International Banks and the Cross-Border Transmission of Business Cycles*

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Abstract

We study the link between the cross-border funding activities of global banks and the international transmission of business cycles. First, using a dataset compiled by the Federal Reserve Board, we document three stylized facts about the operations of foreign banks in the United States: (i) The net borrowing of foreign branches from their parent banks is procyclical with the U.S. economy. (ii) The lending of foreign branches to U.S. firms is procyclical, and also more volatile than the lending of the domestically chartered banks. (iii) The lending of foreign subsidiaries to small U.S. firms is procyclical and more volatile than the corresponding lending by U.S. banks, indicating the presence of an extensive margin in foreign banks' lending to U.S. firms. Second, we build a two-country, dynamic stochastic general equilibrium model to explain these cyclical fluctuations in international bank lending and study their macroeconomic implications. In the model, each economy consists of: one representative household that provides bank deposits; two types of banks, "local" and "global", where the latter collects deposits from abroad and issues loans to foreign firms in addition to its domestic operations; a continuum of monopolistically-competitive firms that are heterogeneous in labor productivity, and that choose endogenously to borrow working capital from either the local or the global bank. Our model provides a framework to analyze the economic impact of proposed Basel III liquidity regulations.

Keywords: International banks, intra-bank lending, firm borrowing, extensive margin.

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1 Introduction

Starting in the summer of 2007, the Federal Reserve and other central banks implemented non-traditional policies to mitigate the effect of disruptions in their local credit and derivatives markets. For example, one trigger of the crisis was the run on the liabilities of special purpose vehicles (non-bank financial entities) that financed their holdings of long term assets with commercial paper (Arteta et al., 2009). Most of the riskier special purpose vehicles were sponsored by large European banks, which provided them with backup liquidity facilities. As these entities became unable to roll over their outstanding commercial paper (largely denominated in U.S. dollars) in August 2007, they tapped into the backup lines of credit provided by their European sponsors. In turn, the sponsoring banks had to seek additional funding in the interbank and other money markets. European banks with a presence in the United States (that is, branches or subsidiaries) sought to borrow in the U.S. money markets to finance their dollar denominated assets, disrupting these markets. In response, by the end of 2007, the Federal Reserve introduced the Term Auction Facility (TAF) to complement its traditional discount window operations, and had arranged liquidity swap lines with other major central banks, as the U.S. interbank market was still under stress.

These events motivate our focus on the role a group of financial institutions that have large and increasing linkages to U.S. credit markets: foreign-owned banks operating in the United States. Our study is both empirical and theoretical. Empirically, we document the cyclical fluctuations of intrabank transactions between foreign banks and their U.S.-based branches, as well as their lending behavior in the United States, using a dataset compiled by the Federal Reserve Board from Federal Financial Institutions Examination Council (FFIEC) reports.[1] First, we document that the "net due to" position of the U.S.-based branches of European banks – a measure of the net outstanding loans issued by foreign banks to their branches in the United States – is positively correlated with the GDP

[1] These reporting forms are used to collect information on the balance sheet position of the U.S.-based branches of foreign banks (FFIEC 002) every quarter, for the interval between1980:Q1 and 2009:Q4. In particular, the reports provide information on the assets and liabilities of these branches with respect to their related offices, including the head office. In addition, we use data on the lending by U.S.-based commercial banks (including subsidiaries of foreign banks) to small and large U.S. firms, reported in the FFIEC 031 report.

growth differential between the United States and the European Union-17 (see Figure 1).[2] Second, we report that lending of foreign branches in the United States is procyclical with respect to U.S. GDP growth, and more volatile than the total lending of domestic banks (see Figure 2). Third, we present evidence of the procyclicality, with respect to U.S. GDP growth, of the share of loans granted by foreign subsidiaries to small U.S. firms in the total *number* (Figure 3) and the total *value* (Figure 4); the share of foreign banks' lending to small U.S. firms is also more volatile than the share of lending by domestic banks to small U.S. firms, indicating the presence of an extensive margin in the lending of foreign banks to U.S. firms. For example, in Figure 3, the share of small U.S. firms (proxied by loans less than $100,000) in the total number of outstanding loans issued by foreign subsidiaries fell during the U.S. recession in 2001, increased during the subsequent recovery, and declined again as the U.S. economy slowed in the late 2000s; it was more volatile than the share of loans to small U.S. firms provided by domestic banks. Figure 4 shows a similar pattern, albeit less pronounced, for the share of small U.S. firms in the total value of outstanding loans provided by foreign subsidiaries.[3]

In the theoretical section, we examine the relationship between the cross-border funding activities of global banks, their ability to use foreign deposits to issue local loans, and the international transmission of business cycles. In order to explain the three stylized facts presented above and study their macroeconomic implications, we propose a two-country, dynamic stochastic general equilibrium (DSGE) model with international banks. In each economy, there is one representative household and a continuum of monopolistically-competitive firms that are heterogeneous in labor productivity. Every period, firms borrow working capital from banks. There are two types of banks in each country – local and global – that attract deposits from the local household and give loans to the local firms. In addition to its domestic operations, the global bank collects foreign deposits through its foreign branch and issues loans to foreign firms, maintaining the ability to fund domestic loans with foreign deposits.

[2] Cetorelli and Goldberg (2011) find that U.S. banks' internal funding transactions between their headquarters and foreign-based affiliates are correlated with U.S. monetary policy.

[3] In level terms, the foreign subsidiaries tend to lend less to the small U.S. firms than it is the case for U.S. banks. Thus, Figure 3 shows that small U.S. firms receive about 75 percent of the *number* of outstanding loans issued by U.S. banks, but only 60 percent of the number of loans issued by foreign subsidiaries. Figure 4 also shows that the loans to small U.S. firms represent a larger share of the *value* of outstanding loans of U.S. banks than foreign subsidiaries (i.e. 20 vs. 10 percent respectively).

The global bank is relatively more productive than the local bank in its ability to transform deposits into loans, and therefore issues loans at a lower interest rate. Thus, each firm can either borrow locally from the local bank or take a syndicated loan provided by the two global banks. Borrowing from the global banks has the advantages of a lower interest rate and access to international funding during expansions, but requires firms to pay a per-period fixed cost.

We aim to explore the dynamics generated by our model for the cross-border lending operations of international banks, as well as their effect on the volatility of the business cycle and welfare in the two economies [4] We focus on two types of shocks: (i) aggregate productivity shocks that affect the firms' demand for bank loans; and (ii) regulatory provisions affecting the foreign banks' ability to use foreign funds for domestic loans. First, following an aggregate productivity increase in Home, foreign banks find it increasingly profitable to convert foreign deposits into loans for the home firms. In turn, this should generate a procyclical "net due to" position of the foreign branch in Home relative to its parent bank, increased foreign lending in the United States, and increased access to foreign funds for the smaller U.S. firms, as in the data. Second, regulatory provisions that reduce the ability of the global banks to transform foreign deposits into local loans should dampen the response of domestic real activity to shocks, thus lowering the volatility of output.

The Basel Committee on Banking Supervision has proposed liquidity regulation designed to incentivize banks to manage liquidity risk more prudently (Basel Committee on Banking Supervision, 2010). As mentioned above, the frameworks developed in our DSGE model allows us to examine, to some extent, the effect of this regulation on cross-border intrabank lending. For example, branches of foreign banks in the United States mostly fund their balance sheets using wholesale and short-term financing. Thus, we analyze the effect of these regulatory restrictions, affecting global liquidity management, on several economic indicators in both the home and foreign countries.

Why do we focus our study on foreign banks? At the end of September 2008, the month when Lehman Brothers collapsed, the U.S.-based branches of foreign banks held $2.1 trillion in assets,

[4] In a related paper, Kollman et al. (2011) study the propagation of shocks between economies when bank capital constraints are binding. Similarly, Kalemli-Ozcan, Papaioannou, and Perri (2011) develop a general equilibrium model with international banking to assess the differential effect of productivity and financial shocks.

equivalent to almost one-fifth of the assets held by all insured commercial banks in the United States. These institutions obtain their funding in the wholesale deposit market and in the interbank market, as they do not participate in the FDIC's deposit insurance scheme, and therefore, do not attract retail deposits. The amount of federal funds borrowed and securities sold under repurchase agreements by U.S. branches of foreign banks reached almost $230 billion at end-September 2008, equivalent to more than one-fourth of similar transactions done by U.S. insured commercial banks. These statistics highlight the importance of foreign banks in the execution of monetary policy and the design of bank regulation.

2 Empirical Evidence

This section provides empirical evidence on the activities of international banks in the United States. We focus on U.S.-based branches of foreign banks, particularly on branches with parent banks headquartered in Europe.

Over the last three decades, U.S. branches of foreign banks have been increasingly active in the U.S. wholesale credit and money markets. Low costs of entering the U.S. market through branches, as opposed to subsidiaries, makes it attractive to foreign banks that want to access U.S. capital markets without a need of tapping retail customers. During the recent financial crisis, these branches played an important role while serving as conduits for foreign banks to the U.S. money markets.

In the rest of this section, we describe a dataset containing information on the activities of U.S. branches of foreign banks. The stylized facts derived from these data guide us in the development of our theoretical model, which explicitly addresses the question of linkages between two economies through the banking sector, particularly through intrabank lending. We test for factors that determine the financial linkages of these branches vis-a-vis their parents through time. Finally, we describe other stylized facts that are incorporated in the model.

2.1 Data

The Federal Financial Institutions Examination Council (FFIEC) requires all U.S. branches of foreign banks to report balance sheet and off-balance sheet information every quarter in the "Report of Assets and Liabilities of U.S. Branches and Agencies of Foreign Banks" (FFIEC 002). Table 1 shows the aggregate balance sheet of branches of U.S. banks as of the end of December 2006 and 2008, and June 2011. Before the financial crisis, U.S. branches of European banks had almost $1.2 trillion in assets. This number went up to $1.4 trillion as of December of 2008 and then decreased to $1.3 trillion as of end-June 2011. The composition of the balance sheet also changed in this period. Although claims on non-related parties remained at about 70 percent of total assets prior and during the financial crisis, more cash holdings, securities and loans compensated for a decrease in transactions in the repo market. In 2011, as European fiscal strains deepend, branches of European banks increased their claims on non-related parties, mostly reserves held at the Federal Reserve. On the liabilities side, access to the Federal Reserve's various lending programs during the financial crisis compensated for the a reduction in repo financing.

