Global Banks' Dynamics and the International Transmission of Shocks

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Abstract

15% of the loans in the US are held by foreign banking institutions, headquartered in more than 50 countries. Using bank-level data, we present novel stylized facts describing characteristics of foreign institutions and compare them to the incumbent set of banks, distinguishing foreign banks by their mode of entry. We incorporate these facts into a structural model of entry in the banking sector where profit maximizing foreign banks decide whether and how to enter a foreign market. The model sheds light on the relationship between market access, capital flows, regulation, and entry, and has implications for the risk exposure that different organizational forms entail.

Keywords: banks, entry, multinational firms

JEL Classification: F12, F23, F36, G21

1 Introduction

"Spanish-based Santander (...) acquired Sovereign Bank in 2009 as the springboard for its US ambitions, [establishing] 700 branches and ATMs across nine northeastern states."

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"Santander is the fourth-largest bank by deposits in Massachusetts and has 1.7 million US customers. Emilio Botin, chairman of the parent company, said last week during a visit to the United States that he hopes to see profits for the American business double in three years to $2 billion." (The Boston Globe, October 26th 2013)

15% of the outstanding loans in the U.S. are held by various types of foreign banking institutions, headquartered in more than 50 countries. Like Banco Santander SA in the quote above, these multinational banks have the ability of reallocating profits and losses in different markets, and they are often very large players in the countries in which they operate. As noted by Goldberg (2009), the sheer size of foreign banking institutions and their involvement with the real economy makes them important vehicles for the global transmission of shocks. Various empirical studies have explored the role of multinational banks in the transmission of shocks across countries.[1] To our knowledge however, previous work has overlooked the importance of banks' mode of entry for shock transmission. Moreover, most of the existent work has been conducted using exclusively reduced form analysis.[2]

This paper contributes to the literature in two ways. First, methodologically, we develop a micro-founded structural model of foreign entry in the banking sector. The model is designed to describe the institutional details of the banking industry and to be consistent with a number of stylized facts from U.S. bank-level data. Second, the model explicitly distinguishes foreign banking institutions by their mode of entry, which is endogenous and responds to differences in cost structure and management efficiency.

Despite the presence of a wide variety of organizational forms in the data, we focus our analysis on the two most prominent forms of foreign banking institutions in the US: branches and subsidiaries. The existing banking regulation treats branches and subsidiaries in different ways, so that the kind of activities that these firms are allowed to undertake differ: for example, while subsidiaries are separately capitalized, branches do not raise independent equity and can freely transfer funds to and from their parent.[3] We model carefully the institutional differences between branches and subsidiaries, so that our framework is an accurate description of the global banking sector. Moreover, branches and subsidiaries display large differences in the extent of their common activities: subsidiaries appear to be larger than branches (in terms of deposits, loans, and overall

[1] See most notably Cetorelli and Goldberg (2011, 2012a,b).

[2] Notable exceptions are Bremus et al. (2013), de Blas and Russ (2013), Niepmann (2012), and Niepmann (2013).

[3] Section 2 illustrates the institutional features of the U.S. banking sector. Appendix A summarizes the U.S. banking regulation and the changes it underwent in the past decades.

assets), and the two types of institutions differ dramatically in their portfolio composition. The stylized facts we present help us discipline the parameterization of our model. The fact that the model is consistent with these stylized facts raises our confidence in effectively using it as a tool to study the response of the banking sector to various kinds of shocks.

Since modeling banks' behavior entails the study of several interconnected markets (loans, deposits, trading assets, equity) we first present an intratemporal version of the model whose scope is to present the trade-offs that banks face in the simplest possible way. Our toy model is a monopolistically competitive extension of the Monti-Klein model (see Klein, 1971, and Monti, 1972), augmented to include risky loans, deposits and investment.

We start with a static model where foreign banks decide to enter into a country and the form of entry (subsidiary or branch) without taking into account any dynamics. Banks are heterogeneous in their efficiency managing assets and liabilities, and there are sunk costs of entry into the new country. We find that there exists a threshold in efficiency which implies that more productive banks will open a subsidiary. We then extend the model to an infinite horizon with aggregate shocks using the investment under uncertainty framework initially proposed in Dixit (1989). In particular, we use the mechanism developed in Fillat and Garetto (2013), which applies investment under uncertainty to foreign direct investment. The dynamic model is better equipped to describe realistically the decisions of banks of how to react to shocks hitting loans supply or deposit demand at varying time horizons. The machinery also allows us to do conterfactual analysis of regulatory policies that target the expansion of foreign banks. We parameterize the model to match moments of the data and use it to simulate banks' optimal responses to various kinds of shocks and policies.

