Kollmann (2013), Olivero (2010), Kollmann et al. (2011), and Greenwood et al. (2013).

[7] We show in the appendix that the model can easily be extended to N countries.

[8] We do not consider positions vis-a-vis the public sector or other positions than loans and receivables.

[9] Additional data come from monthly balance sheet statistics that German banks report to Deutsche Bundesbank. See the data appendix for details.

[10] Due to the large amount of data which is needed to capture the foreign operations of all German banks across various countries, we focus on data for one year.

covering essentially the entire German banking sector except from a few foreign-owned banks. Almost all of the banks in our sample have some non-zero foreign position on either the asset or the liability side of their balance sheets but only around 50 have affiliates abroad. German banks conduct operations in around 180 foreign countries.

1. Sectoral composition of banks's foreign assets and liabilities Table 1 shows the sectoral composition of German banks' aggregate foreign assets and liabilities. Each figure in the table is an average of the monthly positions in 2005. Positions are consolidated, that is, the aggregate numbers include the positions of banks' foreign affiliates. Intrabank positions between parents and affiliates are excluded.

The table shows that both lending and borrowing to and from banks as well as to and from the non-bank private sector are important components of banks' foreign activities. Claims on non-affiliated foreign banks and claims on the foreign non-bank private sector each account for roughly one third of banks' total foreign assets (27 percent and 38 percent, respectively). The table also reports the share of assets that are held in foreign affiliates. Around half of all foreign interbank loans are issued by affiliates (46 percent). They are even more important in the issuance of loans to the non-bank private sector abroad with around 70 percent. Overall, branches are more important for German banks' foreign operation than subsidiaries as the last two columns of table 1 indicate.

Consider next the liability side of banks' balance sheets summarized in the same table. Interbank liabilities represent 56 percent of total foreign liabilities. Liabilities to the foreign non-bank private sector account for around 33 percent, which is still substantial. Also the liability side indicates that foreign affiliates are important for the foreign operations of German banks. Foreign affiliates carry out most of the borrowing from the foreign non-bank private sector (close to 60 percent), and conduct around half of the borrowing from other banks. Given that interbank lending as well as lending to the foreign non-bank private sector matter quantitatively, a theoretical framework to explain banking across borders should incorporate both types of international bank flows.

2. Reallocation of capital through banks The German banking sector as a whole is a net capital exporter as can be seen from table 1. In 2005, the average net foreign asset position of the German banking sector was Euro +719 billion. Interestingly, the German banking sector as a whole was a net borrower from foreign banks (Euro -302 billion) and a net lender to the foreign non-bank private sector (Euro +355 billion). This implies that German banks borrowed on net from foreign banks and that some these funds were re-invested abroad in non-banking firms. A closer look at the data reveals that there is substantial heterogeneity in bank activities across foreign countries. Aggregate net foreign assets by country reached from Euro +143 billion for the U.S. to Euro -71 billion for Luxembourg. This shows that a significant amount of capital is reallocated across countries through banks.

3. Structure of the interbank market Stigum (1990) and Craig and von Peter (2014) find that large banks borrow from small banks on the interbank market. To illustrate that this also

holds in our data, we split the banks in the sample in two groups. The first group collects all banks whose net position vis-a-vis other domestic and foreign banks is positive, that is, banks in this group are net lenders to other banks. The second group includes all banks which are net borrowers. We would like to know whether the two groups differ with respect to their operating sizes and efficiencies. The size of a bank is proxied by the size of the parent banks' balance sheet. To measure the efficiency of a bank, we compute each parent bank's overhead costs to total assets as suggested by Niepmann (2013). Overhead costs collect salaries, expenditures on fixed assets and the likes and are therefore independent of funding costs and the pricing of loans. At the same time, overhead costs are highly negatively correlated with other measures of bank efficiency such as size and labor productivity. For brevity, we only report the results for the overhead cost measure here. The picture that emerges is exactly the same when we use bank size.

The right graph of figure 2 shows the estimated distributions of overhead costs to total assets. The graph clearly indicates that banks that are net borrowers from other banks have, on average, lower overhead costs to total assets than those banks that are net lenders. We repeat the exercise, distinguishing banks now by their net positions vis-a-vis domestic and foreign private sectors. The left graph of figure 2 depicts the distribution of overhead costs for these two groups of banks. Again, there is a clear difference between banks that are net lenders to firms and households and those that are net borrowers. Banks that lend more to than they borrow from firms and households exhibit, on average, lower ratios of overhead costs to total assets. This confirms the finding by Stigum (1990) and Craig and von Peter (2014): the more efficient (larger) banks borrow from the less efficient (smaller) banks on the interbank market to extend loans to non-banking firms and households. The theoretical framework introduced in the next section models the interbank market in a way that is consistent with this structure.[11]

4. Heterogeneity across banks in the sectoral composition of their foreign positions

Buch et al. (2011) and Niepmann (2013) have shown that banks differ substantially with respect to their foreign operations. Only larger banks hold foreign assets and foreign liabilities and establish affiliates abroad. Whereas the aforementioned studies analyze the extensive margin of total foreign assets and liabilities, we investigate whether there are differences in the extensive margin of foreign positions across sectors.

As in the first exercise, we split banks into two groups according to whether they have claims on the non-bank private sector abroad. The left graph of figure 3 plots the estimated distribution of overhead costs to total assets for banks with and without foreign private sector claims. The distribution is shifted to the right for banks with zero foreign claims. This indicates that these banks have, on average, higher overhead costs to total assets than banks that engage in foreign private sector lending. Strikingly, there are no large differences between banks when we distinguish them by their claims on the foreign banking sector as the right graph of figure 3 shows. The distribution of overhead costs to total assets are very similar for banks with non-zero and zero claims on foreign banks.

[11]For other models in which the interbank market is a means to reallocate fund from the less efficient to the more efficient banks, see Boissay (2011) and section 3.1 in Freixas and Rochet (2008) for example.

Figure 4 illustrates differences in the efficiency of banks when we split them according to their foreign liability holdings. The left graph groups banks according to whether they have liabilities vis-a-vis non-banking firms and households. The right graph distinguishes banks with respect to their liabilities toward foreign banks. Figure 4 clearly shows that banks that borrow from abroad are more efficient, regardless of whether they borrow from foreign banks or the foreign private sector, that is, they have, on average, lower overhead costs than banks that borrow only domestically.

While the presented results are overall in line with previous studies, it may be surprising that all banks are similarly likely to extend loans to banks abroad. We argue that this finding mirrors the fact that less efficient (smaller) banks are the lenders on the interbank market and that the fixed costs associated with participation in interbank markets are lower compared to lending to foreign firms and households. Thus also less efficient banks engage in international interbank lending. The theoretical framework introduced in section 3 will demonstrate this point.

As a next step, we analyze the sectoral composition of banks' foreign lending and borrowing along the intensive margin. We calculate, for each bank and destination country, the ratio of bank-to-bank versus private sector lending to study how the sectoral composition of banks' foreign activities varies with their efficiencies. Tables 2 and 3 report results from linear regressions of these log ratios on the log of banks' overhead cost to total assets, our inverse measure of bank efficiency. The regression equation is as follows:

$$\log(Y_{bc}) = \beta \log(\text{overhead}_b) + X_b'\gamma + \delta_c + \epsilon_{bc}, \tag{1}$$

where Y_{bc} stands for the ratio of bank-to-bank lending (borrowing) over private sector lending (borrowing) of bank b in country c. Country fixed effects δ_c as well as dummies for bank types X_b are included but not reported.[12] As commercial banks account for a large part of foreign activities, we provide regression results for this group separately in the second column of each table. Standard errors are clustered at the bank level.

The effects of bank efficiency on the ratios differ depending on whether we analyze the asset or the liability side. As can be seen from table 3, the ratio of borrowing from banks over borrowing from the non-bank private sector decreases with respect to a bank's overhead costs to total assets. This implies that more efficient banks borrow more from other banks than from firms abroad. On the asset side, we find that more efficient banks, if anything, lend less to other banks than to firms abroad. Due to the conservative choice of standard errors (clustered at the bank level), the coefficient on overhead costs to total assets in table 2 in column (2) is not significant at standard significance levels but it is large and has a positive sign. These findings support the notion that the less efficient banks are the suppliers of funds to the more efficient banks, which also holds internationally.[13]

[12]The different types of bank are: commercial banks, Landesbanken, savings banks, regional institutions of credit cooperatives, credit cooperatives, building credit societies, savings and loan associations, and banks with special functions.

[13]Furthermore, we find that both lending and borrowing vis-à-vis banks relative to non-bank private parties declines when a bank uses internal capital markets in a country more extensively. See appendix, tables B.1 and

2.2 Evidence on the Transmission of Shocks through Global Banks

In the previous section, we provided key facts on the composition of international bank flows, but why should we care whether banks engage in international interbank lending or operate through affiliates in foreign markets? A growing number of studies analyzes the transmission of shocks across borders through international bank connections, distinguishing between different types of bank flows. A key result of the literature is that banks do not contract their foreign activities in a symmetric way when they face liquidity problems or disruptions in the domestic financial market. Instead, they reduce certain activities more than others. Thus the transmission of financial shocks across borders through banks depends on the activities banks engage in and, hence, on the composition of international bank flows. In the following, we summarize several papers and their findings. A rough stability pecking order emerges: the most stable form of foreign lending is local lending by affiliates of foreign banks, followed by cross-border lending to firms. The least resilient form of cross-border flows appears to be interbank flows.

There are several papers that show that global banks connect countries through their internal capital markets. This has both upsides and downsides. As de Haas and van Lelyveld (2010), Ongena et al. (2013), and de Haas and van Lelyveld (2014) find, lending by foreign-owned banks in a country is less stable than lending by domestically-owned banks, with some heterogeneity in the stability of foreign-owned banks' lending across countries.[14] Duewel (2013) reports that a parent bank tends to withdraw liquidity from its foreign affiliates which have particularly good access to funding sources when it is hit by a funding shock (see also Cetorelli and Goldberg (2012)). At the same time, foreign bank ownership provides support in a domestic crisis. For example, Jeon et al. (2013) show, for emerging and developing countries, that affiliates of foreign banks are stabilized by their foreign parents when the affiliates' own generated funds become scarce (see also Popov and Udell (2012), de Haas and van Lelyveld (2006), Peek and Rosengren (2000)).

Another group of papers compares the stability of different types of bank flows. First, there is empirical evidence that local lending by affiliates is more stable than cross-border lending by their parent banks. BIS data for the recent financial crisis displays a greater retrenchment of banks from their cross-border operations than from local operations through affiliates in foreign countries (Milesi-Ferretti and Tille (2011)). Cetorelli and Goldberg (2011) find that banking systems which were more dollar-vulnerable pre-crisis experienced lower loan growth to emerging economies post-crisis, and that this effect was larger for cross-border claims than for local claims of foreign-owned banks. de Haas and van Horen (2013) find that banks that were lending internationally reduced credit less to countries in which they had a foreign subsidiary after the collapse of Lehman Brothers. Findings in Kamil and Rai (2010) and Duewel et al. (2011) are also in line with this hypothesis.[15]

B.2).

[14] During the financial crisis in 2009, foreign-owned banks did not cap their business in countries in which they dominated the banking sector (see Claessens and van Horen (2013)). Cull and Martinez Peria (2013) find that foreign banks' loan supply was less stable than domestic banks' lending with regard to Eastern Europe but not with regard to Latin America in the financial crisis.

[15] Kamil and Rai (2010) reveal that, in the financial crisis, lending by foreign banks proved to be more stable in those emerging markets in which foreign banks conducted most of their lending via local subsidiaries in local

Second, intrabank lending between parent banks and affiliates appears to be more stable in times of crisis than interbank lending. Schnabl (2012) investigates how the negative liquidity shock to international banks, which was caused by the 1998 Russian debt default, transmitted to bank lending in Peru. Upon the negative liquidity shock, foreign banks lent more intrabank (to their Peruvian subsidiaries) than across borders (to other Peruvian banks). Using BIS data, Reinhardt and Riddiough (2014) confirm this finding, documenting that the stability of intra-group flows relative to interbank flows is higher in periods of elevated global risk. The analysis by McCauley et al. (2012) of interoffice versus interbank claims held by 20 banking systems also back this result.

Third, cross-border lending to firms appears to be more stable than cross-border lending to banks (interbank lending). Aiyar et al. (2014b) find that banks in the U.K. decreased mainly their international interbank lending as a result of higher capital requirements at home but not so much their cross-border lending to the non-bank private sector.

When international interbank lending contracts, this has negative consequences for economies in which domestic banks borrow heavily on the international interbank market. Ongena et al. (2013) find that the impact of the global financial crisis on firms in Eastern Europe and Central Asia depended on whether their local banks borrowed internationally or not. Schnabl (2012) also reports that Peruvian banks which had relied on funding provided by foreign banks reduced lending to firms more than foreign-owned subsidiaries in their country. Overall, the empirical literature suggests that local lending by affiliates of foreign bank is most resilient in times of financial turmoil while international interbank lending declines the most.

3 Model

The model that we propose to explain the composition of banks' foreign activities is consistent with the facts presented in section 2.1. To build the theoretical framework, we draw heavily on the theory developed in Niepmann (2012) and Niepmann (2013). The former work shows how cross-country differences in banking sector efficiencies and returns to capital lead to banking across borders. The latter study extends the framework to include bank heterogeneity and bank capital. The model presented here is a reduced form version of Niepmann (2013) with a significantly simplified structure. The return on loans is exogenous, banks do not hold equity capital and they do not pay interest on deposits. These simplifications allow us to explicitly introduce interbank lending into the model and to avoid discontinuities so that we can obtain closed-form solutions and extend the model to N countries, which we show in the appendix.

To highlight how barriers to the activities of foreign banks affect the composition of bank flows, we study three open economy scenarios in the model. First, we allow banks to engage only in international interbank lending and borrowing. In the second scenario, banks can also engage in cross-border lending to foreign firms. Finally, banks are allowed to establish affiliates in foreign markets to borrow from foreign depositors and operate internal capital markets. As we will show, while reducing international bank flows overall, bank entry barriers shift the

currency. These subsidiaries also funded most of their lending with local deposits.

composition towards more interbank lending. Moreover, they determine how increases in the cost of financial intermediation and the return on loans in a country affect international bank flows and change their composition.

3.1 Closed Economy Setup

In the closed economy, there is a mass K of bankers and there are K units of depositor capital. In equilibrium, each banker intermediates one unit of deposits or $d = 1$.[16] Bankers can lend the collected funds to the aggregate production sector, which yields an exogenous return $R > 1$ per unit invested.[17] In order for firms to produce profitably, bankers have to monitor them at a cost, which differs across bankers.[18] Bankers draw an efficiency parameter a from a distribution $g(a)$ with support $[\underline{a}, \overline{a}]$ and finite mean a'. The higher the draw is, the more efficient is the banker and the lower are his monitoring costs.[19] Bankers face decreasing returns to scale, that is, total monitoring costs increase in the amount of capital that is lent to firms. This could be rationalized as follows: As the size of a banker's loan portfolio increases, the quality of the borrowers goes down, reflected in higher per unit monitoring costs. On a more technical note, assuming decreasing returns to scale is a simple way to obtain an endogenous bank size distribution.[20]

The monitoring costs c of a banker of type a are given by:

$$c(a) = \frac{1}{a}h(z), \tag{2}$$

where $h(z)$ is continuous and twice differentiable with $h'(z) > 0$ and $h''(z) > 0$. z is the total capital invested in firms by a banker of type a. Bankers can lend and borrow without costs from each other on the interbank market at the endogenous rate R^I. The profits of a banker of type a are therefore:

$$\pi(a) = Rz - \frac{1}{a}h(z) - R^I(z - d). \tag{3}$$

[16]The market for deposits is not modeled explicitly here as this aspect is not essential to convey the key insights of the model. One could assume, for example, that bankers face convex costs of raising deposits and compete for deposits. The deposit rate would then be a function of the interbank lending rate and the cost of raising deposits.

[17]The return on loans could be endogenized. If the return on loans was a function of the capital employed in production relative to labor, as in Niepmann (2012) for example, then the model would incorporate an additional mechanism to limit the international flow of capital. The key mechanism of the model would not be affected.

[18]See Holmstrom and Tirole (1997) for a micro-foundation of the monitoring cost.

[19]Heterogeneity in the cost of financial intermediation is also modeled in Blas and Russ (2010), de Blas and Russ (2013), and, more recently, in Niepmann (2013). In these models, the assumption of heterogeneity in financial intermediation costs across banks generates an endogenous bank size distribution that makes the frameworks consistent with the observed bank heterogeneity (see, e.g., Bremus et al. (2013), Buch et al. (2011), and Niepmann (2013)).