To analyze the transmission of shocks between countries, we focus on intrabank transactions. Financial flows between branches and parent banks can take the form of loans or repatriation of profits. In Table 1, the *Net Due From* position of U.S. branches of European banks is listed on the assets side, while the *Net Due To* position is part of the liabilities. The table shows that, on aggregate, prior and during the financial crisis these branches had a positive Net Due From position with their parents (or a negative Net Due To position) This means that the parents owed their branches more than what the branches owed their parents. Through the financial crisis we observe that the net position of the branches with related institutions remained stable. However, as the Federal Reserve programs expired and interbank funding remained subdued, branches became more reliant on their parents for funding. The Net Due To position of branches increased from 5 percent of total assets to about 20 percent, while the Net Due From position dropped almost 15 percentage points and now represents 15 percent of assets.

In addition to exploring the important role that branches played during the crisis, we study the long run features of intrabank transactions and their role as conduits across economies. In this way, we also provide a benchmark steady state equilibrium for the quantitative analysis performed with the model. Figure 1 shows the Net Due To position of the U.S. branches of European banks as a share of assets from 1983 to 2011. We observe that intrabank positions are positively related to the U.S. GDP growth. In periods with strong growth in the U.S. economy, global banks have an incentive to lend more to U.S. borrowers. Thus, the Net Due To position of their branches in the United States should increase. The opposite is true when growth in the United States slows, most visibly in Figure 1 for the 1990-91 and 2007-09 recessions.

2.2 Determinants of Intrabank Transactions

Above, we provided some evidence on the fluctuations of intrabank transactions through time. In this section, we formally test for the determinants of these flows of resources between parent banks and their branches. In Table 2 we estimate the following equation:

$$\begin{aligned}\frac{NDT_{ijt}}{TA_{ijt}} = \; & \alpha + \beta_1 \text{US GDP Growth}_t + \beta_2 \text{Foreign GDP Growth}_t \\ & + \beta_3 \text{Real Interest Rate Differential}_t + \beta_4 \text{Log Assets}_{ijt} + \theta_{ij} + \mu_q + \varphi_t + \epsilon_{ijt} \qquad (1)\end{aligned}$$

Where NDT is the Net Due To (or Gross Due To or Gross Due From) position of foreign branches in the United States and TA is total assets; branches are indexed by i , countries by j, time by t, and quarters by q; US GDP Growth and Foreign GDP Growth are the growth rates of U.S. GDP and the branch home country's GDP, respectively; Real Interest Rate Differential is equal to the effective real federal funds rate minus the branche's home country policy rate; Log Assets is the log value of claims on non-related parties, a measure of the branch's size; θ_{ij} is a branch specific fixed effect; μ_q and φ_t are quarterly and time fixed effects respectively. We show the results of this estimation in Table 2. The main finding is that the Net Due To position of foreign branches are positively related to U.S. GDP growth. Branches lend less to their parents when the U.S. economy is growing faster, as shown by the negative coefficient on U.S. GDP growth in column (3). Tighter relative monetary policy decreases the Gross Due To position of the branches, but it does not havw a significant effect on the net position.

In Table 3 we estimate the same equation, but break down the sample between large and small branches. Large branches are defined by their position in the distribution of assets every quarter. Branches in the top quintile of the distribution are defined as large. We find that intrabank transactions are more sensitive to U.S. GDP growth for smaller branches.

Lastly, Table 4 provides some evidence on the role that branches played during the recent financial crisis. We estimate a difference-in-difference equation to assess if European banks tapped their branches after the collapse of the U.S. ABCP market in the third quarter of 2007. The control group for this estimations are the branches of non-European banks. As the crisis unfolded, some European banks needed dollar funding to finance assets purchased through off-balance conduits. At the same time, U.S. money markets were experiencing significant problems. European banks used their branches to access dollar funding, particularly after the Federal Reserve introduced a number of liquidity facilities at the end of 2007.

The coefficient of interest in the estimation is the interaction between Dummy Crisis and Dummy Europe. The later equals 1 for four quarters staring the third quarter of 2007 and the former equals 1 for European banks. The table shows that branches of European banks had larger Gross Due From positions and smaller Gross Due To positions after the ABCP market collapse. This results is evidence that branches worked as liquidity conduits after the shock to the ABCP market.

3 The Model

We consider a two-country (Home and Foreign), dynamic stochastic general equilibrium (DSGE) model with international banks. In each economy, there is one representative household and a continuum of monopolistically-competitive firms that are heterogeneous in labor productivity. There are also two types of banks, a local and a global bank, that attract deposits from the local households and give loans to the local firms. In addition to its local operations, the global bank also collects wholesale deposits in the foreign inter-bank market, and issues loans to foreign firms. Also, the global bank is more productive than the local bank in its ability to transform deposits into loans, and therefore issues loans at a lower interest rate.

Every period, firms borrow working capital from banks. For this purpose, each firm can either take a loan from the local bank or a syndicated loan from the global banks in Home and Foreign.[5] Borrowing from the global banks has the advantage of a lower interest rate, but requires a per-period fixed cost paid by the firm. As a result, only the more productive firms can afford to borrow from the global banks, whereas the less productive firms borrow locally.

3.1 Households

In what follows we describe the model from the perspective of the home economy. Since the model is symmetric, the setup for the foreign economy is similar. Variables from the foreign economy are denoted with a star superscript.

The representative household in Home maximizes the expected lifetime utility subject to its budget constraint: $\max_{\{D_t,\, x_t\}} \left[E_t \sum_{s=t}^{\infty} \beta^{s-t} \frac{C_s^{1-\gamma}}{1-\gamma} \right]$, where $\beta \in (0,1)$ is the subjective discount factor, C_t is aggregate consumption, and $\gamma > 0$ is the inverse of the inter-temporal elasticity of substitution. The budget constraint is:

$$(\widetilde{v}_t + \widetilde{\pi}_t) N_t x_{t-1} + (1 + r_t) D_{t-1} + w_t L \geq \widetilde{v}_t (N_t + N_{E,t}) x_t + D_t + \frac{\xi}{2} (D_t)^2 + C_t.$$

The representative household starts every period with share holdings x_{t-1} in a mutual fund of N_t firms whose average market value is $\widetilde{v}_t$, and also with deposits D_{t-1} allocated across the home local bank, the home global bank and the foreign branch operating in Home. It receives dividends equal to the average firm profit $\widetilde{\pi}_t$ in proportion with the number of operating firms N_t and its share holdings x_{t-1}. It also receives interest $r_t D_{t-1}$ on bank deposits, and the real wage w_t for the amount of labor

[5] The home firms have the option to either borrow from the local bank, or borrow from a consortium that includes the home global bank and the domestic branch of the foreign global bank.

$L \equiv 1$ supplied inelastically.

Every period, the household purchases x_t shares in a mutual fund of firms that includes: (i) N_t firms that already produce at time t, and (ii) $N_{E,t}$ new firms that enter the market in period t. Each share is worth its market value $\widetilde{v}_t$, equal to the net present value of the expected stream of future profits for the average firm. The household also places new bank deposits D_t subject to a quadratic adjustment cost $\frac{\xi}{2}(D_t)^2$. Finally, the household purchases the consumption basket C_t.

The first order conditions with respect to consumption C_t and new deposits D_t imply:

$$1 + \xi D_t = \beta E_t \left[(1 + r_{t+1}) \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \right]. \tag{2}$$

The first order condition for stock holdings x_t implies:

$$\widetilde{v}_t = \beta(1-\delta) E_t \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} (\widetilde{v}_{t+1} + \widetilde{\pi}_{t+1}), \tag{3}$$

which takes into account the mechanism of endogenous firm entry (described in the next section), with the law of motion for the number of firms $N_{t+1} = (1-\delta)(N_t + N_{Et})$ and the rate of firm exit δ.

3.2 Firms

3.2.1 Firm entry and exit

New firms enter the market every period, as in Ghironi and Melitz (2005). In the home market, firm entry requires a sunk entry cost equal to f_E units of the home effective labor.[6] After paying the sunk entry cost, each firm is randomly assigned an idiosyncratic labor productivity factor z which is drawn independently from a common distribution $G(z)$ with support over the interval $[z_{min}, \infty)$, and which is fixed over time.

The $N_{E,t}$ firms entering at time t do not produce until period $t+1$. All firms, including the new entrants, are subject to a random exit shock that occurs with probability δ at the end of every period.

[6] The sunk entry cost is equivalent to $f_E w_t / Z_t$ units of the home consumption basket.

Thus, the law of motion for the number of producing firms is:

$$N_{t+1} = (1-\delta)(N_t + N_{E,t}). \tag{4}$$

The potential entrant firms anticipate their expected post-entry value $\widetilde{v}_t$, which depends on the expected stream of future profits $\widetilde{\pi}_t$, the stochastic discount factor, and the exogenous probability δ of exit every period. The forward iteration of the Euler equation for stocks (3) generates an expression for the expected post-entry value of the average firm, $\widetilde{v}_t = E_t \left\{ \sum\limits_{s=t+1}^{\infty} [\beta(1-\delta)]^{s-t} \left(\frac{C_s}{C_t}\right)^{-\gamma} \widetilde{\pi_s} \right\}$. Thus, every period, the unbounded pool of potential entrant firms faces a trade-off between the sunk entry cost and the expected stream of future monopolistic profits. In equilibrium, firm entry takes place until the expected value of the average firm is equal to the sunk entry cost expressed in units of the home consumption basket:

$$\widetilde{v}_t = f_E \frac{w_t}{Z_t}. \tag{5}$$

3.2.2 Country-specific goods

Each firm produces a different variety of goods, $y_t(\omega)$. All varieties ω available at period t (i.e. set Ω) are included a country-specific good:

$$\widehat{Y}_{h,t} = \left[\int_{\omega \in \Omega} y_t(\omega)^{\frac{\theta-1}{\theta}} d\omega \right]^{\frac{\theta}{\theta-1}},$$

where $\theta > 1$ is the symmetric elasticity of substitution across varieties. The home-specific good $\widehat{Y}_{h,t}$ can be consumed domestically ($Y_{h,t}$) or exported ($Y^*_{h,t}$), so that $\widehat{Y}_{h,t} = Y_{h,t} + Y^*_{h,t}$. Under monopolistic competition, the price of the home-specific good depends on the prices of each variety $p_t(\omega)$, so that $p_{h,t} = \left[\int_{\omega\in\Omega} p_t(\omega)^{1-\theta} d\omega\right]^{\frac{1}{1-\theta}}$. The demand for each variety is $y_t(\omega) = \left[\frac{p_t(\omega)}{p_{h,t}}\right]^{-\theta} \left(Y_{h,t} + Y^*_{h,t}\right)$.