[HERE LITERATURE REVIEW TBA]

The remainder of the paper is organized as follows. Section 2 illustrates the data and documents a series of stylized facts about foreign banking institutions in the U.S. market. Section 3 develops a simple model that illustrates the decisions that multinational banks face. The model is extended in Section 4 to a fully dynamic framework featuring frictions to firms' reallocation possibilities across different activities. The full model is calibrated and used to perform counterfactual exercises in Section 5. Section 6 concludes.

2 Foreign Banks in the US: Some Facts

The presence of foreign institutions in the U.S. banking market is substantial. Figure 1 shows data from foreign bank organizations operating in the U.S. About 20% of the aggregate assets held by banks operating in the U.S. belongs to banking offices that are ultimately owned by a foreign parent. Deposits and loans display a similar pattern over the last two decades, ranging from 15% of total deposits to 30% of the total commercial and industrial loans in hands of foreign owned banking offices.

A foreign bank may enter in the U.S. market under different organizational forms. The choice depends, in part, on the business line that the foreign bank wants to export. Foreign banks may open a *subsidiary bank*, which is subject to U.S. regulation and capital requirements. A subsidiary bank may accept both wholesale deposits and retail insured deposits and performs the same type of operations than a domestically owned bank does. Possible capital flows between the subsidiary and the parent must happen at arm's length. This means that if a parent wants to transfer capital to or from a subsidiary in the U.S., it must do so in the interbank market at market prices. Another established form of entry is via *branches and agencies*, which are subject to U.S. regulation, but not to capital requirements, as their balance sheet is consolidated with the one of the parent. A branch or agency may give loans, but accepts only non-insured deposits. Branches and agencies display large intrafirm capital flows with their foreign parents.

Subsidiaries and branches are the two most relevant forms in which foreign banks enter the U.S. banking system. Jointly, they represent more than 99% of the assets held by foreign-owned banking offices. In terms of business line, these two forms of entry also entail activities that are close to those of a traditional bank: in essence, accept deposits from savers, give loans to borrowers, and manage the maturity mismatch between savers and borrowers. In addition to branches and subsidiaries, the data display two more types of organizations. *Edge and Agreement Corporations* cannot engage in business in the U.S. with U.S.-based entities, including making any domestic loan or accept domestic deposits. Lastly, *Representative Offices and Non-depository Trusts* do not accept deposits or give loans, and their asset holdings are negligible, compared with the other types of foreign entities. Given their small weight in aggregate banking activities, we drop Edge and Agreement Corporations, Representative Offices and Non-depository trusts from our sample and focus the analysis on foreign branches and subsidiaries.

We use data from the "Quarterly Reports of Condition and Income" that every national bank,