[20]In Niepmann (2013), an endogenous bank size distribution arises without assuming decreasing returns to scale. In her framework, a bank's equity is fixed and banks are subject to a moral hazard problem in line with Holmstrom and Tirole (1997). As a result, banks with lower monitoring cost can lever up more and are bigger. A similar structure could be assumed here but the assumption of decreasing returns increases the tractability of the model considerably.

Each banker chooses z to maximize profits. The first-order condition implies:

$$h'(z) = a(R - R^I). \tag{4}$$

Given the assumed properties of $h(z)$, there exists a unique solution to z, which increases in the return to capital R and the banker's efficiency a and decreases in the interbank lending rate R^I. Assume that $h(z) = \frac{1}{2}z^2$, then $z = a(R - R^I)$.

Capital market clearing requires that banks invest the entire depositor capital K in the production sector. This conditions pins down the interbank lending rate R^I:

$$K \int_{\underline{a}}^{\overline{a}} z(a)g(a)da = K. \tag{5}$$

Plugging in z, we obtain:

$$\int_{\underline{a}}^{\overline{a}} a(R - R^I)g(a)da = 1. \tag{6}$$

Solving for R^I yields:

$$R^I = R - \frac{1}{\int_{\underline{a}}^{\overline{a}} ag(a)da} = R - \frac{1}{a'}, \tag{7}$$

where $a' = E(a) = \int_{\underline{a}}^{\overline{a}} ag(a)da$ reflects the average efficiency of banks in the economy. Expression (7) shows that the interbank lending rate in the economy is a function of the return on loans and the efficiency of the economy's banking sector. The larger the return R and the lower the bankers' average monitoring costs are, the higher is the equilibrium interbank lending rate R^I.[21]

Bankers with $z < d = 1$ invest the amount z in firms and lend the rest to other banks; that is, they finance themselves with deposits and hold assets in firms and other banks. Bankers for which $z = 1$ invest all their funds in firms and do not engage in interbank lending or borrowing. Bankers with $z > 1$ borrow from depositors and from other banks. Thus, the closed economy model generates an interbank market structure that is consistent with motivating fact number 3: the more efficient banks are the borrowers on the interbank market, whereas the less efficient banks are the lenders.[22] The total volume lent on the interbank market is given by:

$$V = \int_{\underline{a}}^{\frac{1}{R-R^I}} (d - z(a))g(a)da, \tag{8}$$

which is the integral of deposits minus loans over all bankers that are lenders on the interbank market.

[21] It is assumed that parameters are such that investment and financial intermediation are beneficial in the economy so that all funds are in fact invested in projects. This requires that monitoring costs are not too high so that $R - 1/a' > 1$.

[22] Stigum (1990) writes: "In essence, the nation's [the U.S.] smaller banks are the suppliers of fed funds, and the larger banks are the buyers".

3.2 Open Economy

In the open economy, there are two countries 1 and 2. It is assumed that the banking sectors of the two countries are similar in terms of their efficiencies. However, returns to capital differ across countries. In particular, the return is higher in country 1 so that $R_1 > R_2$.[23] We call country 1 the U.S. and country 2 Germany. In the appendix, we show how the model can be generalized to include N countries and any combination of parameters. The simple case considered here increases tractability and is sufficiently complex to convey the key insights of the model.[24]

3.2.1 Scenario 1: International interbank lending

As the first scenario, we consider the case in which there is an international interbank market that allows banks to lend and borrow across borders. However, banks cannot invest in the foreign private sector. Therefore, interbank lending is the only channel through which capital can be reallocated from one country to the other.

Since banks can freely borrow from and lend to each other, an equilibrium requires that the international interbank market clears or:

$$K_1 + K_2 = K_1 \int_{\underline{a}_1}^{\overline{a}_1} a_1(R_1 - R^I)g_1(a_1)da_1 + K_2 \int_{\underline{a}_2}^{\overline{a}_2} a_2(R_2 - R^I)g_2(a_2)da_2. \tag{9}$$

This condition requires that the capital lent to firms in the two countries equals the world capital endowment. Solving for R^I delivers the following expression:

$$R^I = \frac{K_1 R_1 a_1' + K_2 R_2 a_2' - K_1 - K_2}{K_1 a_1' + K_2 a_2'}, \tag{10}$$

where $a_i' = E(a_i) = \int_{\underline{a}_i}^{\overline{a}_i} a_i g_i(a_i)da_i$. The interbank lending rate in the open economy thus depends on the size and the return to capital of the two countries as well as the average efficiency of each of the two banking sectors. The same factors also determine the international capital flow. In equilibrium, capital is allocated such that differences in monitoring costs and differences in returns are optimally traded off.[25] The equilibrium capital flow K_{12}, defined as the capital flow from country 2 (Germany) to country 1 (the U.S.), is given by:

$$K_{12} = K_1 \int_{\underline{a}_1}^{\overline{a}_1} a_1(R_1 - R^I)g_1(a_1)da_1 - K_1 = \frac{K_1 a_1' K_2 a_2'(R_1 - R_2) + (a_1' - a_2')K_1 K_2}{K_1 a_1' + K_2 a_2'}. \tag{11}$$

This expression shows that the larger the return on loans is in the U.S. relative to Germany and the more efficient U.S. banks are relative to German banks, the larger is the capital flow

[23] Differences in the return on loans may arise from cross-country differences in the productivity of firms or from differences in countries' endowments of capital relative to labor, for example.

[24] An implicit assumption of the model is that capital can only flow across borders through banks. No other financial assets but loans (such as bonds) are traded and there is no foreign direct investment by firms. This way we isolate the role of banks in the flow of capital.

[25] This tradeoff is also emphasized in Niepmann (2012) and Niepmann (2013).

from Germany to the U.S. As every additional unit of capital that is employed in production in the U.S. must be intermediated by U.S. banks, a more efficient U.S. banking sector implies that the economic loss in terms of monitoring costs is lower and, hence, it is beneficial to employ more capital in production there.

Since we assume that $R_1 > R_2$ and $a_1' \approx a_2'$, U.S. banks borrow from German banks on the international interbank market on net. The total volume of funds that are reshuffled on the interbank market can be written as:

$$V = \int_{\underline{a}_1}^{\frac{1}{R_1 - R^I}} (1 - z(a_1))g(a_1)da_1 + \int_{\underline{a}_2}^{\frac{1}{R_2 - R^I}} (1 - z(a_2))g(a_2)da_2. \tag{12}$$

Comparison to autarky In line with the empirical evidence presented in section 2.1, the international interbank market in the model is a means to reallocate funds across borders. Here, capital flows from Germany to the U.S. As a consequence, some banks in Germany that were borrowers on the interbank market in the closed economy turn into lenders in the open economy and vice versa in the U.S. Figure 5 illustrates this. It shows the amount z that is lent to the private sector by a bank as a function of its efficiency a in the open economy as well as in autarky. Those banks for which z is below the horizontal line are lenders on the international interbank market. The size of their balance sheets equals $d = 1$. Those banks for which z is above the horizontal line are borrowers on the interbank market. The size of their balance sheets is equal to z. Because U.S. banks borrow on net from German banks, the balance sheet of the U.S. banking sector and, thus, credit in the U.S. expand compared to autarky. In contrast, credit to German firms declines and the share of interbank loans on the balance sheets of German banks rises.

3.2.2 Scenario 2: Interbank lending and cross-border lending

As a next step, we allow banks to also lend to firms abroad, in addition to lending and borrowing on the international interbank market. However, lending to firms abroad is costly. Banks from country j that lend to firms in country i have to pay the fixed cost $f_{ij}^X > 0$. These costs can be interpreted as fixed investment costs or, more broadly, as the cost of acquiring information about the business environment abroad.[26] To facilitate the exposition, we assume that U.S. banks do not operate in Germany because the fixed and variable costs of lending cross-border to German firms are prohibitively high. Only German banks extend loans to foreign firms.

Banks can grow if they engage in lending to the non-bank private sector abroad, in a way that we will specify in a moment. The assumption can be motivated by love for variety in loans, for example. If banks can offer differentiated loans, then each bank specializes in providing a

[26] In the presented framework, banks become global and large because they are more efficient than other banks and therefore can overcome fixed costs. While global banks certainly differ in terms of the services they provide and one might think of simply different types of banks that specialize in providing domestic versus cross-border services, there is evidence that fixed costs play a significant role in cross-border bank operations. Niepmann (2013) finds that the least efficient bank that engage in cross-border lending or borrowing in a host country varies systematically with the cost of operating in the host country, supporting the model approach taken in this paper.

particular type of loan or in lending to a particular type of firm/sector, and it is optimal that every bank operates in every country.[27] Specifically, we model the profit function of a banker in country 2 as follows:

$$\pi_2(a_2) = \sum_{i=1}^{2} \left(R_i z_{i2} - \frac{1}{\delta_{i2} a_j} h(z_{i2}) - R^I z_{i2} - f_{ij}^X \right) + R^I d, \tag{13}$$

where $f_{22}^X = 0$, $\delta_{22} = 1$ and $0 \leq \delta_{12} \leq 1$. This formulation implies that banks' monitoring costs at home and abroad are separable so that their decision to engage in cross-border lending is independent of lending at home; banks seek to replicate their business abroad.[28] δ_{12} reflects inversely the efficiency loss of a banker from Germany that lends to firms in the U.S. This efficiency loss can be due to information frictions, since it may be harder for firms to access information about clients abroad. It can also reflect greater transaction costs. When firms are located in another country, travel costs to meet with clients may increase, for example.[29] If the information friction is so high that monitoring costs go to infinity, which corresponds to $\delta_{12} \to 0$, or if the fixed cost f_{12}^X of operating abroad is prohibitively high, scenario 2 coincides with scenario 1. Then, there is no cross-border lending to firms but only international interbank lending.

A banker in country 2 chooses to lend to firms abroad if he/she makes positive profits on the foreign business, which implies $R_1 z_{12}^X - \frac{1}{\delta_{12} a_2} h(z_{12}^X) - R^I(z_{12}^X) \geq f_{12}^X$. Let a_{12}^* denote the (German) banker who breaks even on the foreign business. Assuming that $h(z) = \frac{1}{2} z^2$, $z_{12}^X(a_2) = \delta_{12} a_2 (R_1 - R^I)$ and the cutoff banker is given by:

$$a_{12}^* = \min \left\{ \max \left\{ \frac{2 f_{12}^X}{(R_1 - R^I)^2 \delta_{12}}, \overline{a}_2 \right\}, \underline{a}_2 \right\}. \tag{14}$$

The expression shows that the lower the interest rate R^I, the lower the fixed cost f_{12}^X, and the higher the return to investment R_1 are, the lower is the cutoff a_{12}^*, implying that even the less efficient banks find it profitable to engage in cross-border lending.

The interbank lending rate R^I is, as in scenario 1, pinned down by the capital market clearing condition:

$$\sum_{i=1}^{2} K_i = \sum_{i=1}^{2} \tilde{K}_i, \tag{15}$$

where $\tilde{K}_i$ represents the capital employed in production in country i whereas K_i denotes country

[27] Love for variety in loans is modeled in Blas and Russ (2010). An alternative interpretation of our assumption is that banks want to invest at home and abroad in order to diversify. If risk is reduced, banks may be able to increase their leverage and, thereby, the size of their balance sheets.

[28] The model would also work without the separability. In this case, banks would either invest at home or abroad as in Niepmann (2013).

[29] It is well documented that information frictions and distance affect banks' foreign activities. See Buch (2003), Focarelli and Pozzolo (2005) and Degryse and Ongena (2005).

i's endowment of capital. Plugging in the expression for $\tilde{K}_i$ yields:

$$K_1 + K_2 = \left(K_2 \int_{a_{12}^*}^{\bar{a}_2} z_{12}^X g_2(a_2) da_2 \right) + \left(K_1 \int_{\underline{a}_1}^{\bar{a}_1} z_{11} g_1(a_1) da_1 \right) + \left(K_2 \int_{\underline{a}_2}^{\bar{a}_2} z_{22} g_2(a_2) da_2 \right). \quad (16)$$

The interbank lending rate can be written as:

$$R^I = \frac{K_1 R_1 a_1' + K_2 R_2 a_2' + K_2 R_1 \delta_{12} a_2'' - K_1 - K_2}{K_1 a_1' + K_2 a_2' + K_2 \delta_{12} a_2''}, \quad (17)$$

where $a_2'' = \int_{\frac{2 f_{12}^X}{(R_1 - R^I)^2 \delta_{12}}}^{\bar{a}_2} a_2 g_2(a_2) da_2$.

Proposition 1 *(i) The solution to the interbank lending rate R^I in the open economy with cross-border lending exists and is unique. (ii) The interbank lending rate is weakly higher than under scenario 1.*

Proof. See the appendix. ■

Comparison between scenarios 1 and scenario 2 The equilibrium interbank lending rate increases compared to the open economy with international interbank lending when banks can engage in cross-border lending to firms. Because the more efficient banks extend loans to firms abroad in addition to lending domestically, their demand for interbank funds increases. For smaller banks to be willing to provide these funds, the interbank lending rate must go up. The total volume of funds that are reallocated on the interbank market increases accordingly compared to scenario 1, which can be seen from expression 12.

Because the monitoring cost of an extra unit of capital that is invested in country 1 has gone down compared to scenario 1, due to the fact that German banks can now operate in the U.S., the tradeoff between allocating capital efficiently and minimizing monitoring costs is alleviated. As a consequence, more capital flows into the country with the higher return to capital. To see this, consider the net capital flow from country 2 (Germany) to country 1 (the U.S.), which can be written as:

$$K_{12} = -K_2 \int_{\underline{a}_2}^{\bar{a}_2} a_2 (R_2 - R^I) g_2(a_2) da_2 + K_2. \quad (18)$$

Since the interbank lending rate has gone up, banks in country 2 invest less domestically compared to scenario 1 so that $K_{12}^{CL} > K_{12}^{IB}$.

Consider next the international interbank flows. In the open economy with cross-border lending, the capital that is channeled on net through the interbank market across borders is determined by:

$$B_{12} = K_1 \int_{\underline{a}_1}^{\bar{a}_1} a_1 (R_1 - R^I) g_1(a_1) da_1 - K_1. \quad (19)$$

It corresponds to U.S. banks' total lending to domestic firms minus total U.S. deposits. Because the interbank lending rate is higher in scenario 2 than under scenario 1, it follows from the

above expression that $B_{12}^{IB} > B_{12}^{CL}$; that is, the amount of capital that flows from Germany to the U.S. through the international interbank market is lower in the open economy with cross-border lending. As German banks find it profitable to invest directly in U.S. firms, they do not pass on as many funds to U.S. banks as in scenario 1. It can in fact happen that the direction of net interbank flows reverses. In this case, German banks borrow on the international interbank market from U.S. banks and invest these funds in U.S. firms by engaging in cross-border lending to firms.[30] Table 1 indicated that the German banking sector as a whole is a net borrower from foreign banks but a net lender to the foreign private sector. The model can map and accommodate this situation.

The next proposition summarizes the finding that lending to foreign firms and lending to foreign banks are substitutes.

Proposition 2 *(i) The net capital flow B_{12} from country 2 to country 1 that goes through the international interbank market decreases in δ_{12}, an inverse measure of the efficiency loss from operating cross-border. The net interbank flow increases in the fixed cost f_{12}^X that banks in country 2 incur when engaging in cross-border lending to firms in country 1. (ii) Lending by banks in country 2 to firms in country 1, in turn, increases in δ_{12} and decreases in the fixed cost f_{12}^X.*

Proof. See the appendix. ■

Figure 6 illustrates how international bank flows behave as the barriers to cross-border lending f_{12}^X rise. The solid line depicts total cross-border lending to firms in country 1 (the U.S.) by banks in country 2 (Germany). As the cost of operating abroad rises, German banks extend fewer loans to U.S. firms. In contrast, the amount of funds that German banks lend to U.S. banks increases, reflected in the upward sloping dotted line. When the cost of operating abroad are very low, German banks borrow on the interbank market from U.S. banks as in the pictured example: the interbank flow is negative for low values of f_{12}^X, that is, the dotted line lies below zero. As the costs of cross-border lending to firms rise, German banks eventually turn into net lenders on the international interbank market, indicated by the dotted line that lies above zero.

The equilibrium composition of bank flows into interbank flows and cross-border flows to firms does not only depend on the cost of operating abroad. Consider what happens as the U.S. banking sector becomes more efficient. This also has an effect on the amount of cross-border lending to firms and net international interbank lending. If a_1' increases, U.S. banks increase their lending to the non-bank private sector and demand more funds on the interbank market. Accordingly, the interbank lending rate rises. When funding costs are higher, fewer German banks find it profitable to lend to U.S. firms. As a consequence, there is less cross-border lending to firms. At the same time, the net interbank flow from German banks to U.S. banks increases.[31]

Proposition 3 *(i) The net interbank flow B_{12} from country 2 to country 1 increases in the*

[30] This result resembles findings in Ju and Wei (2010), who show that financial frictions can make capital leave a country as depositor capital and reenter as FDI.