We define the home consumption basket C_t as an aggregate of the home and foreign-specific goods:

$$C_t = \left[(\lambda_y)^{\frac{1}{\epsilon_y}} \left(Y_{h,t}\right)^{\frac{\epsilon_y - 1}{\epsilon_y}} + (1-\lambda_y)^{\frac{1}{\epsilon_y}} \left(Y_{f,t}\right)^{\frac{\epsilon_y - 1}{\epsilon_y}} \right]^{\frac{\epsilon_y}{\epsilon_y - 1}},$$

where $\epsilon_y > 1$ is the symmetric elasticity of substitution across the home and foreign-specific goods, and λ_y is the degree of home bias. We set C_t as the numeraire good, so that its price is normalized to unit:

$$P_t = \left[(\lambda_y)\left(p_{h,t}\right)^{1-\epsilon_y} + (1-\lambda_y)\left(p_{f,t}Q_t\right)^{1-\epsilon_y}\right]^{\frac{1}{1-\epsilon_y}} \equiv 1. \tag{6}$$

Under monopolistic competition, the demand for the home and foreign-specific goods is $Y_{h,t} = \lambda_y \left(p_{h,t}\right)^{-\epsilon_y} C_t$ and $Y_{f,t} = (1-\lambda_y)\left(p_{f,t}Q_t\right)^{-\epsilon_y} C_t$, respectively, where $Q_t = \frac{P_t^* \varepsilon}{P_t}$ is the real exchange rate.

3.2.3 Working capital: local vs. global borrowing

The firm with idiosyncratic labor productivity z obtains output $y_t(z) = Z_t z n_t(z)$, which is a function of the aggregate productivity Z_t, the firm-specific labor productivity z, and domestic labor $n_t(z)$.[7] Moreover, each firm must borrow working capital in order to pay a fraction ϕ of its labor costs at the beginning of each period, before it produces and sells its output. To this end, firms must choose one of two possible borrowing strategies: (1) Borrow from the local bank for a relatively higher interest rate. (2) Use a global syndicated loan, which includes loans from the home global bank as well as from the local branch of the foreign global bank. Working with the global banks has the advantage of a lower interest rate, but requires a per-period fixed cost.

Below we describe the mechanisms of borrowing from either the local or the global banks as alternative choices for each firm.

Local loans The firm that chooses to borrow from the local bank maximizes its per-period profit:

$$\pi_{L,t}(z) = \underbrace{p_{L,t}(z)y_t(z)}_{\text{revenue}} - \underbrace{w_t n_t(z)}_{\text{wage bill}} - \underbrace{r_{L,t}l_t(z)}_{\text{borrowing cost}}$$

[7] Since each firm produces a different variety, the firm-specific productivity z also serves as an index for varieties. Given that one unit of labor produces $Z_t z$, and given that w_t is the real wage, the unit cost of production is $\frac{w_t}{Z_t z}$.

subject to the demand for variety $y_t(z)$, and the requirement that firms must borrow working capital $l_t(z)$ in order to pay a fraction ϕ of its labor cost $w_t n_t(z)$ at the beginning of each period:

$$
\begin{aligned}
y_t(z) &= \left[\frac{p_{L,t}(z)}{p_{h,t}}\right]^{-\theta} \left(Y_{h,t} + Y_{h,t}^*\right), \\
l_t(z) &\geq \phi w_t n_t(z).
\end{aligned}
$$

Substituting the constraints into the profit function, the profit-maximization problem implies the equilibrium price and profit:

$$
\begin{aligned}
p_{L,t}(z) &= \frac{\theta}{\theta-1}\frac{w_t}{Z_t z}(1+\phi r_{L,t}). \\
\pi_{L,t}(z) &= \frac{1}{\theta}\left[\frac{p_{L,t}(z)}{p_{h,t}}\right]^{1-\theta} p_{h,t}\left(Y_{h,t} + Y_{h,t}^*\right).
\end{aligned}
$$

Global loans The firm that borrows from the global banks obtains a lower interest rate $r_{G,t} < r_{L,t}$ (as described in the next section), but faces a fixed cost $f_G \frac{w_t}{Z_t}$ every period required to develop the relationship with global banks, which lack the familiarity with local borrowers available to the local bank. It maximizes the per-period profit:

$$
\pi_{G,t}(z) = p_t(z) y_t(z) - w_t n_t(z) - r_{G,t} l_t(z) - f_G \frac{w_t}{Z_t}.
$$

The maximization problem implies the following price and profit:

$$
\begin{aligned}
p_{G,t}(z) &= \frac{\theta}{\theta-1}\frac{w_t}{Z_t z}(1+\phi r_{G,t}). \\
\pi_{G,t}(z) &= \frac{1}{\theta}\left[\frac{p_{G,t}(z)}{p_{h,t}}\right]^{1-\theta} p_{h,t}\left(Y_{h,t} + Y_{h,t}^*\right) - f_G \frac{w_t}{Z_t}.
\end{aligned}
$$

3.2.4 Endogenous productivity cutoff

When deciding upon the location of production every period, the firm with productivity z compares the profit obtained if it borrows locally, $\pi_{L,t}(z)$, with the profit obtained if it borrows from the global banks, $\pi_{G,t}(z)$. Each firm chooses the borrowing strategy that maximizes its per-period profit. As a particular case, we define the productivity cutoff $z_{G,t}$ on the support interval $[z_{\min}, \infty)$, so that the firm at the cutoff is indifferent across borrowing from the local or the global banks:

$$z_{G,t} = \{z \mid \pi_{G,t}(z_{G,t}) = \pi_{L,t}(z_{G,t})\} . \tag{7}$$

The model implies that only the relatively more productive firms find it profitable to work with the global banks. Despite the lower interest rate associated with borrowing from the global banks, only firms with idiosyncratic productivity above a certain cutoff ($z > z_{G,t}$) obtain profits that are large enough to cover the fixed cost $f_G \frac{w_t}{Z_t}$.

In order to illustrate the endogenous determination of the productivity cutoff $z_{G,t}$, we re-write the per-period profits from local and global borrowing as functions of $z^{\theta-1}$:

$$\pi_{L,t}(z) = \underbrace{\frac{1}{\theta}\left[\frac{\theta}{\theta-1}\frac{w_t}{Z_t}(1+\phi r_{L,t})\right]^{1-\theta} C_t}_{\text{slope}} z^{\theta-1};$$

$$\pi_{G,t}(z) = \underbrace{\frac{1}{\theta}\left[\frac{\theta}{\theta-1}\frac{w_t}{Z_t}(1+\phi r_{G,t})\right]^{1-\theta} C_t}_{\text{slope}} z^{\theta-1} - \underbrace{f_G\frac{w_t}{Z_t}}_{\text{intercept}}$$

In Figure 5, we plot the two profits as functions of the idiosyncratic productivity parameter $z^{\theta-1}$ over the support interval $[z_{min}, \infty)$. The vertical intercept for local borrowing is zero; the intercept is equal to the negative of the fixed cost required to borrow from the global banks $(-f_G \frac{w_t^* Q_t}{Z_t^*})$. The existence of the equilibrium productivity cutoff $z_{G,t}$ requires that the profit function associated with borrowing from the global banks must be steeper than the profit from working with the local bank, i.e. $\mathit{slope}\{\pi_{G,t}(z)\} > \mathit{slope}\{\pi_{L,t}(z)\}$. When this condition is met, borrowing from the global banks generates greater profits for the firms with idiosyncratic productivity z along the upper range of the support interval ($z > z_{G,t}$). The higher productivity of the global banks allows them to lend for a lower interest rate than the local bank, $r_{G,t} < r_{L,t}$. This property ensures that the slope inequality is satisfied.

3.2.5 Aggregation over heterogeneous firms

We define two average labor productivity levels for firms that borrow locally ($\widetilde{z}_{L,t}$) and globally ($\widetilde{z}_{G,t}$), illustrated in Figure 5, and solve the model in terms of two representative firms. Every period t, $\widetilde{z}_{L,t}$ is the average productivity of the $N_{L,t}$ firms that borrow locally ($z < z_{C,t}$), and $\widetilde{z}_{G,t}$ is the average productivity of the $N_{G,t}$ firms that borrow from the global banks ($z > z_{C,t}$).

Assuming that the firm-specific labor productivity z is Pareto-distributed, with p.d.f. $g(z) = kz_{min}/z^{k+1}$ and c.d.f. $G(z) = 1 - (z_{min}/z)^k$, we obtain the following expressions for the firm productivity averages (see the Appendix):

$$\widetilde{z}_{L,t} = \left[\frac{1}{G(z_{C,t})}\int_{z_{\min}}^{z_{C,t}} z^{\theta-1}g(z)dz\right]^{\frac{1}{\theta-1}} = \nu z_{\min} z_{C,t}\left[\frac{z_{C,t}^{k-(\theta-1)} - z_{\min}^{k-(\theta-1)}}{z_{C,t}^{k} - z_{\min}^{k}}\right]^{\frac{1}{\theta-1}}, \tag{8}$$

$$\widetilde{z}_{G,t} = \left[\frac{1}{1-G(z_{C,t})}\int_{z_{C,t}}^{\infty} z^{\theta-1}g(z)dz\right]^{\frac{1}{\theta-1}} = \nu z_{C,t}. \tag{9}$$

Using the firm productivity averages, we write the average prices of varieties produced by the local and global-borrowing firms as:

$$\widetilde{p}_{L,t} = \frac{\theta}{\theta-1}\frac{w_t}{Z_t\widetilde{z}_{L,t}}(1+\phi r_{L,t}), \tag{10}$$

$$\widetilde{p}_{G,t} = \frac{\theta}{\theta-1}\frac{w_t}{Z_t\widetilde{z}_{G,t}}(1+\phi r_{G,t}). \tag{11}$$