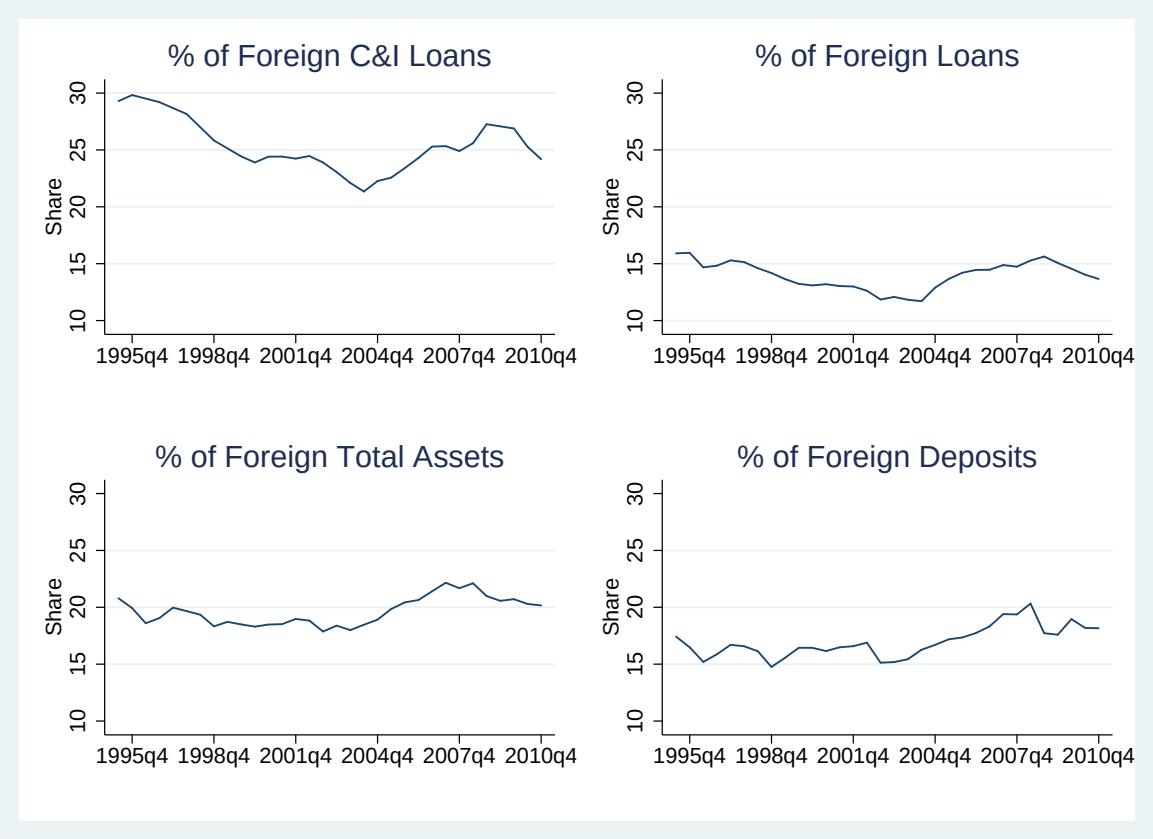

Figure 1: Percentage of assets, commercial and industrial loans, total loans, and deposits held in foreign owned banking institutions in the U.S. Data source: Share Data for U.S. Offices of Foreign Banking Organizations - Selected Assets and Liabilities of Domestic and Foreign Owned U.S. Commercial Banks (state member, non-member and national) plus U.S. Branches and Agencies of Foreign Banks. Data are available on the Federal Reserve Board of Governors website, http://www.federalreserve.gov/releases/iba/fboshr.htm. The data covers the U.S. offices of foreign banking organizations that are located in the 50 states and the District of Columbia. Offices located in Puerto Rico, American Samoa, Guam, the Virgin Islands and other U.S.-affiliated insular areas are excluded. Foreign-owned institutions are those owned by a bank located outside of the United States and its affiliated insular areas.

state member bank, insured state nonmember bank, and savings association chartered in the U.S. is required to file, regardless of the ultimate owner's headquarter location. These reports are better known as "Call Reports".[4] In addition to domestic banks, subsidiaries of foreign banks must fill out these reports as well. We also use the quarterly "Report of Assets and Liabilities of U.S. Branches and Agencies of Foreign Banks" that every branch and agency of a foreign bank is required to file.[5] This report is similar to the Call Reports but it also contains the balances due from and due to the head office (parent) and related depository institutions, wherever located, including unremitted profits, and any reserve accounts. The rest of items reported exclude any transaction with related depository institutions. The Riegle-Neal Interstate Banking and Branching Efficiency act of 1994 repealed interstate restrictions in the original Bank Holding Company act of 1956. We restrict the sample period from 1995 to 2010 to avoid capturing market dynamics stirred by the deregulation of interstate banking.

Table 1 summarizes the average assets, loans, deposits, and number of establishments corresponding to domestic banks, subsidiaries of foreign banks, and branches of foreign banks. Appendix B describes the typical business activities of each of these organizational forms and provides summary statistics on assets which motivate our focus on branches and subsidiaries. Appendix A summarizes the regulatory reforms that have been shaping the U.S. banking industry in recent years, with special focus on those regulations that had an impact on foreign banks operating in the U.S.