[31] This finding is in line with model predictions in Niepmann (2012).

aggregate efficiency a_1' of banking sector 1. (ii) Lending to firms in country 1 by banks from country 2 decreases in a_1'.

Proof. See the appendix. ■

Consider again figure 6. The dashed and dash-dotted line show the amount of cross-border lending and interbank lending, respectively, when the U.S. banking sector is more efficient compared to the parameter values that underly the solid and the dotted line. When banks in the U.S. face, on average, lower monitoring costs, the amount of cross-border loans to U.S. firms by German banks is lower. Instead, German banks increase their lending to U.S. banks.

The model does not only have predictions for aggregate bank flows but also for the composition of single banks' foreign assets and liabilities. Banks sort into cross-border lending to firms based on their efficiency. Only the most efficient banks extend loans to foreign firms and borrow on the international interbank market. In contrast, less efficient banks only lend to domestic firms and do not borrow but lend on the interbank market. This structure is consistent with the empirical observations discussed in section 2.1. There, we showed that larger and more efficient banks are more likely to lend to foreign firms but that banks do not differ significantly in the probability of lending to foreign banks.

Figure 7 illustrates how the balance sheet composition of banks in the two countries changes when they can engage in cross-border lending to firms. As can be seen from the graph, the mass of bankers for which z is below the horizontal line increases in both countries, implying that the smallest banks reduce their lending to the private sector and extend more loans to other banks. These funds go to the most efficient German banks that engage in cross-border lending and can thereby increase the total size of their balance sheets.

3.2.3 Scenario 3: Interbank lending, cross-border lending and FDI

As the final scenario, we consider what happens when German banks are able to open up affiliates in the U.S. for a fixed cost f_{12}^F. A foreign affiliate has the advantage of increasing the efficiency of banks when they operate abroad, that is, $\delta_{12} = 1$. At the same time, the foreign affiliate can obtain additional funds from foreign depositors.[32]

If a banker of type a_2 opens up a foreign affiliate in country 1, his profits that come solely from operations in that country are given by:

$$\pi_{12}(a_2) = R_1 z_{12}^F - \frac{1}{a_2} h(z_{12}^F) - R^I z_{12}^F - f_{12}^F + R^I d_{12}, \tag{20}$$

where $f_{12}^F > f_{12}^X + R^I d_{12}$. This assumption ensures that the fixed cost of establishing a foreign affiliate is sufficiently high so that operating cross-border can be optimal for some banks in the

[32] An affiliate in our framework can be interpreted both as a branch and a subsidiary, although the interpretation as a subsidiary is preferred. Branches often facilitate lending to or borrowing from foreign banks or wholesale investors. In contrast, subsidiaries make it easier for banks to raise retail deposits in a foreign market. (In some countries, foreign bank branches are not allowed to collect deposits at all.) The model could distinguish between branch and subsidiary by assuming that a branch eliminates δ_{12} whereas a subsidiary allows banks to compete for foreign deposits.

economy. The last term in the above equation reflects the value of the additional deposits d_{12} that the banker can raise by establishing a foreign affiliate.

If $h(z) = \frac{1}{2}z^2$, then $z_{12}^F = a_2(R_1 - R^I)$. Each banker chooses to open up an affiliate abroad if profits are positive and higher than the profits from extending loans cross-border. The banker a_{12}^{**} who is indifferent between the two modes is found by setting profits under cross-border lending equal to profits with an affiliate in country 1. Given the assumed monitoring cost function, this delivers the cutoff banker a_{12}^{**} as follows:[33]

$$a_{12}^{**} = \min\left\{\max\left\{\frac{2}{(R_1 - R^I)^2}\frac{1}{1-\delta_{12}}(f_{12}^F - f_{12}^X - R^I d_{12}), \overline{a}_2\right\}, \underline{a}_2\right\} \tag{21}$$

As before, the capital invested in each country by all bankers must equal the world capital endowment. This condition pins down the interbank lending rate R^I:

$$\begin{aligned} K_1 + K_2 &= \left(K_2 \int_{a_{12}^*}^{a_{12}^{**}} z_{12}^X g_2(a_2)da_2\right) + \left(K_2 \int_{a_{12}^{**}}^{\overline{a}_2} z_{12}^F g_2(a_2)da_2\right) \\ &+ \left(K_1 \int_{\underline{a}_1}^{\overline{a}_1} z_{11} g_1(a_1)da_1\right) + \left(K_2 \int_{\underline{a}_2}^{\overline{a}_2} z_{22} g_2(a_2)da_2\right). \end{aligned} \tag{22}$$

All banks located in a country raise capital from domestic depositors. When foreign banks open up affiliates in a country, the mass of bankers that want to raise deposits increases. In equilibrium, each banker obtains the capital stock divided by the mass of bankers located in the country.[34] Therefore, the following condition must hold:

$$K_1 = K_1 \int_{\underline{a}_1}^{\overline{a}_1} d_{11} g_1(a_1)da_1 + K_2 \int_{a_{12}^{**}}^{\overline{a_1}} d_{12} g_2(a_2)da_2, \tag{23}$$

where $d_{11} = d_{12}$. The deposits that each bank operating in country 2 obtains are thus:

$$d_{11} = d_{12} = \frac{K_1}{K_1 + K_2 \int_{a_{12}^{**}}^{\overline{a}_2} g_2(a_2)da_2}. \tag{24}$$

When there is no deposit taking by foreign banks so that $a_{12}^{**} = \overline{a_2}$, then $d_{11} = 1$ as was assumed before.

Proposition 4 *(i) There exists a unique solution to the international interbank lending rate R^I in the open economy with international interbank lending, cross-border lending and FDI if the sufficient condition $f_{12}^F - f_{12}^X > R_1$ holds. (ii) The interbank lending rate is weakly higher than under scenario 2.*

[33]Note that scenario 3 coincides with scenario 2 if the fixed cost f_{ij}^F of FDI is prohibitively large or if there is no efficiency loss from operating cross-border, that is, if $\delta_{12} = 1$.

[34]It is straightforward to add a structure where raising deposits is costly and banks decide how many deposits to take. With synergies between deposit taking and lending or with heterogeneity in the cost of deposit taking across banks, the amount of deposits would vary across banks. We take a short cut to modeling deposit taking here as it is not essential to study the composition of bank flows.

Proof. See the appendix. ■

The solution to the equilibrium is unique if $f_{12}^F - f_{12}^X > R_1$. This condition implies that the cutoff a_{ij}^{**} increases in R^I. Consider again equation 21. When the interbank lending rate rises, there are two countervailing effects on the cutoff. On one hand, a higher interbank lending rate R^I increases banks' funding costs and the optimal amount of lending to firms by the affiliate goes down. On the other hand, the benefit from opening up an affiliate increases because the additional deposits that can be raised abroad are worth more. The aforementioned inequality implies that the negative effect of an increase in R^I on lending volumes dominates the positive effect on the value of the deposits raised abroad. The condition is sufficient to ensure that the solution to R^I is unique.

The international interbank lending rate is given by:

$$R^I = \frac{K_1 R_1 a_1' + K_2 R_2 a_2' + K_2 R_1 \delta_{12} a_2'' + K_2 R_1 a_2''' - K_1 - K_2}{K_1 a_1' + K_2 a_2' + K_2 \delta_{12} a_2'' + K_2 a_2'''}, \tag{25}$$

where $a_2'' = \int_{a_{12}^*}^{a_{12}^{**}} a_2 g_2(a_2) da_2$ and $a_2''' = \int_{a_{12}^{**}}^{\bar{a}_2} a_2 g_2(a_2) da_2$.

Comparison between scenarios 2 and 3 When banks can open up foreign affiliates, their foreign lending increases compared to the case with cross-border lending since monitoring costs have come down. As a consequence, the demand for interbank funds increases and the equilibrium interbank lending rate R^I is higher than under scenario 2. Because even more funds are reshuffled from the less efficient to the more efficient banks, the total volume of interbank lending increases compared to scenario 2. Similarly, the net capital flow from country 2 to country 1 rises.

Since some of the German banks now operate through foreign affiliates in the U.S., they will operate internal capital markets. If we assume that affiliates in foreign markets do not raise funding from or lend to other banks but that the parent borrows from or lends to the affiliate, then we can calculate the size of a bank's internal capital market as the difference between the amount of loans the affiliate extends and the deposits it raises from foreign depositors:

$$m_{12}(a_2) = z_{12}^F(a_2) - d_{12} = a_2(R_1 - R^I) - d_{12}, \tag{26}$$

Note that the parent bank can lend or borrow from its affiliate. The higher the return in country 1 is, the more likely it is that the intra-group flow is positive, that is, that the parent bank in Germany is a lender to its affiliate in the U.S. The total volume of intragroup flows between country 1 and country 2 can be written as:

$$M_{12} = K_j \left(\int_{a_{12}^{**}}^{\bar{a}_2} (z_{12}^F - d_{12}) g_2(a_2) da_2 \right) \tag{27}$$

Given that intra-bank lending and borrowing are assumed to be costless, variable costs can be saved if the affiliate extends the loan and not the parent bank. Therefore, cross-border lending

to firms and local lending through affiliates to firms are substitutes.[35] The next proposition reflects this finding:

Proposition 5 *(i) Lending to the private sector through foreign affiliates and deposit taking decreases in the fixed cost f_{12}^F of establishing an affiliate abroad. (ii) The volume of cross-border lending to foreign firms increases in f_{12}^F.*

Proof. See the appendix. ■

With internal capital markets in operation, the net capital flow that goes through the international interbank market is given by:

$$B_{12} = K_1 \int_{\underline{a}_1}^{\overline{a}_1} a_1(R_1 - R^I) g_1(a_1) da_1 - K_1 \int_{\underline{a}_1}^{\overline{a}_1} d_{11} g_1(a_1) da_1. \tag{28}$$

Whether the net capital flow through international interbank markets increases or decreases compared to the case with cross-border lending depends on how much German banks are able to raise from U.S. depositors relative to the additional capital they want to invest in the U.S. Because the friction δ_{12} is eliminated, German banks that operate through foreign affiliates increase their lending to U.S. firms. At the same time, they raise additional deposits d_{12} in the U.S. If the volume of deposits that are raised plus the additional capital that German banks can obtain domestically is smaller than the additional funds that German banks want to lend to U.S. firms, then the net interbank flow B_{12} is smaller than under scenario 2. In this case, German banks borrow more from U.S. banks as local lending increases.

Figure 8 depicts such a situation. It illustrates the composition of bank flows as a function of the fixed cost f_{12}^F. Start from the left hand side of the left graph, where f_{12}^F is so low that all German banks operate through foreign affiliates (dash-dotted line) and do not extend loans to firms cross-border (solid line). Consider now the right graph of figure 8. In such a situation the net interbank flow from Germany to the U.S., indicated by the solid line, is negative, which implies that German banks borrow from U.S. banks to lend to U.S. firms. As the fixed cost of establishing an affiliate rises, intra-bank lending and local lending fall. See the dash-dotted lines in the graph on the right and on the left, respectively. In contrast, more banks engage in cross-border lending to firms. Because the reduction in local lending is not compensated by the increase in cross-border lending to firms, the amount of total lending to foreign firms by German banks goes down, which is depicted by the dotted line in the left graph. In turn, the net interbank flow rises, which, again, shows that lending to foreign firms and lending to foreign banks are substitutes. As the fixed cost of FDI increases even more, the German banking sector turns, at some point, from a net borrower on the international interbank market into a net lender. Eventually, German banks only operate cross-border and do not have foreign affiliates in the U.S. anymore. This is illustrated in the graph on the left, where local lending eventually drops to zero (dash-dotted line), and cross-border lending (solid line) equals total lending (dotted line).

Figure 9 provides the bank-level view. It shows a bank's private sector lending as a function of its efficiency a. In line with the empirical facts, the model predicts that only the most

[35] Such a proximity-fixed cost tradeoff is also present in Niepmann (2013).

efficient banks establish affiliates in foreign markets.[36] Because these banks can reduce the cost of lending to foreign firms, they increase their lending volumes and, hence, the size of their balance sheets. The dash-dotted line in figure 9 depicts lending by German banks when they can open up affiliates in the U.S. The less efficient German banks only lend to domestic firms as in the closed economy. The more efficient banks extend loans cross-border because it is not profitable for them to invest in FDI.[37] In contrast, the most efficient German banks operate through foreign affiliates in the U.S. and are largest in terms of their balance sheet size. These banks raise funding not only from foreign banks but also from foreign depositors.[38]

The model assumes that U.S. banks do not operate in Germany. If they were allowed to, the proof of the propositions would become more involved but the key results would still hold. In the appendix, we show that the model can be easily generalized to allow for N countries and that a unique equilibrium exists. Deriving general results of comparative statics is more complex as third country effects start playing a role. However, the result that lending to the foreign private sector and lending to the foreign banking sector are substitutes is unchanged. Simulating the model and matching it to the data to conduct policy experiments is a promising avenue for future research.

3.3 Implications for the Macroeconomy

The model shows that entry barriers shift the composition of bank flows toward more interbank lending and away from lending to the foreign non-bank private sector. This has implications for the macroeconomy. As we discussed in the beginning of this paper, there is growing empirical evidence that different types of international bank flows respond differentially to distress in the home or the host country. A common conclusion is that lending to firms either through affiliates or cross-border is more stable than international interbank lending. Therefore, because barriers to foreign bank operations can shift bank flows towards more interbank lending as the model highlights, they may make credit in an economy less resilient to shocks. In the next section, we show that the effect of entry barriers on the composition of bank flows is supported by the data. We also quantify the effect and discuss policy implications in more detail.

Beyond the effect of entry barriers on the composition of bank flows, the model also shows that changes in macroeconomic conditions have differential effects, depending on the structure of international bank flows. Changes in the return to capital lead to a larger reallocation of capital when banks lend cross-border to firms or operate through foreign affiliates. To see this, consider figure 10. The graph shows the equilibrium capital flow as a function of the return to investment in country 1 for different degrees of banking sector openness. When the U.S. banking sector is more open, both domestic and foreign banks can channel capital to foreign firms so the monitoring friction is reduced as capital can be intermediated by the more efficient banking sector. The model does not explicitly incorporate productivity shocks, consumption

[36] See Buch et al. (2011) and Niepmann (2013).

[37] The model in Niepmann (2013) predicts the same sorting.

[38] Conditional on having a physical presence abroad, more efficient banks in the model source a larger share of the their funds from banks because larger banks have the same access to deposits as smaller banks, similar to the closed economy.

risk etc. However, the fact that the same differences in returns lead to larger capital flows when banks can directly lend to the foreign private sector suggests that output can become less correlated and consumption profiles more correlated when barriers to cross-border lending and FDI are reduced. This is reminiscent of results in Backus et al. (1994).

Similarly, a shock to the intermediation costs in country 1 has different consequences for investment and capital flows when banks only engage in international interbank lending but not in direct lending to the private sector. This is similar to findings in Niepmann (2012) who shows that the effect of an increase in banking sector efficiency depends on a country's banking sector and capital account openness. When German banks can only engage in international interbank lending, the effect of a decrease in the efficiency a_1' of banking sector 1 on the equilibrium capital flow K_{12} and, hence, on investment in the U.S. is stronger. Figure 11 illustrates this point. With interbank lending only, the capital flow from Germany to the U.S. goes down because the cost of investing a unit of capital in the U.S. has gone up. The mechanism under cross-border lending is different. A reduction in the efficiency of banking sector 1 leads to a drop in the interbank lending rate ceteris paribus. This implies that German banks increase their lending at home and abroad, which attenuates the negative effect on lending in the U.S.[39]

4 Additional Support for the Theory

According to the model, the composition of banks' foreign activities depends not only on bank efficiency in the home country but also on country characteristics such as the average efficiency of banks in the host country, barriers to foreign bank entry, and transaction costs from operating across borders. In this section, we provide empirical support for these additional implications. We show that foreign interbank positions by German banks relative to positions in the foreign non-bank private sector are higher the more efficient the host country banking sector is and the larger the costs from operating abroad are. While the presented evidence is preliminary, it supports the idea that the composition of banks' foreign activities shifts as entry barriers and local intermediation costs change. The effects are economically significant.