The corresponding average profits are:

$$\widetilde{\pi}_{L,t} = \frac{1}{\theta}\left[\frac{\widetilde{p}_{L,t}}{p_{h,t}}\right]^{1-\theta} p_{h,t}\left(Y_{h,t} + Y_{h,t}^*\right), \tag{12}$$

$$\widetilde{\pi}_{G,t} = \frac{1}{\theta}\left[\frac{\widetilde{p}_{G,t}}{p_{h,t}}\right]^{1-\theta} p_{h,t}\left(Y_{h,t} + Y_{h,t}^*\right) - f_G\frac{w_t}{Z_t}. \tag{13}$$

The price indexes for the home and foreign-specific goods become:

$$N_t \left(p_{h,t}\right)^{1-\theta} = N_{L,t} \left(\widetilde{p}_{L,t}\right)^{1-\theta} + N_{G,t} \left(\widetilde{p}_{G,t}\right)^{1-\theta} \tag{14}$$

$$N_t^* \left(p_{f,t}\right)^{1-\theta} = N_{L,t}^* \left(\widetilde{p}_{L,t}^*\right)^{1-\theta} + N_{G,t}^* \left(\widetilde{p}_{G,t}^*\right)^{1-\theta} \tag{15}$$

The expressions for total profits in Home and Foreign are:

$$N_t \widetilde{\pi}_t = N_{L,t} \widetilde{\pi}_{L,t} + N_{G,t} \widetilde{\pi}_{G,t} \tag{16}$$

$$N_t^* \widetilde{\pi}_t^* = N_{L,t}^* \widetilde{\pi}_{L,t}^* + N_{G,t}^* \widetilde{\pi}_{G,t}^* \tag{17}$$

3.3 Banks

There are two types of banks in each economy, a local and a global bank. Banks are competitive and earn zero profits. In Home, the local bank and the global bank attract deposits from the local households and issue loans to the local firms. In addition to its domestic operations, the home global bank collects wholesale deposits from the foreign inter-bank market and issues loans to foreign firms.

Let $c_j \geq 1$, with $j \in \{L, G\}$, be the cost parameter for the local and the global banks, respectively, that characterizes the technology used by each bank to transform deposits $(D_{j,t-1})$ into loans $(L_{j,t})$:

$$L_{j,t} = \frac{D_{j,t-1}}{c_j}, \; c_j \geq 1.$$

Following de Blas and Russ (2010), the cost parameter represents non-interest expenditures or institutional inefficiencies that prevent the bank from transforming a certain portion of deposits into loans. The portion of deposits not used to make loans increases with the cost parameter c_j. More, the cost introduces a wedge between the interest rate that banks pay on deposits and the rate they charge for loans, which increases with the cost parameter. Therefore, the assumption that global banks are more productive than the local banks, $c_G < c_L$, implies that the global bank can issue loans at a lower rate than the local bank.

3.3.1 The local bank

The local bank obtains zero profits under perfect competition:

$$\Omega_t^L = \underbrace{r_{L,t}(1-\delta)L_{L,t}}_{\text{interest received for good loans}} - \underbrace{\mu\delta L_{L,t}}_{\text{monitoring cost for non-performing loans}} - \underbrace{r_t D_{L,t-1}}_{\text{interest paid on deposits}},$$

where $r_{L,t}$ is the interest rate on loans, and $L_{L,t} = \frac{D_{L,t-1}}{c_L}$ is the amount of loans issued based on deposits $D_{L,t-1}$. Given the mechanism of endogenous firm entry/exogenous exit, a fraction δ of all firms exit every period without producing any output. We assume that firms receiving the exit shock default on their bank loans, as in Russ and Valderrama (2010): In the event of default, banks must audit the exiting firms in order to liquidate the remaining assets at the cost μ. Banks recover the borrowed funds, but with no interest and minus the monitoring cost. Therefore, $r_{L,t}(1-\delta)L_{L,t}$ is the total interest income received by the bank for good loans, and $\mu\delta L_{L,t}$ is the monitoring cost paid for non-performing loans. Finally, $r_t D_{L,t-1}$ represents the interest paid on deposits.

Substituting $D_{L,t-1} = c_L L_{L,t}$ in the expression for bank profits Ω_t^L gives the equilibrium interest rate:

$$r_{L,t} = \frac{c_L r_t}{1-\delta} + \frac{\mu\delta}{1-\delta}. \tag{18}$$

3.3.2 The global bank

The profit of the home global bank is similar to that of the local bank, except for that the global bank borrows and lends in both Home and Foreign:

$$\Omega_t^G = r_{G,t}(1-\delta)L_{H,t} + r_{G,t}(1-\delta^*)L_{H,t}^* Q_t - \mu\delta L_{H,t} - \mu^*\delta^* L_{H,t}^* Q_t - r_t D_{H,t-1} - r_t^* D_{H,t-1}^* Q_t.$$

The home global bank charges interest rate $r_{G,t}$ for loans granted to the home firms ($L_{H,t}$) and to the foreign firms ($L_{H,t}^*$). Since the loans issued to foreign firms are expressed in units of the foreign consumption basket ($L_{H,t}^*$), we convert them into home units using the real exchange rate Q_t. The bank must pay the monitoring cost μ associated with non-performing loans issued in Home and μ^* for non-performing loans issued in Foreign. Finally, the global bank obtains deposits $D_{H,t-1}$ from home, for which it pays the interest rate r_t. It also receives wholesale deposits $D^*_{H,t-1}Q_t$ from the foreign inter-bank market, for which it pays the interest rate r^*_t.

The total amount of loans issued by the global bank is constrained by the bank's ability to transform total deposits into total loans, $L_{H,t} + L^*_{H,t}Q_t = \frac{D_{H,t-1}+D^*_{H,t-1}Q_t}{c_G}$, where $c_G \geq 1$,where $D_{H,t-1}$ and $D^*_{H,t-1}Q_t$ are the deposits received at home and abroad, respectively. Under symmetry $\mu = \mu^*$and $\delta = \delta^*$, the interest charged by the global bank is a weighted average of the cost of home and foreign deposits:

$$r_{G,t} = \frac{D_{H,t-1}}{D_{H,t-1} + D^*_{H,t-1}Q_t}\left(\frac{c_G r_t + \mu\delta}{1-\delta}\right) + \frac{D^*_{H,t-1}Q_t}{D_{H,t-1} + D^*_{H,t-1}Q_t}\left(\frac{c_G r^*_t + \mu\delta}{1-\delta}\right). \tag{19}$$

3.3.3 Market clearing for loans

The market clearing condition for loans issued by the local bank is:

$$L_{L,t} = N_{L,t}\frac{\phi w_t}{Z_t \widetilde{z}_{L,t}}\left(\frac{\widetilde{p}_{L,t}}{p_{h,t}}\right)^{-\theta}\left(Y_{h,t} + Y^*_{h,t}\right),$$

where $N_{L,t}$ is the number of firms that borrow locally, and $\widetilde{z}_{L,t}$ and $\widetilde{p}_{L,t}$ are the average productivity and price of local borrowers.

The more productive home firms obtain a syndicated loan issued by the home global bank ($L_{H,t}$) and the foreign global bank ($L_{F,t}$), with elasticity of substitution $\epsilon > 1$ and home bias $0 < \lambda < 1$:

$$L_{S,t} = \left[\lambda^{\frac{1}{\epsilon}}\left(L_{H,t}\right)^{\frac{\epsilon-1}{\epsilon}} + (1-\lambda)^{\frac{1}{\epsilon}}\left(L_{F,t}\right)^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}} = N_{G,t}\frac{\phi w_t}{Z_t \widetilde{z}_{G,t}}\left(\frac{\widetilde{p}_{G,t}}{p_{h,t}}\right)^{-\theta}\left(Y_{h,t} + Y^*_{h,t}\right),$$

where N^G_t is the number of home firms that borrow from global banks, and $\widetilde{z}_{G,t}$ and $\widetilde{p}_{G,t}$ are their average productivity and price. The interest rate for the syndicated loan is:

$$r_{S,t} = \left[\lambda\left(r_{G,t}\right)^{1-\epsilon} + (1-\lambda)\left(r^*_{G,t}\right)^{1-\epsilon}\right]^{\frac{1}{1-\epsilon}} \tag{20}$$

Finally, the demand for loans provided by the home and foreign global banks are:[8]

$$L_{H,t} = \lambda \left(\frac{r_{G,t}}{r_{S,t}} \right)^{-\epsilon} L_{S,t}, \tag{21}$$

$$L_{F,t} = (1-\lambda)(\left(\frac{r^*_{G,t}}{r_{S,t}} \right)^{-\epsilon} L_{S,t}. \tag{22}$$

3.3.4 The allocation of deposits

We assume that the financial intermediaries in Home (i.e. the home local bank, the home global bank, and the local branch of the foreign global bank) obtain fixed fractions of the total deposits D_{t-1} made by the representative household, which we define as S_L, S_H and S_F, respectively, so that $S_L+S_H+S_F=1$. For instance, the home local and global banks receive deposits $S_L D_{t-1}$ and $S_H D_{t-1}$ in the home retail market every period. The local branch of the foreign global bank receives deposits $S_F D_{t-1}$ in the home wholesale market every period.[9]

3.3.5 Loan constraints for banks

The total amount of loans issued by the home global bank (domestically and abroad), expressed in units of the home consumption basket, is constrained by the total amount of deposits it receives:

$$L_{H,t} + L^*_{H,t} Q_t = \frac{S_H D_{t-1} + S^*_H D^*_{t-1} Q_t}{c_G}$$

Similarly, the loan constraint of the foreign global bank, in units of the foreign consumption basket,

[8] Similarly, the credit market clearing condition for loans issued by the foreign local banks is:

$$N^*_{L,t} \widetilde{l}^*_{L,t} = L^*_{L,t}.$$

For the loans issued to foreign firms working with global financial intermediaries, the market clearing condition is:

$$L^*_{S,t} = \left[(\lambda^*)^{\frac{1}{\epsilon}} \left(L^*_{F,t} \right)^{\frac{\epsilon-1}{\epsilon}} + (1-\lambda^*)^{\frac{1}{\epsilon}} \left(L^*_{H,t} \right)^{\frac{\epsilon-1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon-1}} = N^*_{G,t} \widetilde{l}^*_{G,t}.$$

The demand functions for each type of loans included in the aggregate are $L^*_{F,t} = \lambda^* \left(\frac{r^*_{G,t}}{r^*_{S,t}} \right)^{-\epsilon} N^*_{G,t} \widetilde{l}^*_{G,t}$ for the foreign bank loans and $L^*_{H,t} = (1-\lambda^*)(\left(\frac{r_{G,t}}{r^*_{S,t}} \right)^{-\epsilon} N^*_{G,t} \widetilde{l}^*_{G,t}$ for the home bank loans, expressed in units of the foreign consumption basket.