In Figures 2-4, we plot the time series of assets, loans, and deposits for the three type of banks that we consider: domestic depository institutions owned by a domestic company (which we refer as to domestic banks), domestic subsidiaries owned by a foreign depository institution (foreign subsidiaries), and domestic branches of a foreign depository institution (foreign branches). The average subsidiary of a foreign bank is substantially bigger than the average branch in terms of both deposits and loans. In addition, the average balance sheet of a foreign office (either branch or subsidiary) is substantially larger than the one of a domestic bank in terms of assets, loans, or deposits, and these differences have been growing over time. The selection of firms into foreign markets makes the domestic institutions much smaller on average, as their numbers include all

[4]FFIEC, which stands for "Federal Financial Institutions Examination Council", collects the Call Reports in two different reporting forms: FFIEC 031 and FFIEC 041. Banks with foreign offices must report the FFIEC 031 form and banks with only domestic offices must file the 041. A foreign office is defined as either (a) an international banking facility, (b) a branch or consolidated subsidiary in a foreign country, or (c) a majority-owned Edge or Agreement subsidiary. The information about domestic operations is identical across reports for all practical purposes.

[5]FFIEC 002.

Table 1: **Summary Statistics.** Assets, loans, and deposits of the U.S. offices of domestic and foreign banking organizations for 2010. Quantities are reported in billion dollars. Data source: U.S. Share Data for U.S. Offices of Foreign Banking Organizations - Selected Assets and Liabilities of Domestic and Foreign Owned U.S. Commercial Banks (state member, non-member and national) plus U.S. Branches and Agencies of Foreign Banks, available on the Federal Reserve Board of Governors website, http://www.federalreserve.gov/releases/iba/fboshr.htm.

	Mean	Std. Dev.	Median	N. obs.
		Assets		
Domestic	1,649.91	33,640.07	147.62	6934
Foreign Subsidiary	15,270.86	35,613.84	1,314.64	64
Foreign Branch	8,892.19	19,548.42	803.33	215
		Deposits		
Domestic	1,160.49	23,003.66	123.82	6934
Foreign Subsidiary	11,006.95	26,373.87	985.61	64
Foreign Branch	5026.401	11990.65	299.34	215
		Loans		
Domestic	940.6878	16038.81	93.389	6934
Foreign Subsidiary	8092.347	17701.04	748.5415	64
Foreign Branch	2215.568	5411.098	345.288	215

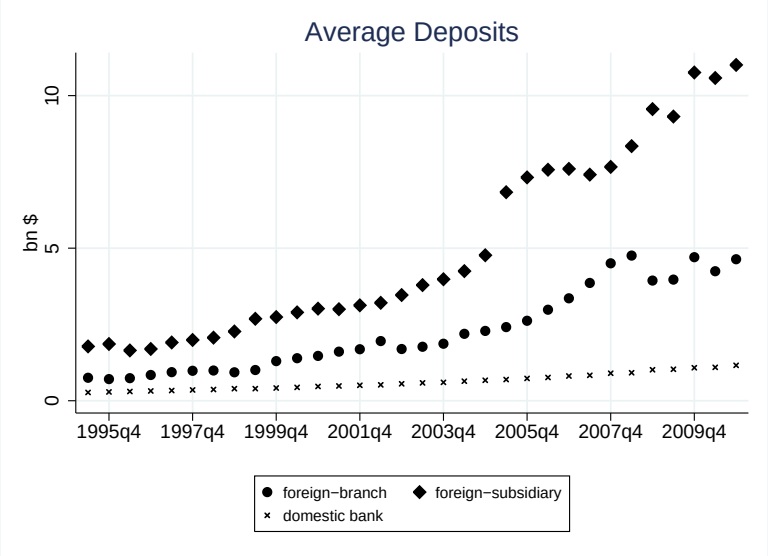

Figure 2: **Deposits**. Time series of average deposits per domestic bank, foreign subsidiary, and foreign branch. Data source: FFIEC 031, FFIEC 041, and FFIEC 002.