4.1 Banks' Foreign Positions and Host Country Characteristics

To explore whether banking sector efficiency in the host country and frictions due to borders help explain the composition of bank flows, we employ again the German bank-level data described in detail in section 2.1. The dependent variables that we construct from this data are discussed below. To measure frictions from operating across borders, we use two different proxies. First, we obtain a measure of bank entry barriers from an IMF database on financial reform described in Detragiache et al. (2008). The variable *Openness to foreign bank entry* captures the repressive effect of policies on competition in the domestic banking market. It

[39]This illustrates the mechanism through which foreign banks can "fill the gap" in lending that may arise when domestic banks shrink their balance sheets due to higher costs in line with findings in Aiyar et al. (2014a). This mechanism can be perceived as both positive and negative. On one hand, lending may remain stable if domestic banks are in distress. On the other hand, regulators may not be able to limit credit expansion and risk taking in the economy if they cannot regulate foreign banks.

takes four different values in the sample: largely liberalized (e.g. the United States), partially repressed A (positive tendence, e.g. Malaysia), partially repressed B (negative tendence, e.g. China) and fully repressed (e.g. Pakistan). Second, we include an index of *Financial Freedom* provided by the Heritage Foundation in our regressions, which captures the degree to which a country's government interferes with the functioning of financial services, for instance by regulating the allocation of credit or intervening in banks. The index also assesses the overall development of financial and capital markets. The index goes from 1 to 100, with higher values indicating larger degrees of financial freedom.

In addition to these variables that proxy the fixed and variable costs of operating in a given host country, we include the variable *overhead* contained in the World Banks' Financial Structure Database as independent variable. This variable reflects the average ratio of overhead costs to total assets of banks residing in a country and is a proxy of the aggregate banking sector efficiency in a host country. It is consistent with the efficiency measure for single German banks that we employed in the beginning of the paper.

To control for the size and the overall development of the host country, we also include GDP and GDP per capita in the regressions. Moreover, we add a host country's distance from Germany as a regressor to capture the costs arising from informational frictions. The efficiency measure, GDP, GDP per capita and distance enter the regression in logs.[40]

Variation of the extensive margin with country characteristics As a first step, we investigate how the composition of bank flows varies with host country characteristics along the extensive margin. To that end, we regress the log ratio of the number of German banks that engage in bank-to-bank lending over the number of banks that engage in private sector lending in a foreign country on the independent variables described before. This allows us to assess whether banking sector efficiency in the host country and the cost of operating there have differential effects on the extensive margin of interbank lending relative to private sector lending. The regression equation is as follows:

$$\log(Y_c) = \alpha + X_c'\beta + \epsilon_c, \tag{29}$$

where Y_c stands for the ratio of the number of banks with positive foreign assets (liabilities) in the banking sector of country c over the number of banks with positive foreign assets (liabilities) in the private sector of country c. X_c collects the country variables.

The regression results for the asset side are presented in table 4. Table 5 shows the results for foreign liabilities. Robust standard errors are in parentheses. Columns (1) and (2) of tables 4 and 5 indicate that barriers to foreign entry in a host country are correlated with the composition of banks' foreign activities. When the openness to foreign bank entry in a host country is "fully repressed", the number of German banks that lend to/borrow from the banking sector relative to the number of banks that lend to/borrow from the private sector is significantly larger than in countries that are "largely liberalized", which is the omitted baseline category of the openness indicator. This result is in line with the predictions of the model.

[40]See the data appendix for data sources and further details on the different variables.

According to the theory, fewer banks engage in lending to foreign firms when operating abroad is more difficult. Moreover, when entry barriers are higher, fewer banks borrow from foreign households. The implicit assumption in the model is that entry barriers harm interactions with foreign firms and households more than with banks, which is supported by the empirical results. The coefficient of financial freedom is not significant in tables 4 and 5. However, we will see that financial freedom is correlated with the composition of bank flows when we analyze the intensive margin.

In addition to entry barriers, banking sector efficiency in the host country also helps explain the sectoral composition of banks' foreign liabilities. Tables 5 indicates that the number of banks that borrow from foreign banks relative to the number of banks that borrow from the foreign non-bank private sector is smaller when the average ratio of overhead costs to total assets of the foreign banking sector is higher, i.e. if the foreign banking sector as a whole is less efficient in line with proposition 3. As the theory predicts, German banks play an important role in the local banking market in countries with traditionally less efficient banking sectors, for example in Eastern Europe. At the same time, more German banks participate in international interbank lending in countries that have an equally developed banking market.[41]

Variation of the intensive margin with country characteristics Next, we turn to the intensive margin, comparing the volume of German banks' interbank activities with their volume of direct business with firms and households in foreign countries. The dependent variable is now the log ratio of a bank's consolidated claims (liabilities) on the foreign banking sector over its consolidated claims (liabilities) on the foreign private sector. As before, we test whether the proxies for the costs of operating abroad shape the composition of German banks' foreign activities. The regression equation is now given by:

$$\log(Y_{bc}) = X_c'\beta + \delta_b + \epsilon_{bc}, \tag{30}$$

where Y_{bc} stands for bank b's ratio of bank assets (liabilities) to private sector assets (liabilities) in country c. The vector X_c collects the proxies for entry barriers, GDP etc. The regression also includes bank fixed effects δ_b. Standard errors are clustered at the country-bank type level.[42]

Regression results are presented in tables 6 and 7. They are broadly consistent with the results of the extensive margin. Column (2) of table 6 indicate that if openness to foreign bank entry changes for a country from "largely liberalized" (the omitted baseline category of the indicator *Openness to foreign bank entry*) to "partially repressed B", this shifts the composition of claims towards interbank lending and away from private sector lending. Moreover, the coefficients of financial freedom and banking sector efficiency in the host country are significant at a 5 and 1 percent level, respectively. They suggest that German banks hold less interbank

[41]The regression results suggest further that the relative number of banks that extend loans to foreign banks decreases in the distance to the host country. This might reflect the large degree of interconnectedness within Europe, where German banks have an important stance in the interbank market, which is also a means to share liquidity risks across banks, which the model in this paper abstracts from.

[42]The different types of bank are: commercial banks, Landesbanken, savings banks, regional institutions of credit cooperatives, credit cooperatives, building credit societies, savings and loan associations, and banks with special functions.

claims relative to private sector claims if there is greater financial freedom in the host country and if the banking sector in the host country is less efficient, that is, it has a higher ratio of overhead costs to total assets.

The estimated coefficients in table 7, in which we investigate the composition of bank borrowing, are mostly insignificant.[43] However, the signs of the coefficients are in line with expectations and match those obtained for the extensive margin regressions.

Together, the empirical results provide support for the notion that interbank lending and private sector lending can be seen as substitutes. Lower costs of operating in a host country are associated with relatively less interbank activity and more lending to and borrowing from the non-bank private sector there. This suggests that if barriers to the foreign operations of banks rise, the composition of foreign borrowing and lending shifts towards more interbank activity and away from activities with firms and households.

Quantifying the effect of bank entry barriers on the composition of international bank flows To assess whether entry barriers are economically important determinants of the composition of international bank flows, we focus on German banks' interbank claims and claims on the non-bank private sector in the United States and use the regression results in column (3) of table 6 to study the effect of a decrease in financial freedom in the U.S.

In 2005, the financial freedom index of the U.S. took a value of 90. According to the Heritage Foundation, an index of 90 is interpreted as "minimal government interference".[44] For comparison, Canada, Mexico or Spain were assigned an index of 70 in the same year, which indicates "limited government interference", implying that the credit allocation is influenced by the government.[45]

To calculate the impact of a decrease in financial freedom in the U.S., we assume that the U.S. index drops to the level of Canada, Mexico and Spain. According to the estimated coefficient in column (3) of table 6, a one unit decrease in financial freedom translates, on average, into a 0.94 percent increase in the ratio of claims on banks relative to claims on firms. Hence, the ratio of a German bank's claims in the U.S. would, on average, increase by roughly 19 percent in the considered scenario. To translate the change in the ratio into dollar amounts, we assume that each German bank replaces bank-to-firm lending with bank-to-bank lending when the U.S. becomes less open. Then, the 19 percent change in the ratio implies that roughly Euro 3.9 billion of credit to firms would be replaced with loans to banks. This corresponds to a decrease of 1.5 percent in aggregate German bank lending to the U.S. non-bank private sector and to an increase of 9.4 percent in lending to U.S. banks. These are economically significant effects.

[43] This could be due to the conservative choice of the standard errors, which are clustered at the country-bank type level.

[44] "Regulation of financial institutions is minimal but may extend beyond enforcing contractual obligations and preventing fraud."

[45] "Private allocation of credit faces almost no restrictions. Government ownership of financial institutions is sizeable. Foreign financial institutions are subject to few restrictions."

4.2 Discussion

The theory together with the suggestive empirical evidence presented in the previous section indicate that interbank lending and lending to non-banking firms abroad can be seen as substitutes. Barriers to bank entry mainly harm lending to and borrowing from non-banking firms, while interbank lending and borrowing seem to be less affected. Increases in the impediments to the foreign operations of banks may thus shift activities between foreign banks, their affiliates and firms in the host country onto international interbank markets. This is also supported by additional results presented in appendix B. We find that banks that use internal capital markets more intensively engage less in activities with banks in the host market relative to activities with firms and households. This indicates that banks establish affiliates abroad to mainly promote business with the non-banking private sector. The BIS consolidated statistics are also consistent with this view. Over the past 20 years, the share of private assets in total international assets held by BIS reporting countries increased continuously as can be seen from figure 12. As countries opened up to foreign capital and banks over the past decades, both international interbank lending and private sector lending increased but private sector lending increased by much more accounting today for roughly 55 percent of total international assets compared to 43 percent at the end of the 20th century.[46]

While the model highlights the benefits of banking across borders (in form of reduced costs of financial intermediation and a more efficient allocation of capital across countries that leads to higher world output), concerns have been raised that global banks may make economies more vulnerable to foreign shocks because they transport financial conditions in one market across borders.[47] As discussed in detail in section 2.2, a large number of empirical studies in the literature find that banks do not reduce all activities to the same degree. International interbank lending seems to be less stable than other forms of international bank flows that occur between banks of the same banking group or involve non-banking firms.[48] Taking the perspective of a host country, increased impediments to foreign bank operations may therefore make loan supply to the domestic economy less stable. Firms may be less dependent on credit from foreign banks. At the same time, domestic banks may increase their borrowing on the international interbank market. Global banks with the ability to lend to foreign firms and move capital across countries through internal capital markets may overall increase, not reduce, the resilience of a host country to foreign shocks.[49]

[46] Figure 12 shows the sectoral split of BIS international assets based on the immediate borrower basis, which exclude local claims. The picture that emerges from the sectoral composition of foreign assets on an ultimate risk basis, which include local claims, is very similar.

[47] Bremus et al. (2013) and Amiti and Weinstein (2013) show that single banks are big enough to affect macroeconomic outcomes.

[48] This is also reflected in figure 12: from the first quarter in 2008 to the first quarter in 2009, BIS international interbank assets dropped by 32 percent, whereas international assets in the non-bank private sector fell by less than 19 percent.

[49] Information asymmetries can lead to interbank market freezes as, e.g., Flannery (1996) and Heider et al. (2009) show. Such information frictions are less likely to occur between parent banks and their affiliates.

5 Conclusions

This paper starts from the observation that different types of international bank flows have different stability properties. A growing body of empirical literature finds that interbank lending is less stable than other types of foreign bank operations, for example, intrabank lending, local lending or cross-border lending to foreign firms. This suggest that the composition of international bank flows is key for the degree to which shocks to the financial health of banks or disruptions in local financial markets are transmitted across borders. Strikingly, there is no theoretical framework to explain the composition of international bank flows to start with. This paper aims at filling this gap.

The modeling approach proposed in this paper is motivated by several empirical observations. First, both lending by banks to foreign non-banking firms and households as well as to other foreign banks are important components of banks' foreign positions and, hence, of international bank flows. Second, banks reallocate capital across borders. Third, more efficient banks borrow from less efficient banks on the interbank market. This also holds internationally. Finally, banks differ substantially in their foreign activities. Less efficient banks engage mostly in international interbank lending, whereas larger banks are more likely to raise funds from foreign banks and depositors and lend to foreign non-banking firms.

Building on Niepmann (2012) and Niepmann (2013), we provide a model of banking across border that is consistent with these facts and pins down the composition of international bank flows into interbank lending, intrabank lending, cross-border lending by parent banks and local lending by foreign affiliates. Similar to the aforementioned studies, the model in this paper shows that international bank flows are determined by differences in the return to capital and differences in banking sector efficiencies across countries as well as by impediments to operating across borders in the form of increased transactions cost and additional fixed cost. A key novel result of the framework is that interbank lending and private sector lending are substitutes. When entry barriers in the host country rise, lending by foreign banks to domestic firms decreases. At the same time, domestic banks borrow more from foreign banks.

We go on to show that this relationship is supported by the German bank-level data. In the cross-section, German banks lend to and borrow more from banks relative to firms when the impediments to operating abroad measured by different proxies of bank entry barriers are higher. The effect on the composition of international bank flows is economically significant. If the U.S. were to increase its barriers to foreign bank entry to the level of Canada, Spain or Mexico, then interbank lending by German firms to U.S. banks would increase by 9.4 percent. Lending to non-banking firms would decline by 1.5 percent.[50]

The recently provided evidence that global banks transmit shocks across border through global capital markets might have evoked the idea that it could be beneficial to limit the operations of global banks and the extent to which they can reallocate capital within the banking organization. This paper shows that increasing entry barriers for foreign banks may

[50]The figures are based on the assumption that banks replace bank-to-firm lending one for one with bank-to-bank lending. This assumption allows us to get at the effect on absolute values given that the empirical analysis only delivers predictions regarding the relative magnitudes of bank-to-bank versus bank-to-firm flows.

not have the desired effect. Since bank entry barriers seem to harm foreign affiliate lending and cross-border lending to firms more than interbank lending, international interbank lending may become more important. To the extent that interbank lending is less stable, which recent studies suggest, a host country may become less resilient rather than more resilient to shocks abroad when it increases the impediments to foreign bank operations.

The model indicates that the transmission of shocks across borders depends on the structure of bank activities. This issue should be studied in more detail, for example, by introducing maturity mismatch and information asymmetries to the presented framework. Explaining why banks reduce different types of international activities to different degrees when they face liquidity problem or when there are general disruptions in financial markets should be the goal of future research.

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A Data Appendix

Monthly balance sheet statistics: All banks with a German banking license provide monthly reports to Deutsche Bundesbank containing information on total assets and liabilities as well as various detailed positions on the asset and the liability side. The statistics furthermore distinguish between different counterparty sectors and destinations (domestic and foreign), and are reported by the German parent bank, its foreign branches and its foreign subsidiaries. The separate reports by affiliates allow the calculation of intra-bank flows between the parent bank and its affiliates. Subsidiaries report the position vis-à-vis the parent bank directly, for branches, the position vis-à-vis the German banking sector serves as an approximation (as proposed by Duewel and Frey (2012)). Bank-level data is confidential, but available for research purposes on the premises of Deutsche Bundesbank. We use yearly averages of the monthly data from 2005. The sample includes different types of bank: commercial banks, Landesbanken, savings banks, regional institutions of credit cooperatives, credit cooperatives, building credit societies, savings and loan associations, and banks with special functions. "Claims" refer to accounts receivable and do not include securities holdings. "Liabilities" refer to accounts payable, likewise excluding obligations arising from securities.

External positions report: Data are reported by the banks to Deutsche Bundesbank on a monthly basis. Balance sheet positions vis-à-vis foreign counterparties are split into the various destination countries. We use consolidated figures (for the banking group) of foreign assets, claims and liabilities as totals and vis-à-vis banks and the non-bank private sector (firms and households). The monthly data of 2005 is averaged over 12 months.

Profit and loss accounts: German banks report profit and loss accounts to Deutsche Bundesbank. Data from 2004 are used. Overhead costs relative to size as an efficiency measure of a bank are calculated as general administrative expenditure over total assets of the German parent bank including its foreign branches, but not its foreign subsidiaries. We use the logarithm of this variable in the regressions (*ln(Overhead costs/TA)*).

Banking sector efficiency: A country's banking sector efficiency is proxied by the variable *overhead* relative to the banking sector's total assets from the Financial Structure Database of the World Bank (see Beck et al. (2000)). We use the logarithm of this variable in the regressions (*ln(Banking sector overhead costs/TA)*). The definition corresponds to the one for the single bank.

Entry barriers: Entry barriers are taken from an IMF database on financial reforms described in Detragiache et al. (2008). The index increases with lower entry barriers.

Financial freedom: The index on financial freedom provided by the Heritage Foundation is used to measure barriers to foreign bank entry as in Buch and Lipponer (2007) for example.[51]

Other country-level variables: GDP in current U.S. dollars and GDP per capita in current U.S. dollars are from the World Development Indicators. Distance from Germany to foreign countries comes from a dataset provided by CEPII (see Mayer and Zignago (2005); Head et al.

[51] See http://www.heritage.org/index/financial-freedom.

(2010)).