[9] In Foreign, the local bank, the global bank, and the local branch of the home bank obtain fixed fractions of the total foreign deposits D^*_{t-1} made by the representative household in Foreign each period, defined as S^*_L, S^*_F and S^*_H, respectively, so that $S^*_L + S^*_F + S^*_H = 1$.

is:

$$L_{F,t}^{*}+L_{F,t}/Q_{t}=\frac{S_{F}^{*}D_{t-1}^{*}+S_{F}D_{t-1}/Q_{t}}{c_{G}^{*}}$$

3.3.6 Net due to position of bank branches

Global banks receive fixed shares of the local deposits, but place variable shares of their loans across countries, according to the relative demand for loans. For example, the foreign branch in Home can issue more local loans than it receives deposits if it borrows from abroad. We define the net due position expressed in units of the foreign consumption basket as the difference between the total loans issued in Home and the amount of such loans covered by local deposits:

$$NDTP_{t}^{*}=\frac{1}{Q_{t}}\left[L_{F,t}-\frac{S_{F}D_{t-1}}{c_{G}^{*}}\right].$$

Similarly, the net due position of the home branch in Foreign is:

$$NDTP_{t}=Q_{t}\left[L_{H,t}^{*}-\frac{S_{H}^{*}D_{t-1}^{*}}{c_{G}}\right]$$

3.3.7 Balance of Payments

The balance of payments condition implies that the trade balance equals the negative of the financial account balance:

$$p_{h,t}Y_{h,t}^{*}-p_{f,t}Q_{t}Y_{f,t}+r_{t}S_{F}D_{t-1}-r_{t}^{*}S_{H}^{*}D_{t-1}^{*}Q_{t}=S_{F}\left(D_{t}-D_{t-1}\right)-S_{H}^{*}\left(D_{t}^{*}-D_{t-1}^{*}\right).$$

4 Results

4.1 Calibration

The calibration for Home is summarized in Table 5; the parameters for Foreign are identical to those for Home. For Home, we use a standard quarterly calibration by setting the subjective rate of time discount $\beta=0.99$ to match an average annualized interest rate of 4 percent. The coefficient of relative risk aversion is $\gamma=2$. The elasticity of substitution between country specific goods in the consumption bundle is $\epsilon_y = 1.5$, and the share of each good is 0.5.

Following Ghironi and Melitz (2005), we set the intra-temporal elasticity of substitution $\theta = 3.8$, the sunk entry cost for firms $f_E = 1$, and the Pareto distribution parameter $k = 3.4$; the probability of firm exit $\delta = 0.025$ matches the annual 10 percent job destruction in the United States.

We set the share of the wage bill to be financed in advance at $\phi = 0.5$, following the quantitative literature on working capital constraints, such as Mendoza and Yue (2011). We also calibrate the firms' fixed cost for international loans at $f_G = 0.0002$. In line with our assumption that global banks are more efficient financial intermediaries than local banks, we set a lower cost parameter $C_G = 1.01$ for global banks against $C_L = 1.05$ for the local banks. The share of home deposits received by the local bank is $S_L = 0.4$, the share received by the home global bank is $S_H = 0.3$, and the share received by the branch of the foreign global bank is $S_F = 0.3$. The banks' monitoring cost for non-performing loans is set at $\mu = 0.01$. The elasticity of substitution between home and foreign loans is set to $\epsilon = 1.5$. The share of the home global bank in the syndicated loan is $\lambda = 0.5$.

With these parameter values, the model matches the proportion of large firms in the United States, which we assume are the firms with access to global syndicated loans, relative to the number of small and medium-sized firms with access to local bank loans (less than 1 percent): In 2003, there were about 17,000 large firms in the United States (with more than 500 employees), compared to the 3.4 million small and medium-sized firms (with less than 500 employees) that had access to bank loans (i.e. 60.4 percent of the 5.7 million small and medium-sized firms had access to bank loans; see Mach and Wolken, 2006; U.S. Small Business Administration, 2011). In addition, in the model, the share of the foreign global banks in total home lending is 5 percent; this is more conservative than the 16 percent share of loans from banks residing outside of the United States in the total amount of commercial and industrial loans in the United States in 2010 (Bank for International Settlements, 2011).

4.2 Impulse response analysis

In order to illustrate the transmission of shocks across countries, Figure 7 shows the impulse responses of key model variables to a transitory one-percent increase in aggregate productivity in Home. We assume that aggregate productivity is described by the autoregressive process $\log Z_{t+1} = \rho \log Z_t + u_t$, with persistence $\rho = 0.9$. For each variable, the horizontal axis shows quarters after the initial shock, and the vertical axis shows the percent deviations from the original steady state in each quarter. The only exception is the net due to position (NDTP) of the foreign branch in Home, for which we plot the level differences from steady state (with is zero).

Following the positive technology shock in Home, the marginal product of labor increases, which leads to an increase in output and consumption. The higher aggregate productivity prompts an immediate increase in firm entry (a flow variable), causing the total number of firms to increase gradually over time (a stock variable).

The positive shock to aggregate productivity also induces an immediate increase in deposits, which causes interest rates to fall on impact. However, over time, firm entry leads to a gradual increase in the demand for labor and bank loans, as firms need to pay a fraction of the wage bill in advance before producing. In turn, the increase in demand for bank loans causes interest rates to rise gradually for loans provided by either the local bank or the global banks.

Importantly, note that, a few quarters after the shock, the interest rate for loans provided by the local bank increases by more than the interest rate on syndicated loans provided by the global banks. This result is due to the local bank being constrained by local deposits, and the global banks receiving additional funding in the form of deposits raised in the foreign economy. The use of foreign deposits towards making loans in Home is reflected by the increase in the net due to position of the foreign branch in Home, as the branch borrows more from its foreign parent in order to satisfy the higher demand for loans in Home. Thus, a few quarters after the shock, the net due to position of the foreign branch in Home displays a positive response to the productivity increase in Home, like in the data.

Since the interest rate charged by the local bank increases by more than the interest rate charged for syndicated loans by the global banks, the productivity cutoff for firms' participation in the international loan market decreases gradually over time, allowing for a larger share of the home firms to borrow from the global banks. Thus, a few quarters after the shock, the share of firms borrowing from the global banks responds positively to the productivity increase in Home, which is consistent with the procyclical pattern of small U.S. firms borrowing from foreign banks seen in the data.

5 Conclusions and Further Extensions

This paper studies the dynamics of cross-border intrabank lending in the presence of country-specific productivity shocks, with particular focus on the extensive margin of cross-border bank lending. In response to a positive productivity shock in the home economy, the firms' increased ability to access foreign loans amplifies the economic boom. The amplification effect is enhanced as more of the small firms find it optimal to tap international loans. In contrast, following an adverse local productivity shock, the decline in international bank lending – as foreign banks withdraw funds from the less productive economy – and the smaller fraction of home firms that find it optimal to borrow globally exacerbate the domestic contraction.

We aim to expand this framework in order to study the economic effects of proposed Basel III liquidity standards – that would dampen the fluctuations in cross-border intrabank lending by limiting banks' ability to use short-term funding for cross-country loans – on output volatility and welfare in the economies involved.

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A Firm Averages

A.1 Average productivity levels

Firms borrowing from local banks The average productivity of the firms that borrow from the local banks is:

$$
\begin{aligned}
\widetilde{z}_{L,t} &= \left[\frac{1}{G(z_{G,t})}\int_{z_{\min}}^{z_{G,t}} z^{\theta-1} g(z)dz\right]^{\frac{1}{\theta-1}} = \left[\frac{z_{V,t}^{k}}{z_{G,t}^{k}-z_{\min}^{k}}\int_{z_{\min}}^{z_{V,t}} z^{\theta-1}\frac{kz_{\min}^{k}}{z^{k+1}}dz\right]^{\frac{1}{\theta-1}} = \\
&= \left[\frac{z_{G,t}^{k}}{z_{G,t}^{k}-z_{\min}^{k}}\frac{kz_{\min}^{k}}{(\theta-k-1)}\left(z_{G,t}^{\theta-1-k}-z_{\min}^{\theta-1-k}\right)\right]^{\frac{1}{\theta-1}} = \\
&= \nu\left[\frac{\left(z_{\min}z_{V,t}\right)^{k}}{z_{\min}^{k}-z_{G,t}^{k}}\left(\frac{1}{z_{G,t}^{k-(\theta-1)}}-\frac{1}{z_{\min}^{k-(\theta-1)}}\right)\right]^{\frac{1}{\theta-1}} = \\
&= \nu z_{\min}z_{G,t}\left[\frac{z_{G,t}^{k-(\theta-1)}-z_{\min}^{k-(\theta-1)}}{z_{G,t}^{k}-z_{\min}^{k}}\right]^{\frac{1}{\theta-1}}.
\end{aligned}
\tag{23}
$$

Firms borrowing from global banks Under the assumption that the firm-specific productivity factors are Pareto-distributed, the average productivity of the firms that borrow from global banks is obtained by integrating over the upper range of the support interval $[z_{\min}, \infty)$, above the productivity cutoff $z_{G,t}$:

$$
\begin{aligned}
\widetilde{z}_{G,t} &= \left[\frac{1}{1-G(z_{G,t})}\int_{z_{G,t}}^{\infty} z^{\theta-1} g(z)dz\right]^{\frac{1}{\theta-1}} = \left[\left(\frac{z_{G,t}}{z_{\min}}\right)^{k}\int_{z_{G,t}}^{\infty} z^{\theta-1}\frac{kz_{\min}^{k}}{z^{k+1}}dz\right]^{\frac{1}{\theta-1}} = \\
&= \left[\left(\frac{z_{G,t}}{z_{\min}}\right)^{k}\frac{kz_{\min}^{k}}{k-(\theta-1)}z_{G,t}^{\theta-1-k}\right]^{\frac{1}{\theta-1}} = \\
&= \nu z_{G,t},
\end{aligned}
\tag{24}
$$

where $\nu \equiv \left[\frac{k}{k-(\theta-1)}\right]^{\frac{1}{\theta-1}}$.