B More Empirical Results

In this appendix, we provide additional empirical results which deliver additional insights into the relevance of foreign affiliates for the sectoral composition of foreign bank assets and liabilities.

In section 2.1, we demonstrated that more efficient banks tend to lend more to the non-bank private sector abroad than to the banking sector. Besides, if anything, these banks hold more claims on firms than on banks. Here, we investigate whether the composition of banks' foreign activities is different when banks make intensive use of internal capital markets. In the model, an affiliate allows the bank to reduce informational and transaction costs and to, thereby, grow its balance sheet. At the same time, banks can raise deposits from firms and households in the local market. So affiliates are a means for banks to better interact with the private sector abroad. Accordingly, we should see that banks that use internal capital markets more intensively lend more to the non-bank private sector than to the banking sector abroad.

To check whether this hypothesis is supported by the data, we extend equation (1) to include the extent to which banks use internal capital markets. For the asset side, this corresponds to the amount of intra-bank claims of parent banks on own affiliates in country c normalized by total assets held by the bank in country c ($lnClaimsICM$). We then rerun regressions for the liability side, featuring the amount of intra-bank liabilities of parent banks to own affiliates located in country c normalized by total liabilities vis-à-vis country c ($lnLiabICM$). The results are in line with our conjectures. As can be concluded from tables B.1 and B.2, both lending and borrowing vis-à-vis banks relative to privates declines when a bank makes more intensive use of internal capital markets. The corresponding measures turn out to be negative and significant across most specifications. This suggests that a local presence and the use of internal capital markets foster interaction with the non-bank private sector relative to the banking sector.

Table B.1: The effect of the use of internal capital markets on the sectoral composition of banks' foreign claims

This table reports linear regressions of the intensive margin of foreign lending using German bank level data. The dependent variable (*lnClaimsBvP*) is the bank- and country-specific volume of lending to banks relative to the volume of lending to the non-bank private sector. *ln(Overhead costs/TA)*, which equals the bank's overhead costs relative to total assets declines in parent bank's efficiency. *lnClaimsICM* are the parent bank's claims on the local affiliate (via the internal capital market) relative to total foreign assets vis-à-vis the host country. Country-fixed effects and bank-type-fixed effects are included but not reported. Standard errors are clustered by bank. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)
	lnClaimsBvP	lnClaimsBvP
VARIABLES	All banks	Commercial banks only
ln(Overhead costs/TA)	0.141	-0.112
	(0.733)	(1.030)
lnClaimsICM	-0.160*	-0.197
	(0.0932)	(0.125)
Observations	227	140
Adjusted R-squared	0.385	0.0690
Number of clusters	39	19

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B.2: The effect of the use of internal capital markets on the sectoral composition of banks' foreign liabilities

This table reports linear regressions of the intensive margin of foreign lending using German bank level data. The dependent variable (*lnClaimsBvP*) is the bank- and country-specific volume of lending to banks relative to the volume of lending to the non-bank private sector. *ln(Overhead costs/TA)*, which equals the bank's overhead costs relative to total assets declines in parent bank's efficiency. *lnLiabICM* are the parent bank's liabilities to the local affiliate relative to total foreign liabilities to the host country. Country-fixed effects and bank-type-fixed effects are included but not reported. Standard errors are clustered by bank. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)
	lnLiabBvP	lnLiabBvP
VARIABLES	All banks	Commercial banks only
ln(Overhead costs/TA)	-0.766*	-0.759
	(0.406)	(0.625)
lnLiabICM	-0.253**	-0.234*
	(0.101)	(0.123)
Observations	215	133
Adjusted R-squared	0.252	-0.0769
Number of clusters	38	17

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

C Proofs

Proof of Proposition 1

Proof. (i) Note that the RHS of equation 16 cuts the LHS one from above on the interval $R^I \in [0, R_1]$. (ii) Note that the first term of the RHS of equation 16 is zero in autarky. ■

Proof of Proposition 2

Proof. (i) $\frac{dR^I}{df_{12}^X} < 0$ from equation 16 and $\frac{\partial B_{12}}{\partial R^I} < 0 \Rightarrow \frac{dB_{12}}{df_{12}^X} > 0$. The proof of $\frac{dB_{12}}{d\delta_{12}} < 0$ follows accordingly.

(ii) To see that $\frac{d(a_2''(R_1 - R^I))}{df_{12}^X} < 0$, rearrange equation 16 to

$$K_1 + K_2 - \left(K_1 \int_{\underline{a}_1}^{\overline{a}_1} z_{11} g_1(a) da \right) - \left(K_2 \int_{\underline{a}_2}^{\overline{a}_2} z_{22} g_2(a) da \right) = \left(K_2 \int_{a_{12}^*}^{\overline{a}_2} z_{12} g_j(a) da \right) = CL_{12}. \tag{C.1}$$

This equation implies that $\frac{\partial LHS}{\partial R^I}\frac{dR^I}{df_{12}^X} = \frac{\partial RHS}{\partial f_{12}^X} + \frac{\partial RHS}{\partial R^I}\frac{dR^I}{df_{12}^X}$. Because $\frac{\partial LHS}{\partial R^I}\frac{dR^I}{df_{12}^X} < 0$, it follows that $\frac{\partial RHS}{\partial f_{12}^X} + \frac{\partial RHS}{\partial R^I}\frac{dR^I}{df_{12}^X} < 0$. The last expression corresponds to the total derivative of the amount of cross-border lending with respect to f_{12}^X. The proof of $\frac{dCL_{12}}{d\delta_{12}} < 0$ follows accordingly. ■

Proof of Proposition 3

Proof. (i) Follows directly from equation 19. (ii) Follows from applying the implicit function theorem to equation 16. ■

Proof of Proposition 4

Proof. (i) Equation 22 has a unique solution if

$$\frac{\partial a_{ij}^{**}}{\partial R^I} = \begin{cases} \frac{-2d_{12}(R_1 + R^I) + 4(f_{12}^F - f_{12}^X)}{(R_1 - R^I)^3(1 - \delta_{12})} > 0 \text{ if } \underline{a}_2 < a_{12}^{**} < \overline{a}_2, \\ 0 \text{ if } a_{12}^{**} \leq \underline{a}_2 \text{ or } a_{12}^{**} \geq \overline{a}_2. \end{cases} \tag{C.2}$$

This condition insures that the RHS of 22 cuts the LHS once from above on the interval $R^I \in [0, R_1]$. Note that $\frac{\partial a_{ij}^{**}}{\partial R^I} \neq \frac{da_{ij}^{**}}{dR^I}$ because there is a secondary effect of a change in R^I on the cutoff a_{12}^{**} through a change in the equilibrium value of d_{12}. However, this second-order effect can be ignored because $\frac{\partial a_{12}^{**}}{\partial R^I} > 0$ implies that $\frac{da_{12}^{**}}{dR^I} > 0$.

Because $\frac{\partial a_{ij}^{**}}{\partial R^I} = 0$ if $R^1 > R^I$ and $d_{12} \leq 1$, a sufficient condition for a_{12}^{**} to increase in R^I is $f_{12}^F - f_{12}^X > R_1$. The rest of the proof is then parallel to the proof of proposition 1. (ii) Lending to foreign firms by the same German bank is larger with an affiliate than otherwise.

This implies that the RHS of equation 22 is smaller under scenario 2 than under scenario 3, implying that the interbank lending rate is higher under scenario 3. ■

Proof of Proposition 5

Proof. Aggregate cross-border lending to the private sector is given by:

$$CL_{12} = \int_{\frac{2f_{12}^X}{(R_1-R^I)^2\delta_{12}}}^{\frac{2}{(R_1-R^I)^2}\frac{1}{1-\delta_{12}}(f_{12}^F-f_{12}^X-R^I d_{12})} z_{12}^X g_2(a_2)da_2. \tag{C.3}$$

Aggregate lending to the private sector by foreign affiliates is given by:

$$LL_{12} = \int_{\frac{2}{(R_1-R^I)^2}\frac{1}{1-\delta_{12}}(f_{12}^F-f_{12}^X-R^I d_{12})}^{\bar{a}_2} z_{12}^F g_2(a_2)da_2. \tag{C.4}$$

(i) From equation 22, it is clear that $\frac{dR^I}{df_{12}^F} < 0$ and $\frac{da_{12}^{**}}{df_{12}^F} = \frac{\partial a^{**}}{\partial f_{12}^F} + \frac{\partial a^{**}}{\partial R^I}\frac{dR^I}{df_{12}^F} > 0$. Moreover,

$$\begin{aligned}
\frac{dCL_{12}}{df_{12}^F} &= \frac{\partial CL_{12}}{\partial f_{12}^F} + \frac{\partial CL}{\partial R^I}\frac{dR^I}{df_{12}^F} \qquad (C.5)\\
&= \frac{\partial a_{12}^{**}}{\partial f_{12}^F} z(a_{12}^{**})g(a_{12}^{**}) + \\
&+ \left(\int_{a_{12}^*}^{a_{12}^{**}} \frac{\partial z(a_2)}{\partial R^I} g(a_2)da_2 + \frac{\partial a_{12}^{**}}{\partial R^I} z(a_{12}^{**})g(a^{**}) - \frac{\partial a_{12}^*}{\partial R^I} z(a_{12}^*)g(a_{12}^*)\right)\frac{dR^I}{df_{12}^F}.
\end{aligned}$$

Rearranging and using the information on $\frac{da_{12}^{**}}{df_{12}^F}$, we obtain:

$$\begin{aligned}
\frac{dCL_{12}}{df_{12}^F} &= \underbrace{\frac{\partial a_2^{**}}{\partial f_{12}^F} z(a_2^{**})g(a^{**}) + \frac{\partial a_2^{**}}{\partial R^I} z(a_{12}^{**})g(a_{12}^{**})\frac{dR^I}{df_{12}^F}}_{>0} \qquad (C.6)\\
&+ \underbrace{\frac{dR^I}{df_{12}^F}\left(\int_{a_{12}^*}^{a_{12}^{**}} \frac{\partial z(a_2)}{\partial R^I} g(a_2)da_2 - \frac{\partial a_{12}^*}{\partial R^I} z(a_{12}^*)g(a_{12}^*)\right)}_{>0} > 0. \qquad (C.7)
\end{aligned}$$

(ii) Applying the implicit function theorem to 22 gives the result that $\frac{d(CL_{12}+LL_{12})}{df_{12}^F} < 0$. If $\frac{dCL_{12}}{df_{12}^F} > 0$, then it must hold that $\frac{dLL_{12}}{df_{12}^F} < 0$. ■

D Extension of the Model to N Countries

If a banker of type a_j opens up a foreign affiliate in country i, his profits that come solely from operations in that country are given by:

$$\pi_{ij}^F(a_j) = R_i z_{ij}^F - \frac{1}{a_j} f(z_{ij}^F) - R^I z_{ij}^F - f_{ij}^F + R^I d_{ij}, \tag{D.1}$$

where $z_{ij}^F = a_j(R_i - R^I)$. Each banker chooses to open up an affiliate abroad if the resulting profits are positive and higher than the profits from investing cross-border, which are given by:

$$\pi_{ij}^X(a_j) = R_i z_{ij}^X - \frac{1}{a_j \delta_{ij}} f(z_{ij}^X) - R^I z_{ij}^X - f_{ij}^X, \tag{D.2}$$

where $z_{ij}^X = a_j \delta_{ij}(R_i - R^I)$. The banker who is indifferent between cross-border lending and operating through affiliates abroad is found by setting profits under cross-border lending to market i equal to profits with an affiliate in country i:

$$a_{ij}^{**} = \min\left\{\max\left\{\overline{a}_j, \frac{2}{(R_i - R^I)^2}\frac{1}{1-\delta_{ij}}(f_{ij}^F - f_{ij}^X - R^I d_{ij})\right\}, \underline{a}_j\right\}. \tag{D.3}$$

Under the condition that $f_{ij}^F > f_{ij}^X + R^I d_{ij}$, the FDI cutoff a_{ij}^{**} is positive. The cross-border lending cutoff is given by:

$$a_{ij}^{*} = \min\left\{\max\left\{\overline{a_j}, \frac{2 f_{ij}^X}{(R_i - R^I)^2 \delta_{ij}}\right\}, \underline{a}_j\right\}. \tag{D.4}$$

The capital invested in each country by all banks must equal the world capital endowment.

$$\sum_{i=1}^{N} K_i = \sum_{i=1}^{N} \tilde{K}_i, \tag{D.5}$$

where

$$\tilde{K}_i = \underbrace{K_i \int_{\underline{a}_i}^{\overline{a}_i} z_{ii} g_i(a_i) da_i + \sum_{j=1, j\neq i}^{N} K_j \int_{a_{ij}^*}^{a_{ij}^{**}} z_{ij}^X g_j(a_j) da_j + \sum_{j=1, j\neq i}^{N} K_j \int_{a_{ij}^{**}}^{\overline{a}_j} z_{ij}^F g_j(a_j) da_j}_{RHS}. \tag{D.6}$$

In equilibrium, each banker obtains the capital stock divided by the mass of bankers competing for the deposits. Therefore, the following condition must hold for each country i:

$$K_i = K_i \int_{\underline{a}_i}^{\overline{a}_i} d_{ii} g_i(a_i) da_i + \sum_{j=1, j\neq i}^{N} K_j \int_{a_{ij}^{**}}^{\overline{a}_j} d_{ij} g_j(a_j) da_j, \tag{D.7}$$

where $d_{ii} = d_{ij}$. The deposits that a bank operating in country i raises are thus:

$$d_i = \frac{K_i}{K_i \int_{\underline{a}_i}^{\overline{a}_i} g_i(a_i)da_i + \sum_{j=1,j\neq i}^{N} K_j \int_{a_{ij}^{**}}^{\overline{a}_j} g_j(a_j)da_j} = \frac{K_i}{K_i + \sum_{j=1,j\neq i}^{N} K_j \int_{a_{ij}^{**}}^{\overline{a}_j} g_j(a_j)da_j}. \quad \text{(D.8)}$$

Proposition 6 *There exists a unique solution to the open economy if* $f_{ij}^F - f_{ij}^X > R_i \ \forall i, j \in \{1, 2, .., N\}$ *and* $i \neq j$.

Proof. When $R^I = \max\{R_1, R_2, ..., R_N\}$, RHS of equation D.6 is equal to zero. If $R^I = 0$, then $RHS > \sum_{i=1}^{N} K_i$ because monitoring is assumed to be beneficial, which implies $K_i a_i' R_i > K_i$. RHS of equation D.6 is strictly decreasing in R^I on the interval $R^I \in [0, \max\{R_1, R_2, ..., R_N\}]$. To see this, note that:

$$\begin{aligned}
\frac{\partial RHS}{\partial R^I} &= K_i \int_{\underline{a}_i}^{\overline{a}_i} \frac{\partial z_{ii}}{\partial R^I} g_i(a_i)da_i + \\
&+ \sum_{j=1,j\neq i}^{N} K_j \left(\int_{a_{ij}^*}^{a_{ij}^{**}} \frac{\partial z_{ij}^X}{\partial R^I} g_j(a_j)da_j + \frac{\partial a_2^{**}}{\partial R^I} z_{ij}^X(a_{ij}^{**})g(a^{**}) - \frac{\partial a_{ij}^*}{\partial R^I} z^X(a_{ij}^*)g(a_{ij}^*) \right) \\
&+ \sum_{j=1,j\neq i}^{N} K_j \left(\int_{a_{ij}^{**}}^{\overline{a_j}} \frac{\partial z_{ij}^F}{\partial R^I} g_j(a_j)da_j - \frac{\partial a_2^{**}}{\partial R^I} z^F(a_{ij}^{**})g(a^{**}) \right) \\
&= \underbrace{K_i \int_{\underline{a}_i}^{\overline{a}_i} \frac{\partial z_{ii}}{\partial R^I} g_i(a_i)da_i}_{<0} + \underbrace{\sum_{j=1,j\neq i}^{N} K_j \left(\int_{a_{ij}^*}^{a_{ij}^{**}} \frac{\partial z_{ij}^X}{\partial R^I} g_j(a_j)da_j + \int_{a_{ij}^{**}}^{\overline{a_j}} \frac{\partial z_{ij}^F}{\partial R^I} g_j(a_j)da_j \right)}_{\leq 0} + \\
&+ \sum_{j=1,j\neq i}^{N} K_j \left(\frac{\partial a_{ij}^{**}}{\partial R^I} \left(z^X(a_{ij}^{**})g(a_{ij}^{**}) - z^F(a_{ij}^{**})g(a_{ij}^{**}) \right) \right) - \underbrace{\frac{\partial a_{ij}^*}{\partial R^I} z^X(a_{ij}^*)g(a_{ij}^*)}_{\geq 0}.
\end{aligned} \quad \text{(D.9)}$$

$z_{ij}^X(a_j) < z_{ij}^F(a_j) \Rightarrow z_{ij}^X(a_j^{**})g(a_j^{**}) - z_{ij}^F(a_j^{**})g(a_j^{**}) < 0$. Under the assumption that $f_{ij}^F - f_{ij}^X > R_i$, $\frac{\partial a_{ij}^{**}}{\partial R^I} \geq 0$. With RHS of equation D.6 being strictly decreasing in R^I, it follows that RHS of equation D.6 cuts LHS of equation D.6 once from above. ■

Table 1: Components of banks' foreign activities

This table illustrates the size and components of German banks' claims and liabilities on foreign banks and the foreign non-bank private sector. Data are from monthly reportings to Deutsche Bundesbank for the year 2005, averaged over all 12 months. They cover domestically-owned banks only. Interbank positions exclude positions vis-à-vis the banks' own foreign affiliates.

FOREIGN ASSETS	share in total foreign assets	gross position (in EUR bn.)	thereof via... all affiliates	branches	subsidiaries
Claims on banks	0.274	682.806	0.462	0.402	0.060
Claims on non-bank private sector	0.376	935.900	0.700	0.532	0.168
(...)					
Total foreign assets		2,487.470			

FOREIGN LIABILITIES	share in total foreign liabilities	gross position (in EUR bn.)	thereof via... all affiliates	branches	subsidiaries
Liabilities to banks	0.557	985.202	0.458	0.330	0.128
Liabilities to non-bank private sector	0.328	580.477	0.574	0.368	0.206
(...)					
Total foreign liabilities		1,768.502			

NET FOREIGN ASSETS	(in EUR bn.)
Net claims on banks	-302.396
Net claims on non-bank private sector	355.423
(...)	
Net foreign assets	718.968

Table 2: Intensive margin of lending abroad

This table reports linear regressions for the intensive margin of foreign lending using German bank level data. The dependent variable (*lnClaimsBvP*) is the bank- and country-specific volume of lending to banks relative to the volume of lending to the non-bank private sector. Claims on affiliated banks abroad are excluded. The main explanatory variable is a parent bank's efficiency which declines in *ln(Overhead costs/TA)*. Country-fixed effects and bank-type-fixed effects are included but not reported. Banks in the sample belong to one of the following types: commercial banks, Landesbanken, savings banks, regional institutions of credit cooperatives, credit cooperatives, building credit societies, savings and loan associations, and banks with special functions. Standard errors are clustered by bank. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)
	lnClaimsBvP	lnClaimsBvP
VARIABLES	All banks	Commercial banks only
ln(Overhead costs/TA)	0.0197	0.522
	(0.255)	(0.367)
Observations	6,608	1,139
Adjusted R-squared	0.138	0.185
Number of clusters	1416	73

Table 3: Intensive margin of borrowing abroad

This table reports linear regressions for the intensive margin of foreign borrowing using German bank level data. The dependent variable (*lnLiabBvP*) is the bank- and country-specific volume of borrowing from banks relative to the volume of borrowing from the non-bank private sector. Liabilities toward affiliated banks abroad are excluded. The main explanatory variable is a parent bank's efficiency which declines in *ln(Overhead costs/TA)*. Country-fixed effects and bank-type-fixed effects are included but not reported. Banks in the sample belong to one of the following types: commercial banks, Landesbanken, savings banks, regional institutions of credit cooperatives, credit cooperatives, building credit societies, savings and loan associations, and banks with special functions. Standard errors are clustered by bank. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)
	lnLiabBvP	lnLiabBvP
VARIABLES	All banks	Commercial banks only
ln(Overhead costs/TA)	-1.280***	-1.276**
	(0.375)	(0.542)
Observations	2,680	1,113
Adjusted R-squared	0.443	0.218
Number of clusters	514	57

Table 4: Lending abroad: Relevance of country characteristics for the extensive margin

This table reports linear regressions of the number of German banks that engage in bank-to-bank lending relative to the number of banks that engage in lending to the non-bank private sector in a given country (dependent variable *lnNumClBvP*). Explanatory variables vary by country. See the data appendix for details on these variables, in particular for the indices measuring fixed costs of cross-border activity (Openness to foreign bank entry and financial freedom). The baseline category for *Entry* that is omitted corresponds to "Largely liberalized (1/0)". Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
VARIABLES	lnNumClBvP	lnNumClBvP	lnNumClBvP
Entry: Partially repressed A (1/0)	0.0307	0.0274	
	(0.219)	(0.215)	
Entry: Partially repressed B (1/0)	0.497	0.491	
	(0.351)	(0.343)	
Entry: Fully repressed (1/0)	1.133***	1.129***	
	(0.233)	(0.229)	
Financial Freedom	0.00173		0.00152
	(0.00650)		(0.00430)
ln(Banking sector overhead costs/TA)	-0.0613	-0.0616	-0.127
	(0.133)	(0.131)	(0.107)
lnDistance	-0.182	-0.184*	-0.137
	(0.111)	(0.110)	(0.0875)
lnGDP	-0.0932	-0.101	-0.0574
	(0.0973)	(0.0830)	(0.0546)
lnGDP per capita	0.286**	0.306***	0.214***
	(0.138)	(0.109)	(0.0718)
Constant	-0.561	-0.422	-1.389
	(2.132)	(1.886)	(1.507)
Observations	85	85	126
Adjusted R-squared	0.187	0.197	0.210

Table 5: Borrowing abroad: Relevance of country characteristics for the extensive margin

This table reports linear regressions of the number of German banks that engage in bank-to-bank borrowing relative to the number of banks that engage in borrowing from the non-bank private sector in a given country (dependent variable *lnNumLiBvP*). Explanatory variables vary by country. See the data appendix for details on these variables, in particular for the indices measuring fixed costs of cross-border activity (Openness to foreign bank entry and financial freedom). The baseline category for *Entry* that is omitted corresponds to "Largely liberalized (1/0)". Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
VARIABLES	lnNumLiBvP	lnNumLiBvP	lnNumLiBvP
Entry: Partially repressed A (1/0)	0.00303	0.00617	
	(0.154)	(0.157)	
Entry: Partially repressed B (1/0)	0.106	0.112	
	(0.187)	(0.189)	
Entry: Fully repressed (1/0)	0.953***	0.957***	
	(0.157)	(0.156)	
Financial Freedom	-0.00164		-0.00158
	(0.00368)		(0.00321)
ln(Banking sector overhead costs/TA)	-0.335***	-0.335***	-0.408***
	(0.123)	(0.122)	(0.0988)
lnDistance	-0.118*	-0.116*	-0.0719
	(0.0606)	(0.0605)	(0.0657)
lnGDP	-0.0984**	-0.0911**	-0.172***
	(0.0465)	(0.0448)	(0.0352)
lnGDP per capita	0.0410	0.0223	0.0756
	(0.0700)	(0.0633)	(0.0514)
Constant	-0.963	-1.094	0.0424
	(1.123)	(1.071)	(1.088)
Observations	85	85	127
Adjusted R-squared	0.167	0.175	0.249

Table 6: Lending abroad: Relevance of country characteristics for the intensive margin

This table reports linear regressions for bank-to-bank versus direct lending. The dependent variable (*lnClaimsBvP*) is the bank- and country-specific volume of lending to banks relative to the non-bank private sector. Explanatory variables vary by country. See the data appendix for details on these variables, in particular for the indices measuring fixed costs of cross-border activity (Openness to foreign bank entry and financial freedom). Bank-fixed effects are included but not reported. The baseline category for *Entry* that is omitted corresponds to "Largely liberalized (1/0)". Standard errors are clustered by country and bank type. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
VARIABLES	lnClaimsBvP	lnClaimsBvP	lnClaimsBvP
Entry: Partially repressed A (1/0)	-0.677	-0.642	
	(0.450)	(0.451)	
Entry: Partially repressed B (1/0)	0.657	0.802*	
	(0.460)	(0.446)	
Entry: Fully repressed (1/0)	-1.451	-1.349	
	(0.940)	(0.939)	
Financial Freedom	-0.00896*		-0.00936**
	(0.00467)		(0.00455)
ln(Banking sector overhead costs/TA	-0.617***	-0.607***	-0.625***
	(0.232)	(0.233)	(0.223)
lnDistance	-0.101	-0.0724	-0.115
	(0.0735)	(0.0721)	(0.0708)
lnGDP	-0.0264	-0.0439	-0.0124
	(0.0573)	(0.0542)	(0.0542)
lnGDP per capita	0.266**	0.207	0.263***
	(0.126)	(0.131)	(0.101)
Observations	6,055	6,055	6,055
Number of clusters	336	336	336
Adj. R-squared	0.151	0.149	0.149

Table 7: Borrowing abroad: Relevance of country characteristics for the intensive margin

This table reports linear regressions for bank-to-bank versus private sector borrowing. The dependent variable (*lnLiabBvP*) is the bank- and country-specific volume of borrowing from banks relative to borrowing from the non-bank private sector. Explanatory variables vary by country. See the data appendix for details on these variables, in particular for the indices measuring fixed costs of cross-border activity (Openness to foreign bank entry and financial freedom). Bank-fixed effects are included but not reported. The baseline category for *Entry* that is omitted corresponds to "Largely liberalized (1/0)". Standard errors are clustered by country and bank type. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
VARIABLES	lnLiabBvP	lnLiabBvP	lnLiabBvP
Entry: Partially repressed A (1/0)	0.446	0.466	
	(0.443)	(0.440)	
Entry: Partially repressed B (1/0)	0.306	0.327	
	(0.639)	(0.645)	
Entry: Fully repressed (1/0)	-0.0882	-0.0617	
	(0.671)	(0.679)	
Financial Freedom	-0.00844		-0.00862
	(0.00649)		(0.00651)
ln(Banking sector overhead costs/TA	-0.510	-0.514	-0.543*
	(0.328)	(0.329)	(0.317)
lnDistance	-0.146	-0.137	-0.144
	(0.122)	(0.126)	(0.120)
lnGDP	-0.232**	-0.208**	-0.219**
	(0.105)	(0.104)	(0.102)
lnGDP per capita	-0.0531	-0.152	-0.102
	(0.172)	(0.149)	(0.149)
Observations	2,014	2,014	2,014
Number of clusters	308	308	308
Adj. R-squared	0.501	0.501	0.502

Figure 1: The composition of international bank flows

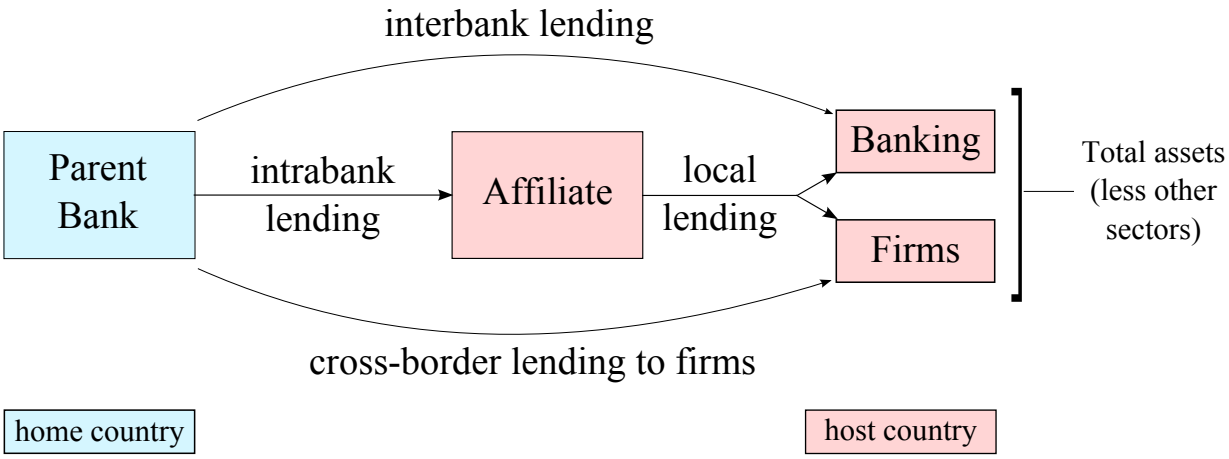


Figure 2: The efficiency of lenders and borrowers on the interbank market

The graph plots kernel density estimates of banks' overhead costs to total assets separately for two different groups of banks. In the left graph, banks are grouped according to their net position vis-à-vis the (domestic and foreign) non-bank private sector. In the right graph, banks are grouped according to their net position vis-à-vis the (domestic and foreign) banking sector. If a bank has a positive position, it is a net lender to the respective sector. If its net position is negative, it is a net borrower. The overhead cost measure is logarithmized and banks in the 1st and 99th percentiles of the cost distribution are excluded from the picture.

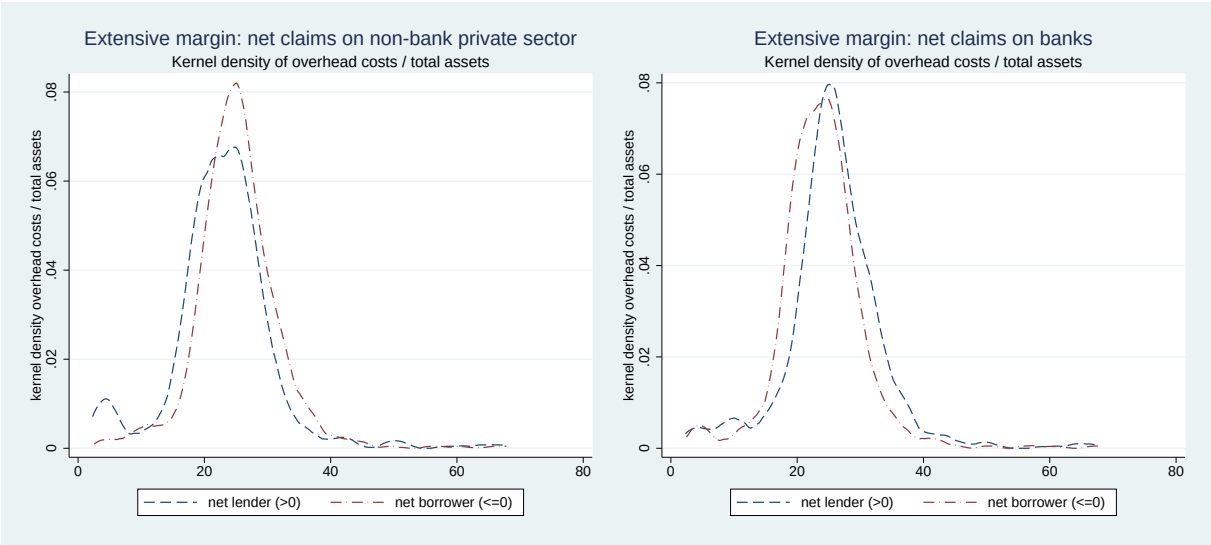


Figure 3: The efficiency of banks with and without foreign claims

Each graph plots the kernel density estimate of banks' overhead costs to total assets for two different groups of banks. In the left graph, banks are grouped according to whether they have claims on the non-bank private sector of a given country. In the right graph, banks are grouped according to whether they have claims on the banking sector of a given country. The overhead cost measure is logarithmized and banks in the 1st and 99th percentiles of the cost distribution are excluded from the picture.

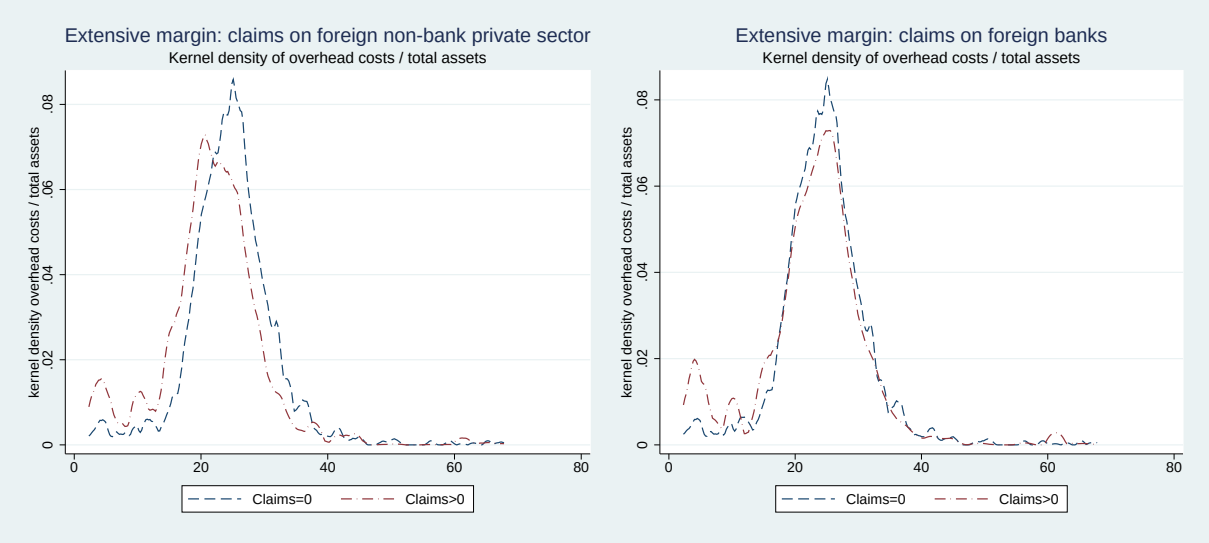


Figure 4: The efficiency of banks with and without foreign liabilities

Each graph plots the kernel density estimate of banks' overhead costs to total assets for two different groups of banks. In the left graph, banks are grouped according to whether they have liabilities in the non-bank private sector of a given country. In the right graph, banks are grouped according to whether they have liabilities in the banking sector of a given country. The overhead cost measure is logarithmized and banks in the 1st and 99th percentiles of the cost distribution are excluded from the picture.