A.2 Average profits

The average profit of the local borrowers is:

$$
\begin{aligned}
\widetilde{\pi}_{L,t} = \pi_{L,t}(\widetilde{z}_{L,t}) &= \frac{1}{\theta}\left[\frac{\theta}{\theta-1}\frac{w_t}{Z_t\widetilde{z}_{L,t}}\left(1+\phi r_{L,t}\right)\right]^{1-\theta} C_t = \\
&= \frac{1}{\theta}\left[\frac{\theta}{\theta-1}\frac{w_t}{Z_t}\left(1+\phi r_{L,t}\right)\right]^{1-\theta} C_t\widetilde{z}_{L,t}^{\theta-1} = \\
&= \frac{1}{\theta}\left[\frac{\theta}{\theta-1}\frac{w_t}{Z_t}\left(1+\phi r_{L,t}\right)\right]^{1-\theta} \underbrace{C_t(\nu z_{\min} z_{G,t})^{\theta-1}\left[\frac{z_{G,t}^{k-(\theta-1)} - z_{\min}^{k-(\theta-1)}}{z_{G,t}^{k} - z_{\min}^{k}}\right]}_{\widetilde{z}_{L,t}^{\theta-1}} = \\
&= \underbrace{\frac{1}{\theta}\left[\frac{\theta}{\theta-1}\frac{w_t}{Z_t z_{G,t}}\left(1+\phi r_{L,t}\right)\right]^{1-\theta} C_t}_{\pi_{L,t}(z_{G,t})} \left(\nu z_{\min}\right)^{\theta-1}\left[\frac{z_{G,t}^{k-(\theta-1)} - z_{\min}^{k-(\theta-1)}}{z_{G,t}^{k} - z_{\min}^{k}}\right] = \\
&= \pi_{L,t}(z_{G,t})\left(\nu z_{\min}\right)^{\theta-1}\left[\frac{z_{G,t}^{k-(\theta-1)} - z_{\min}^{k-(\theta-1)}}{z_{G,t}^{k} - z_{\min}^{k}}\right]. \qquad (25)
\end{aligned}
$$

The average profit of the firms that borrow from global banks is:

$$
\begin{aligned}
\widetilde{\pi}_{G,t} = \pi_{G,t}(\widetilde{z}_{G,t}) &= \frac{1}{\theta}\left[\frac{\theta}{\theta-1}\frac{w_t}{Z_t\widetilde{z}_{G,t}}\left(1+\phi r_{G,t}\right)\right]^{1-\theta} C_t - f_G\frac{w_t}{Z_t} = \\
&= \frac{1}{\theta}\left[\frac{\theta}{\theta-1}\frac{w_t}{Z_t}\left(1+\phi r_{G,t}\right)\right]^{1-\theta} C_t\widetilde{z}_{G,t}^{\theta-1} - f_G\frac{w_t}{Z_t} = \\
&= \underbrace{\left\{\frac{1}{\theta}\left[\frac{\theta}{\theta-1}\frac{w_t}{Z_t z_{G,t}}\left(1+\phi r_{G,t}\right)\right]^{1-\theta} C_t - f_G\frac{w_t}{Z_t}\right\}}_{\pi_{G,t}(z_{G,t})}\nu^{\theta-1} + \left(\nu^{\theta-1}-1\right) f_G\frac{w_t}{Z_t} = \\
&= \pi_{G,t}(z_{G,t})\nu^{\theta-1} + \frac{\theta-1}{k-(\theta-1)} f_G\frac{w_t}{Z_t}. \qquad (26)
\end{aligned}
$$

A.3 Indifference condition for the marginal firm

The firm with productivity equal to the cutoff $z_{G,t}$ is indifferent between borrowing from local or global banks. Using the profit indifference condition $\pi_{L,t}(z_{G,t}) = \pi_{G,t}(z_{G,t})$ and equations (25) and (26), we write the link between the average profits of the local and global borrowers. Starting with (26),

$$\begin{aligned}
\widetilde{\pi}_{G,t} &= \pi_{G,t}(z_{G,t})\nu^{\theta-1} + \frac{\theta-1}{k-(\theta-1)} f_G \frac{w_t}{Z_t} = \\
&= \pi_{L,t}(z_{G,t})\nu^{\theta-1} + \frac{\theta-1}{k-(\theta-1)} f_G \frac{w_t}{Z_t} = \\
&= \underbrace{\left(\frac{1}{\nu z_{\min}}\right)^{\theta-1} \left[\frac{z_{G,t}^{k-(\theta-1)} - z_{\min}^{k-(\theta-1)}}{z_{G,t}^{k} - z_{\min}^{k}}\right]^{-1} \widetilde{\pi}_{L,t}}_{=\pi_{L,t}(z_{G,t}),\text{ from eq. (25)}} \nu^{\theta-1} + \frac{\theta-1}{k-(\theta-1)} f_G \frac{w_t}{Z_t} = \\
&= z_{\min}^{1-\theta} \left[\frac{z_{G,t}^{k-(\theta-1)} - z_{\min}^{k-(\theta-1)}}{z_{G,t}^{k} - z_{\min}^{k}}\right]^{-1} \widetilde{\pi}_{L,t} + \frac{\theta-1}{k-(\theta-1)} f_G \frac{w_t}{Z_t} = \\
&= \underbrace{\frac{k}{k-(\theta-1)} \left(\frac{z_{G,t}}{\widetilde{z}_{L,t}}\right)^{\theta-1}}_{\text{from eq. (23)}} \widetilde{\pi}_{L,t} + \frac{\theta-1}{k-(\theta-1)} f_G \frac{w_t}{Z_t}. \qquad (27)
\end{aligned}$$

Table 1. Aggregate balance sheet of U.S. branches and agencies of European banks in the United States

Assets	***Q4 2006***	***Q4 2008***	***Q2 2011***	**Liabilities**	***Q4 2006***	***Q4 2008***	***Q2 2011***
Cash	4%	11%	39%	Deposits	53%	52%	52%
Fed Funds Sold	1%	0%	0%	Fed Funds Purchased	6%	1%	2%
Resale Agreements	15%	3%	5%	Repurchase Agreements	8%	3%	5%
U.S. Gov. Securities	2%	2%	4%	Trading Liabilities	6%	9%	5%
Other Securities	21%	25%	13%	Other Liabilities	18%	30%	17%
Loans	24%	27%	22%				
Other Assets	2%	2%	2%				
Total Claims on Non-Related Parties	69%	70%	85%	***Total Liabilities to Non-Related Parties***	91%	95%	81%
Net Due from Related Depository Institutions	31%	30%	15%	Net Due to Related Depository Institutions	9%	5%	19%
Total Assets	1,193,532	1,402,416	1,328,310	***Total Liabilities***	1,193,532	1,402,416	1,328,310

Source: Federal Financial Institutions Examination Council 002 report.

Table 2. Baseline results: determinants of intrabank lending

Dependent variable:	***Net due to / Assets***	***Gross due to /Assets***	***Gross due from / Assets***
	(1)	**(2)**	**(3)**
U.S. GDP Growth	1.167**	-0.106	-1.273***
	[0.536]	[0.326]	[0.342]
Foreign GDP Growth	0.029	0.024	-0.005
	[0.124]	[0.073]	[0.083]
Real Interest Rate Differential	-1.377	-1.218*	0.159
	[1.019]	[0.662]	[0.557]
Log of Claims on Nonrelated Parties	3.852	-2.106	-5.958***
	[2.443]	[1.416]	[1.281]
Constant	-41.740**	50.994***	92.734***
	[20.651]	[12.018]	[10.844]
Branch Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Quarterly Dummies	Yes	Yes	Yes
Observations	4,514	4,514	4,514
Number of Branches	136	136	136

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

Table 3. Determinants of intrabank lending for small vs. large branches

Dependent variable:	*Net due to / Assets*	*Gross due to /Assets*	*Gross due from / Assets*	*Net due to / Assets*	*Gross due to /Assets*	*Gross due from / Assets*
	(1)	(2)	(3)	(4)	(5)	(6)
U.S. GDP Growth	0.11	0.091	-0.019	1.155*	0.003	-1.152***
	[0.638]	[0.399]	[0.507]	[0.670]	[0.387]	[0.387]
Foreign GDP Growth	0.134	0.021	-0.112	0.071	0.068	-0.002
	[0.094]	[0.071]	[0.111]	[0.145]	[0.080]	[0.090]
Real Interest Rate Differential	-0.439	-0.685	-0.246	-1.903	-1.726**	0.178
	[1.239]	[0.855]	[1.101]	[1.282]	[0.762]	[0.617]
Log of Claims on Nonrelated Parties	19.127***	4.406	-14.720***	2.103	-2.950**	-5.054***
	[5.053]	[3.046]	[2.582]	[2.320]	[1.456]	[1.145]
Constant	-221.454***	-14.609	206.845***	-25.856	55.221***	81.078***
	[56.298]	[33.060]	[28.152]	[20.844]	[13.469]	[10.333]
Branch Size	Large	Large	Large	Small	Small	Small
Branch Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,037	1,037	1,037	3,477	3,477	3,477
Number of Branches	43	43	43	128	128	128