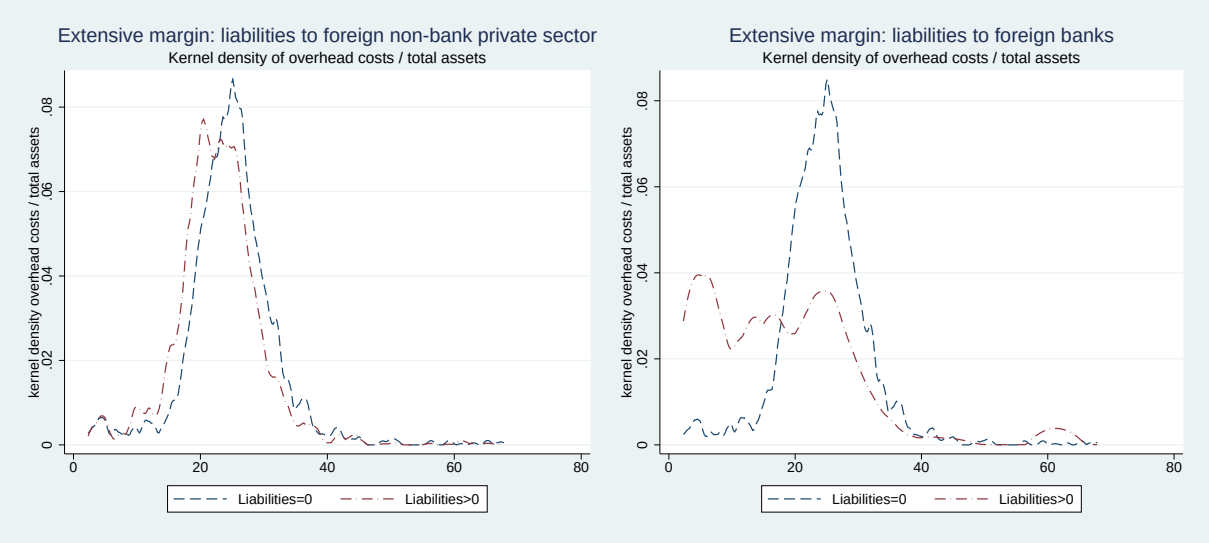


Figure 5: Scenario 1: Lending to the private sector as a function of the efficiency parameter a

The graph shows the amount of funds that a bank lends to the private sector as a function of its efficiency a in autarky and in scenario 1 in the open economy (OE) with international interbank lending. Banks for which z lies below the horizontal line lend fewer funds to firms than they raise from depositors. Therefore, these banks are lenders on the interbank market. Banks for which z lies above the horizontal line are borrowers on the interbank market. The size of their balance sheets is equal to z. In scenario 1, the interbank lending rate in country 1 (the U.S.) is higher than in autarky. In contrast, the interbank lending rate is lower in country 2 (Germany). Therefore, additional banks in country 1 become borrowers on the interbank market, whereas some banks in country 2 turn into lenders on the interbank market in the open economy.

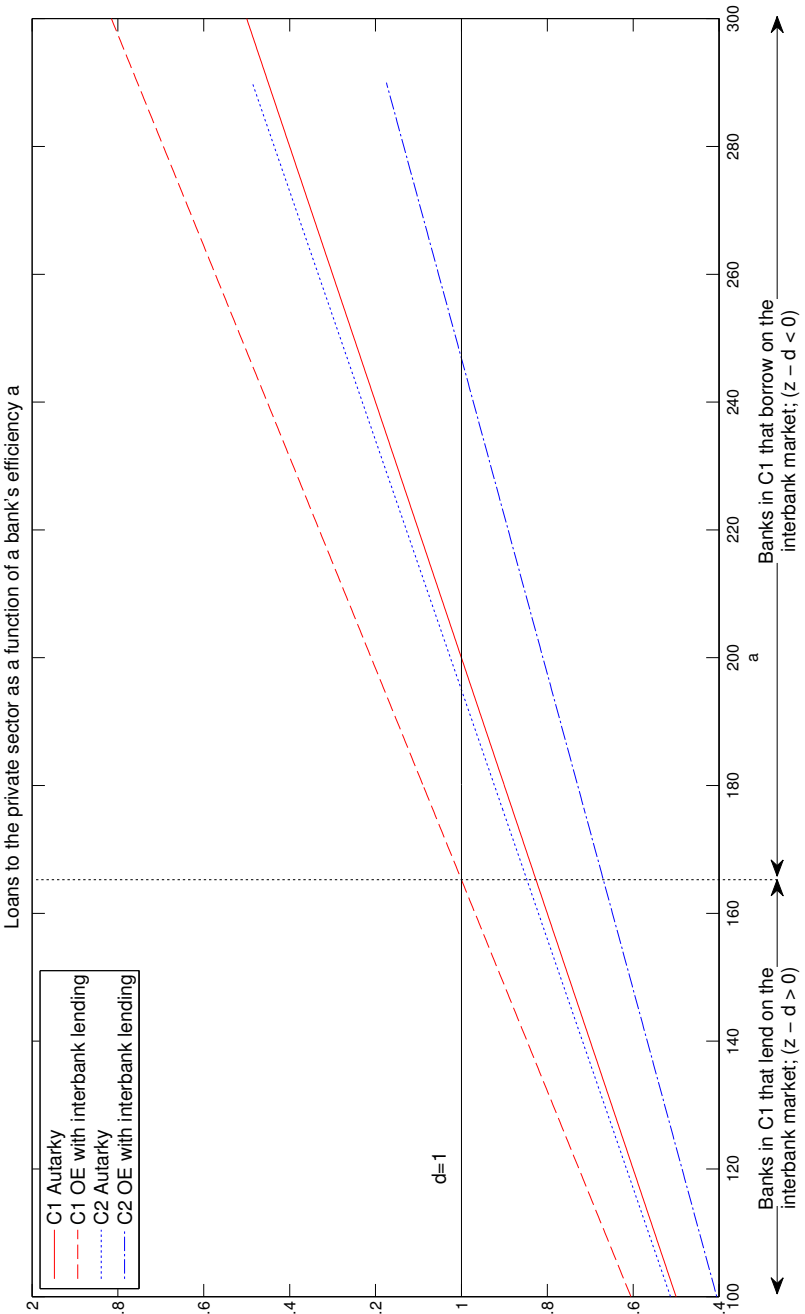


Figure 6: Scenario 2: The effect of impediments to cross-border lending f_{12}^X on the composition of international bank flows

The figure shows the composition of international bank flows as a function of the fixed cost f_{12}^X of cross-border lending for two different parameter values of a_1', which denotes the average efficiency of banks in country 1. The solid line and the dotted line show the amount of cross-border lending and interbank lending from country 1 (Germany) to country 1 (the U.S.), respectively, when the efficiency of banks in country 1 is low. The dashed and the dash-dotted line depict these types of flows when the average efficiency of banks in country 1 has improved. Then cross-border bank flows to firms in country 1 are lower and net interbank lending from country 2 to country 1 is higher.

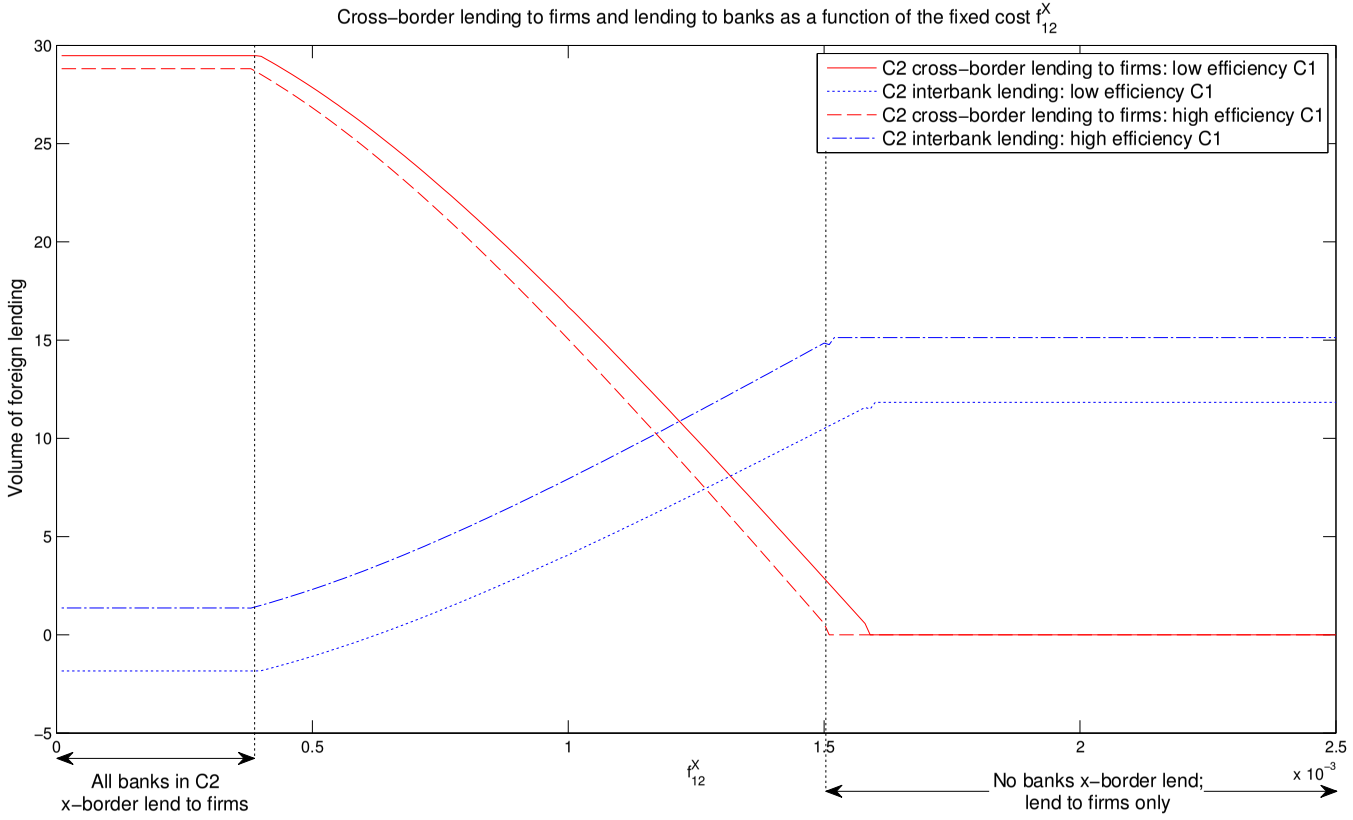


Figure 7: Scenario 2: Lending to the private sector as a function of the efficiency parameter a

The graph shows the amount of funds that a bank lends to the private sector as a function of its efficiency a under scenarios 1 (open economy (OE) with international interbank lending) and 2 (OE with cross-border lending to firms). Banks for which z lies below the horizontal line lend fewer funds to firms than they raise from depositors. Therefore, these banks are lenders on the interbank market. Banks for which z lies above the horizontal line are borrowers on the interbank market. The size of their balance sheets is equal to z. In scenario 2, the most efficient banks in country 2 (Germany) engage in cross-border lending to firms in country 1 (the U.S.) and thereby grow in size. They obtain additional funds from the smaller banks in the two countries.

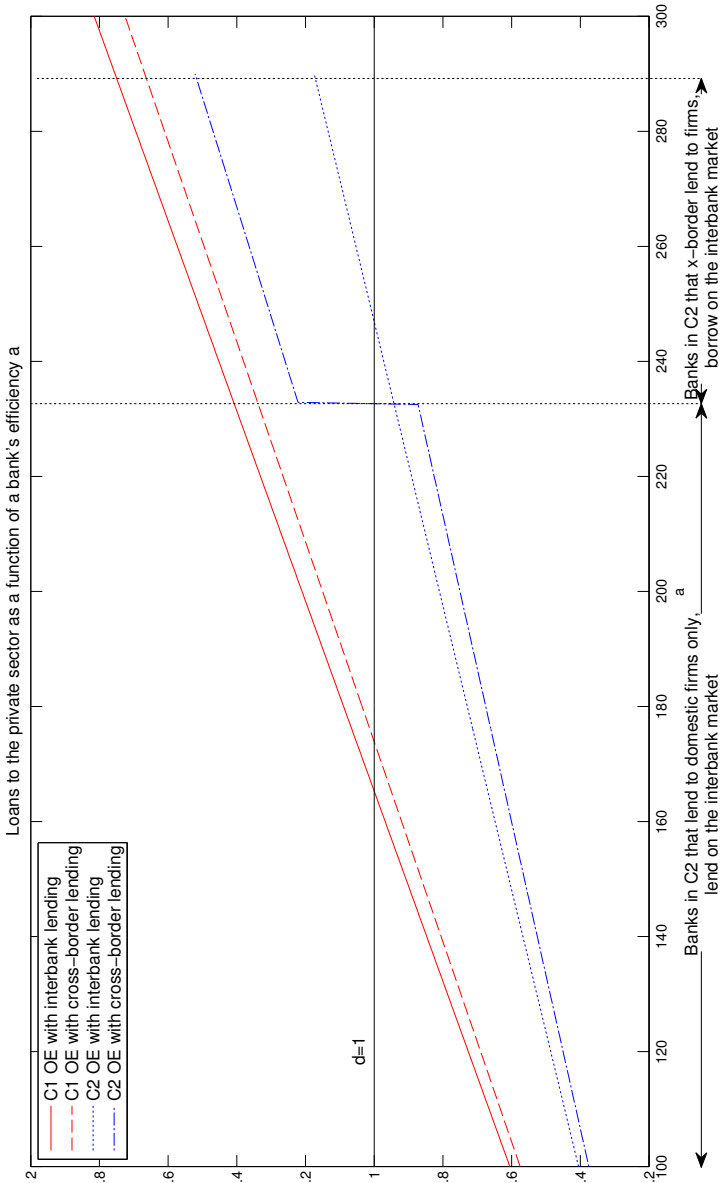


Figure 8: Scenario 3: The effect of barriers to foreign bank entry on the composition of international bank flows

The figure shows the composition of international bank flows as a function of the fixed cost of establishing a foreign affiliate in country 1 (the U.S.). The left graph depicts the total amount of cross-border lending, local lending and intra-bank lending of banks in country 2 (Germany). The right panel illustrates the total amount of lending to firms and lending to banks in country 1 (the U.S.) by banks in country 2 (Germany). When the fixed cost of establishing a foreign affiliate is low, all banks in country 2 operate in country 1 through foreign affiliates. When the fixed cost is sufficiently high, banks do not lend locally in country 1 through their affiliates, but only engage in cross-border lending to firms. As total lending to foreign firms decreases, net interbank lending by banks in country 2 to banks in country 1 rises.

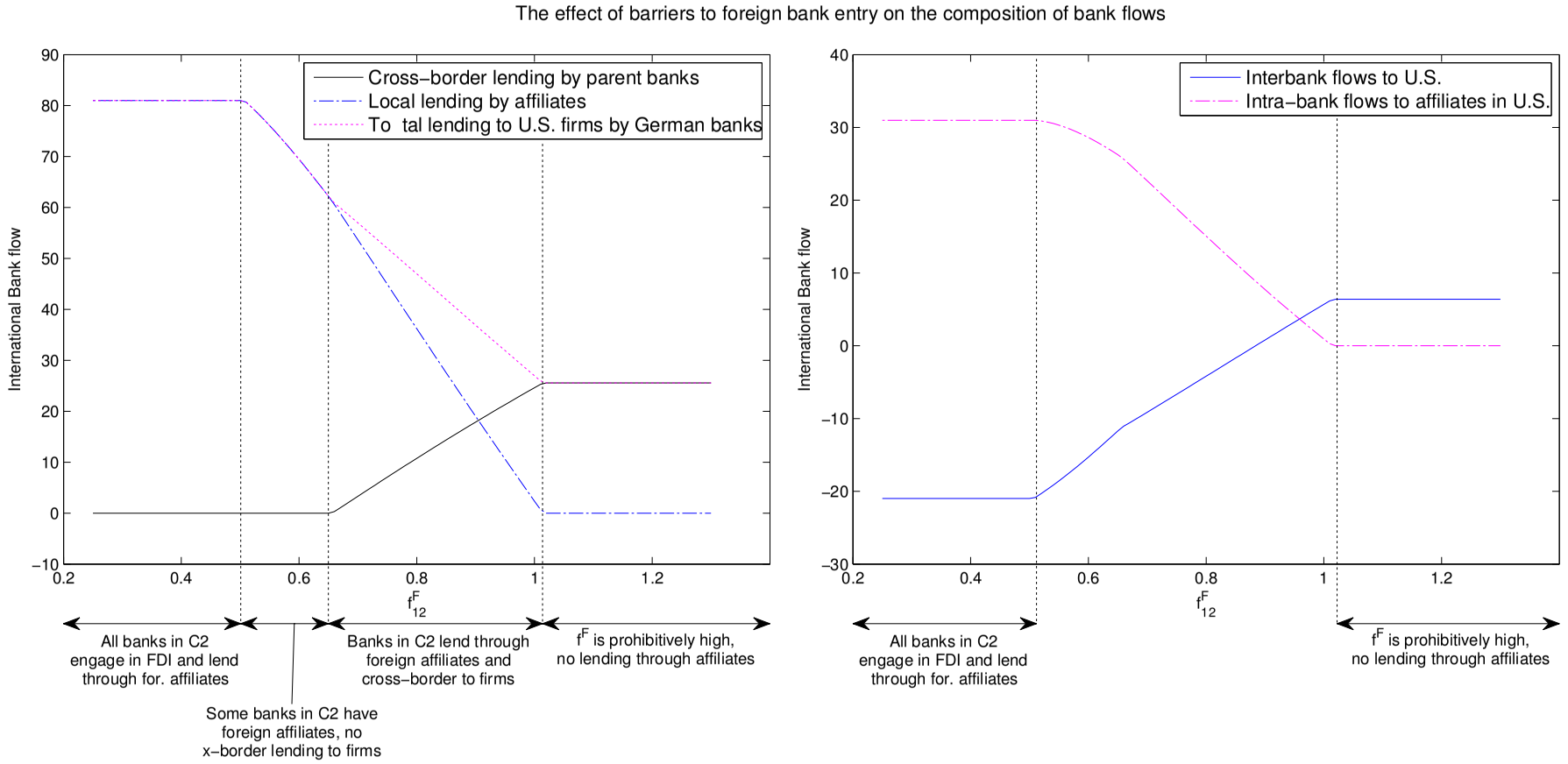


Figure 9: Scenario 3: Lending to the private sector as a function of the efficiency parameter a

The graph shows the amount of funds that a bank lends to the private sector as a function of its efficiency a under scenario 2 (open economy (OE) with cross-border lending) and scenario 3 (OE with foreign affiliates). Banks for which z lies below the horizontal line lend fewer funds to firms than they raise from depositors. Therefore, these banks are lenders on the interbank market. Banks for which z lies above the horizontal line are borrowers on the interbank market. The size of their balance sheets is equal to z. In scenario 2, the most efficient banks in country 2 (Germany) engage in cross-border lending to firms in country 1 (the U.S.). In scenario 3, the most efficient banks in country 2 engage in FDI and lend, through their foreign affiliates, to firms in country 1. As a consequence, they grow in size and are larger than in scenario 2. These banks obtain additional funds from the smaller banks in the two countries.

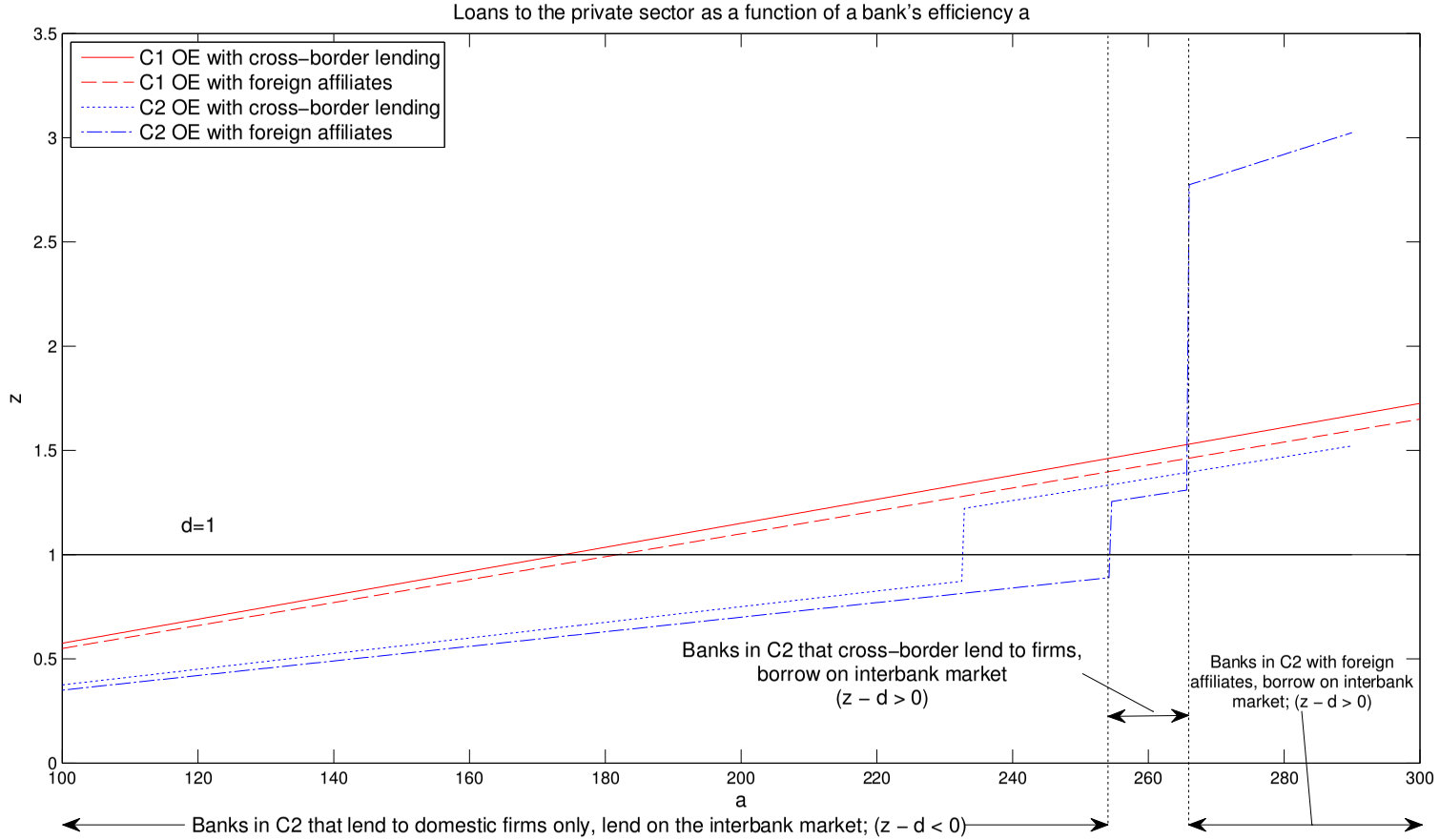


Figure 10: The effect of a change in the return on loans in country 1 on the capital flow under different scenarios

The figure illustrates the effect of a change in the return on loans in country 1 on the equilibrium capital flow. The solid line shows this effect for scenario 1, in which banks can only lend and borrow on international interbank markets but they cannot lend to or borrow from the private sector. The dashed line depicts the relationship under scenario 3, when banks engage in cross-border lending and establish affiliates abroad.

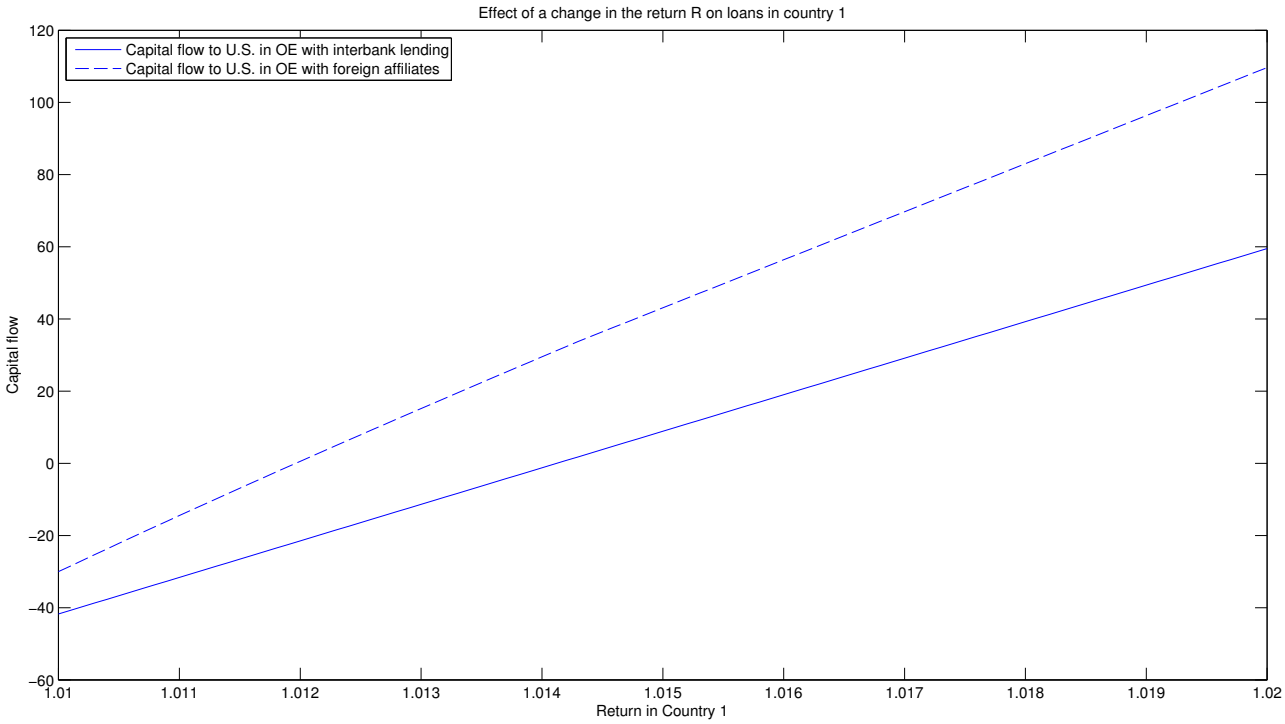


Figure 11: The effect of a change in the efficiency of banking sector 1 on the equilibrium capital flow under different scenarios

The figure illustrates the effect of a change in the average efficiency of banks in country 1 on the equilibrium capital flow. The solid line shows this effect for scenario 1, in which banks can only lend and borrow on international interbank markets but cannot lend to or borrow from the private sector. The dashed line depicts the relationship under scenario 3, when banks engage in cross-border lending and establish affiliates abroad.

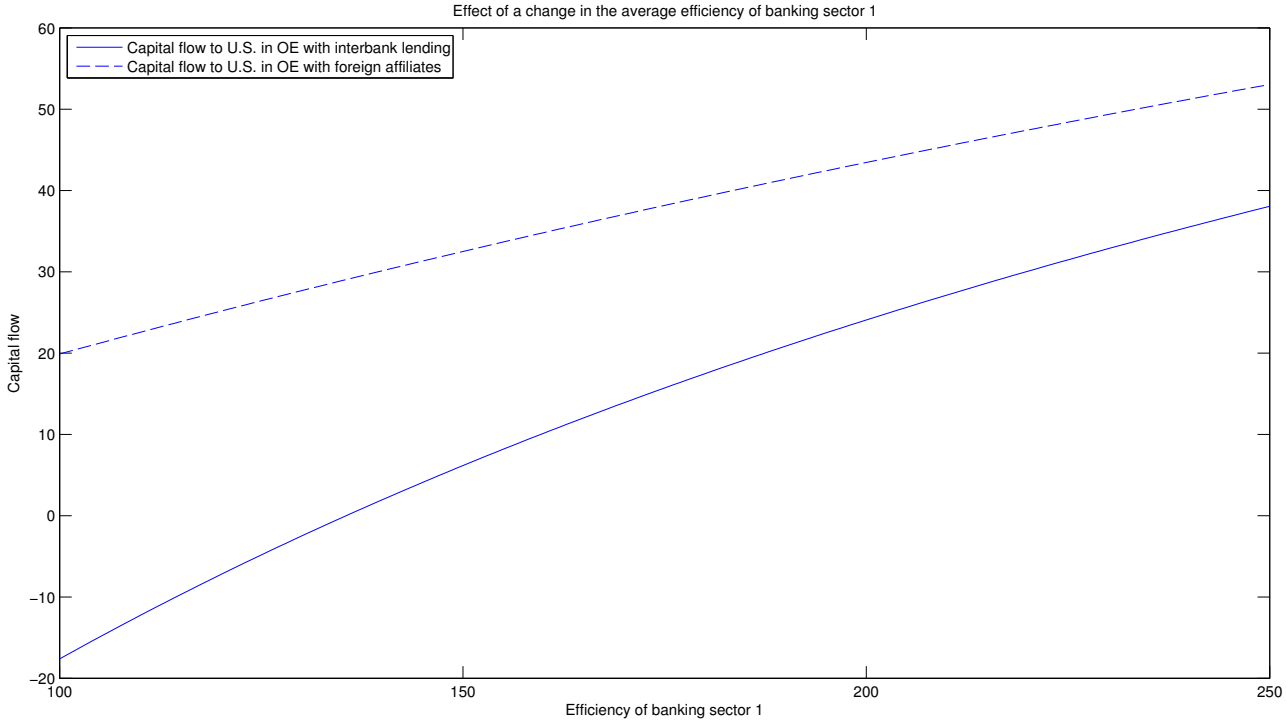
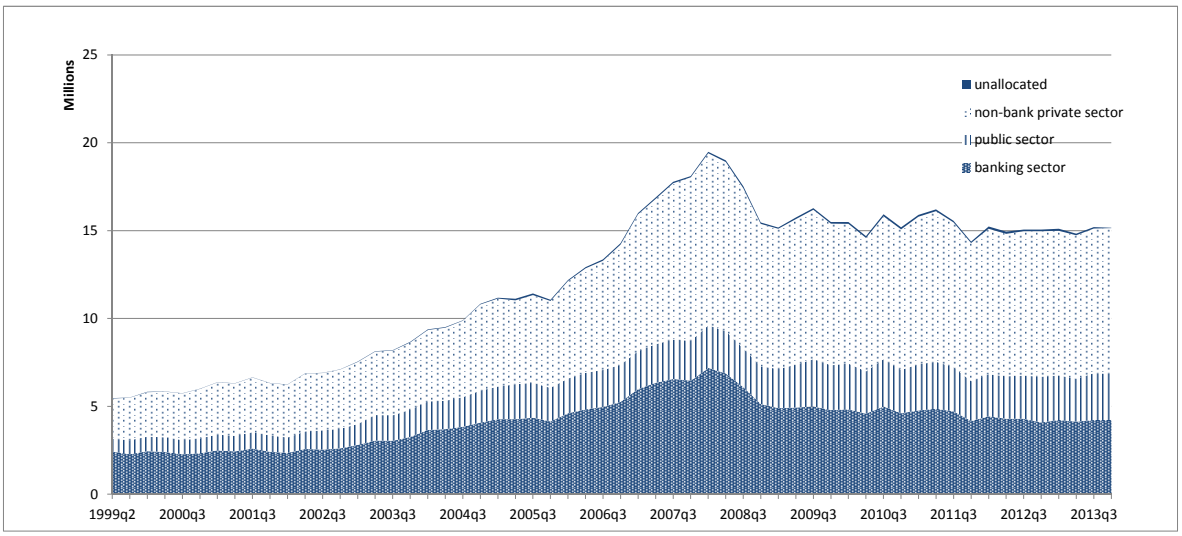


Figure 12: The sectoral composition of international assets held by BIS reporting countries, 1999-2013

The upper chart shows the evolution of total international assets of BIS reporting countries over time split by sector. The data source are the BIS Consolidated Statistics. Claims are on an immediate borrower basis and exclude local claims. The lower chart depicts the share of private sector assets and the share of banking sector assets in total international assets.

The sectoral composition of international assets



Shares in total international assets by sector