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

Table 4. Intrabank funding during during the August 2007 ABCP market shock

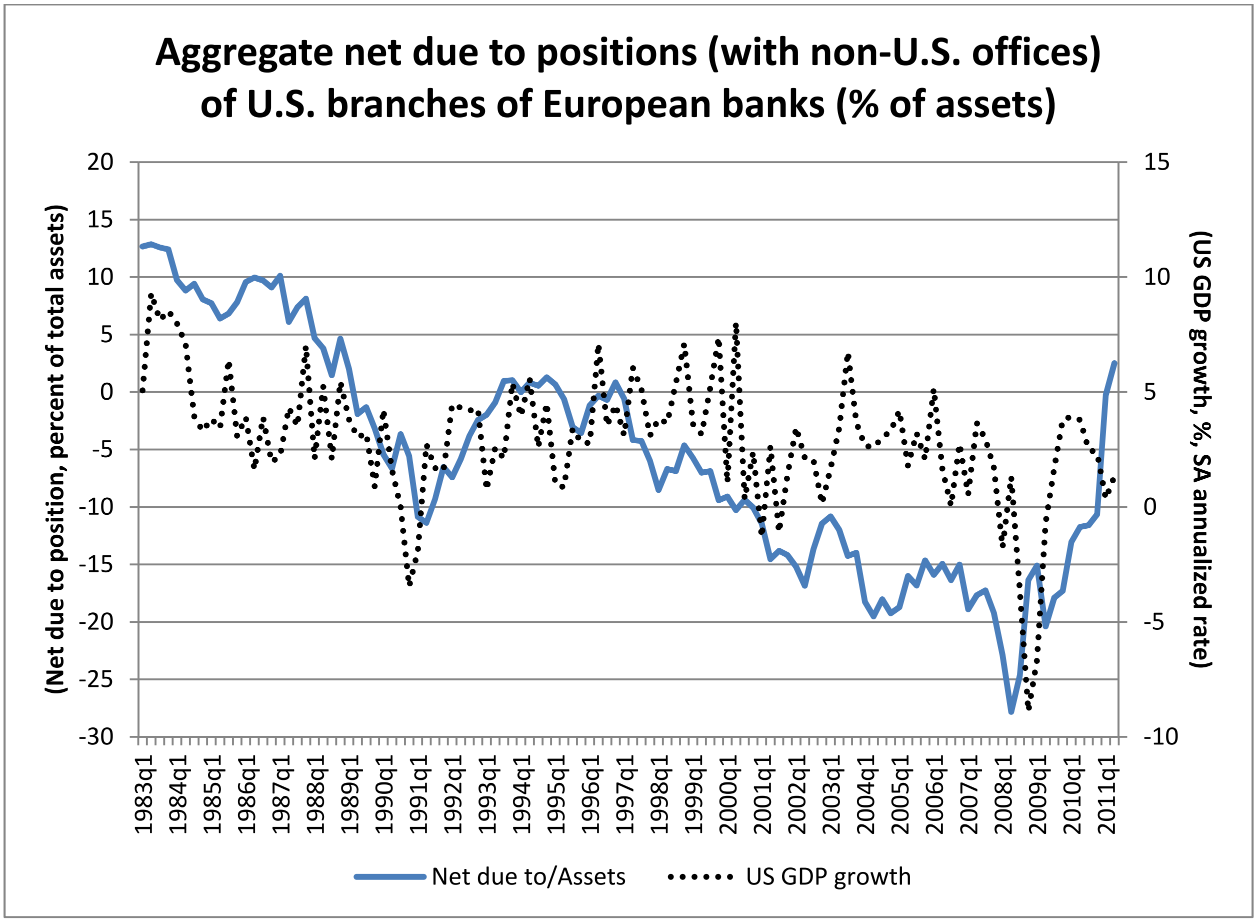
Dependent variable:	***Net due to / Assets***	***Gross due to /Assets***	***Gross due from / Assets***	***Net due to / Assets***	***Gross due to /Assets***	***Gross due from / Assets***
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Dummy Crisis	3.086	4.072*	0.986	3.692**	4.366***	0.674
	[2.574]	[2.367]	[1.313]	[1.489]	[1.474]	[0.663]
Dummy Europe	-23.298***	-14.067***	9.231***			
	[2.760]	[2.423]	[1.402]			
Dummy Crisis X Dummy Europe	-7.454*	-4.169	3.285*	-8.478***	-4.959**	3.519**
	[3.902]	[3.456]	[1.955]	[2.694]	[2.438]	[1.581]
Constant	26.045***	39.855***	13.810***	17.265***	34.621***	17.355***
	[1.760]	[1.671]	[0.913]	[0.616]	[0.577]	[0.332]
Branch Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	1,204	1,204	1,204	1,204	1,204	1,204
R-squared	0.13	0.06	0.09	0.03	0.03	0.04

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

Table 5. Calibration

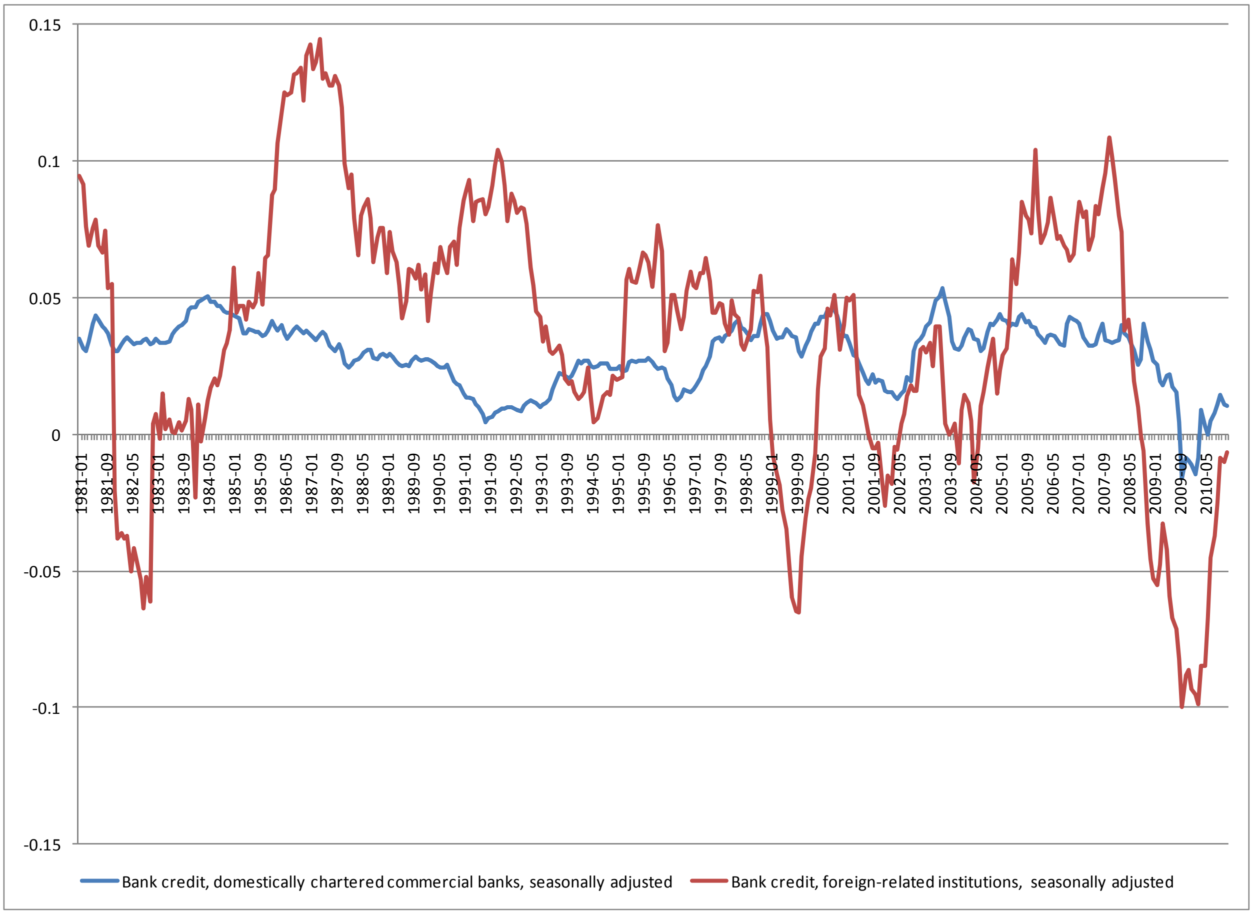
Parameter value	Description
β= 0.99	Discount factor
γ= 2	CRRA coefficient
ε_y = 1.5	Elasticity of substitution, home and foreign goods
λ_y = 0.5	Share of the home good in consumption composite
θ= 3.8	Intra-temporal elasticity of substitution
f_E = 1	Sunk entry cost
k = 3.4	Pareto distribution parameter
δ= 0.025	Probability of firm exit
ϕ = 0.5	Share of wage bill to be financed with bank loans
f_G = 0.0002	Firms' fixed cost for international loans
C_L = 1.05, C_G = 1.01	Cost parameters, local and global bank
S_L = 0.4, S_H = 0.3, S_F = 0.3	Shares of home local, home global, and foreign global bank in home deposits
μ = 0.01	Banks' monitoring cost for non-performing loans
ε = 1.4	Elasticity of substitution, home and foreign loans
λ = 0.5	Share of the home global bank in syndicated loan

Figure 1. Aggregate net due to positions of U.S. branches of European banks
(% of assets)



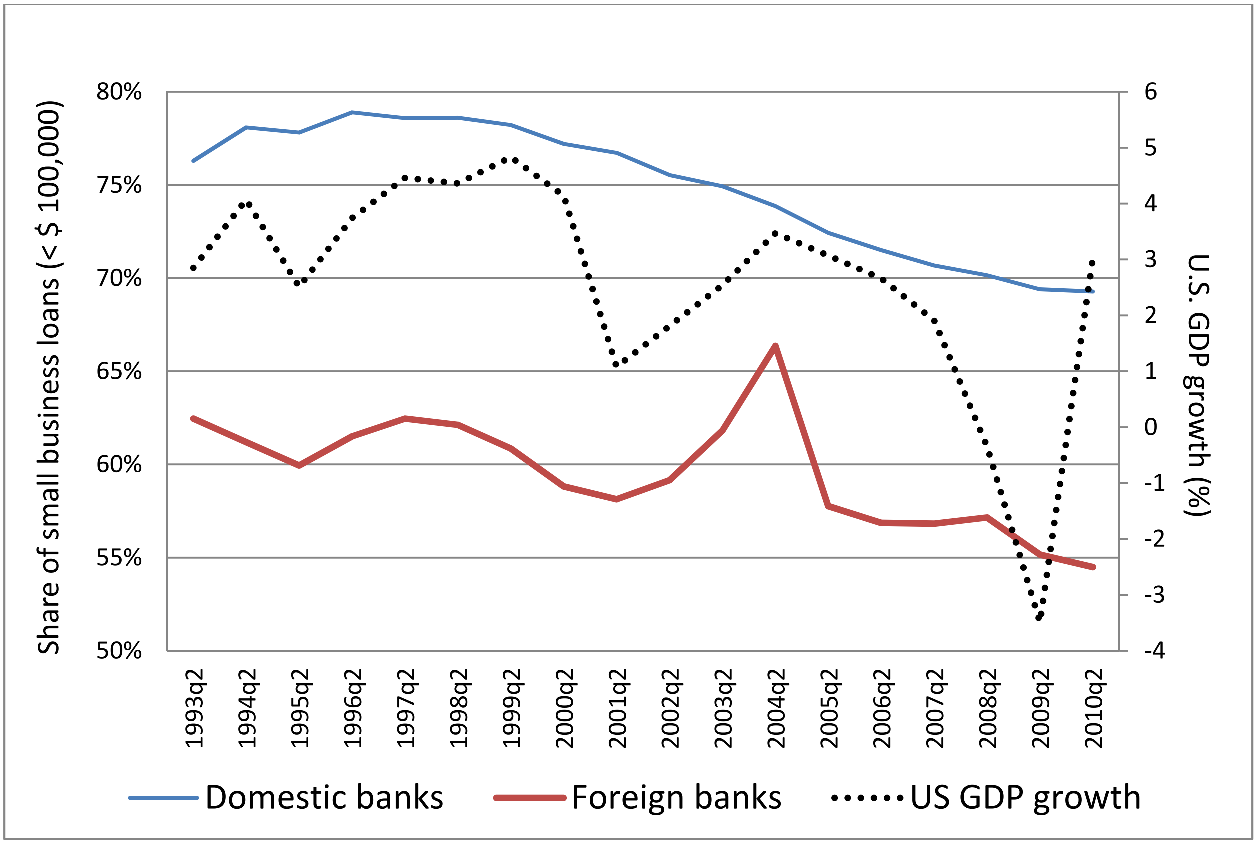
Source: Federal Reserve Board (net due to positions), Haver Analytics (U.S. GDP growth annualized rate using GDP in chained 2005 dollars; EU 17 GDP growth annualized using GDP in chained 2000 euros)

Figure 2. Bank credit growth rates for U.S. domestically chartered banks and foreign related institutions in the United States



Source: Federal Reserve Board (H.8 statistical release).

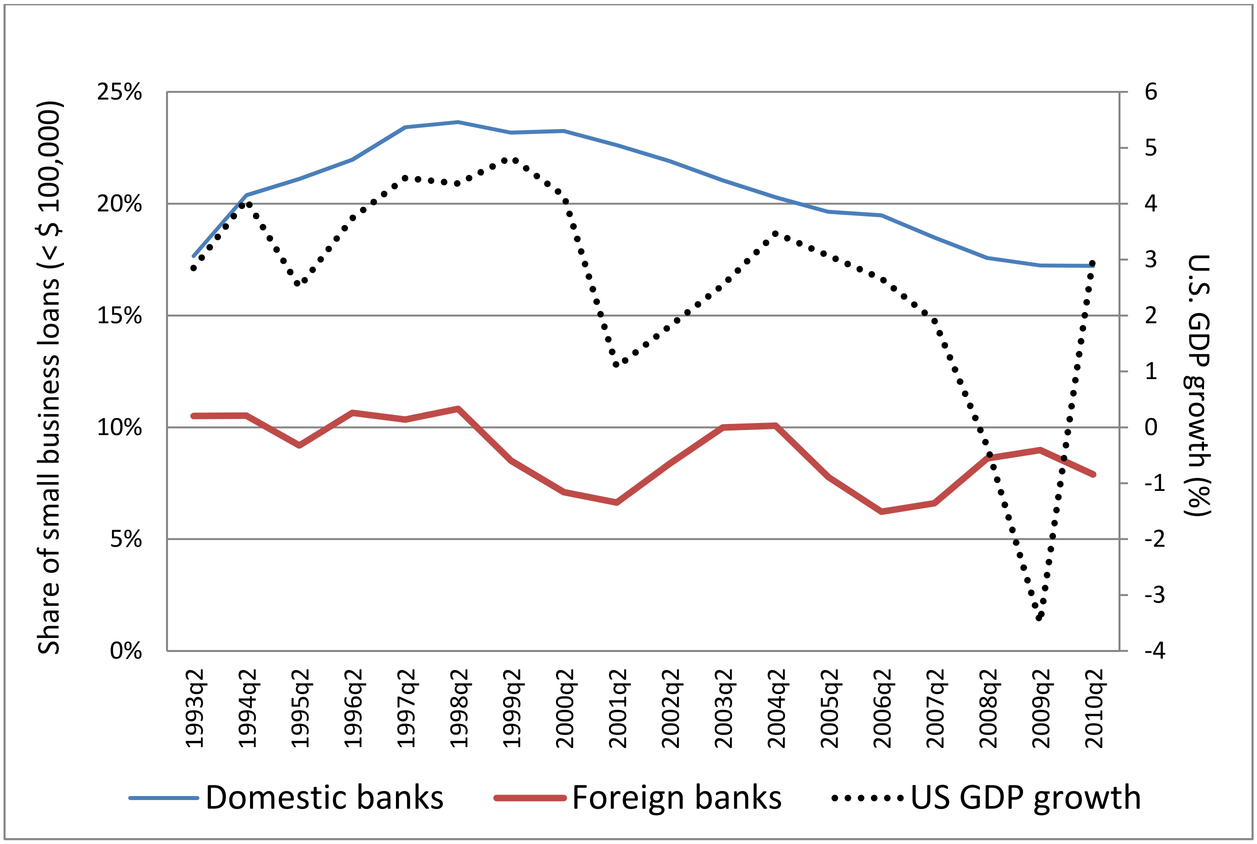
Figure 3. Mean share of small business loans in the <u>total number</u> of outstanding loans
(by domestic vs. foreign banks in the U.S.)



Sources: Federal Reserve Board (for commercial and industrial loans to U.S. entities issued by FDIC-insured commercial banks in the U.S. with at least US$ 300 million in assets); Haver Analytics (for U.S. GDP in billions of chained 2005 dollars, annual).

Note: The number of small business loans (i.e. less than US$ 100,000) is expressed as a fraction of the total number of outstanding loans for each bank, measured at the end of the second quarter of each year; we average the resulting shares over domestic vs. foreign banks.

Figure 4. Mean share of small business loans in the <u>total value</u> of outstanding loans
(by domestic vs. foreign banks in the U.S.)



Sources: Federal Reserve Board (for commercial and industrial loans to U.S. entities issued by FDIC-insured commercial banks in the U.S. with at least US$ 300 million in assets); Haver Analytics (for U.S. GDP in billions of chained 2005 dollars, annual).

Note: The number of small business loans (i.e. less than US$ 100,000) is expressed as a fraction of the total number of outstanding loans for each bank, measured at the end of the second quarter of each year; we average the resulting shares over domestic vs. foreign banks.

Figure 5. Firm profits with local vs. global borrowing as functions of idiosyncratic productivity

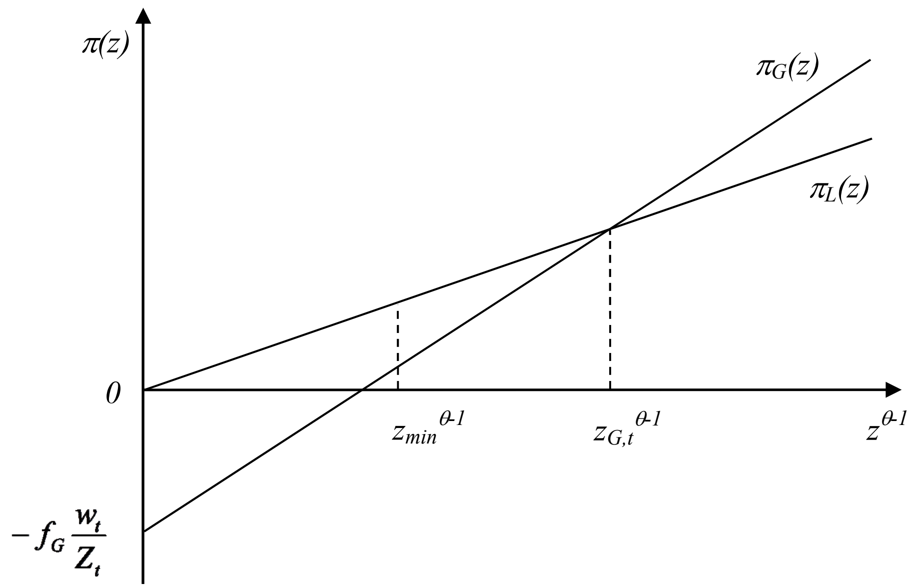


Figure 6. Average labor productivity for firms working with local banks ($\tilde{z}_{L,t}$) and global banks ($\tilde{z}_{G,t}$)

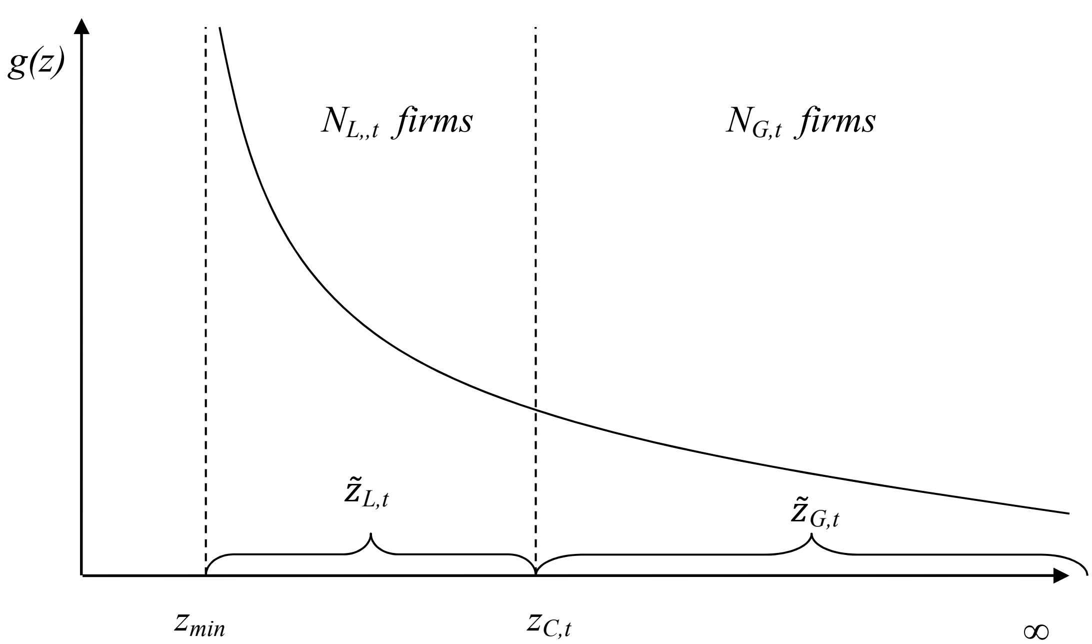


Figure 7. Impulse responses to a one-percent shock to aggregate productivity in Home, with persistence $\rho = 0.90$.