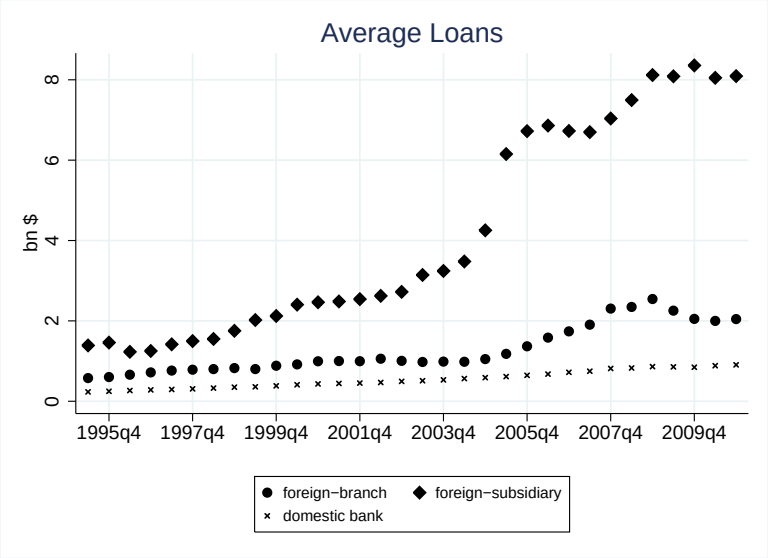

Figure 3: **Loans**. Time series of average loans per domestic bank, foreign subsidiary, and foreign branch. Data source: FFIEC 031, FFIEC 041, and FFIEC 002.

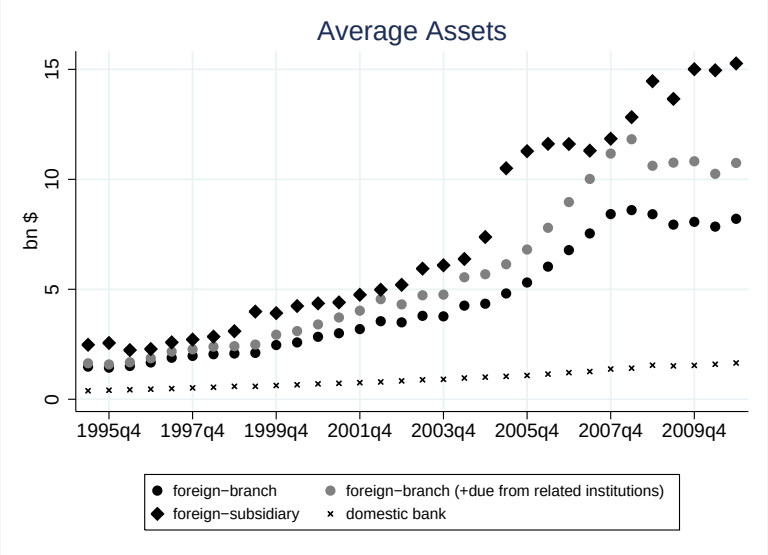

Figure 4: **Assets**. Time series of average assets per domestic bank, foreign subsidiary, and foreign branch (with and without net due from related institutions). Data source: FFIEC 031, FFIEC 041, and FFIEC 002.

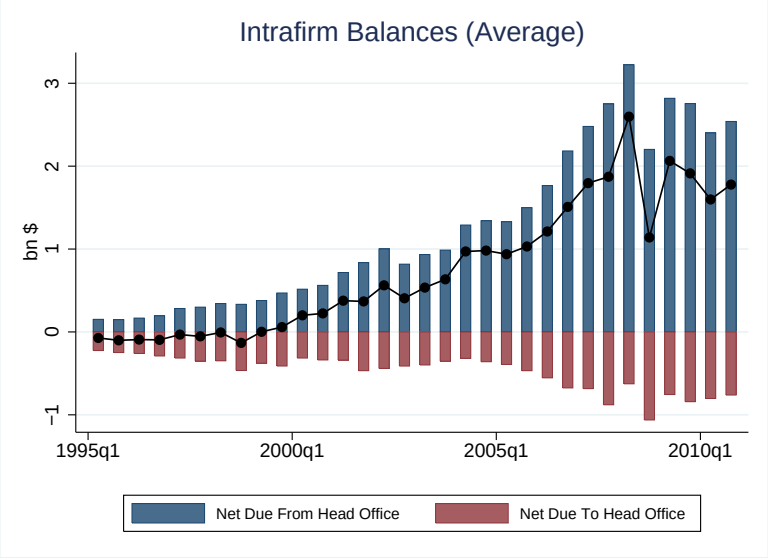

Figure 5: **Net intrafirm flows for foreign branches.** Net due from and net due to related parties. Data source: "Report of Assets and Liabilities of U.S. Branches and Agencies of Foreign Banks", or FFIEC 002. The items reported here are *Net due from related depository institutions* and *Net due to related depository institutions*, 2 and 5, respectively, from the "Schedule RAL–Assets and Liabilities". The solid line represents the net due from related parties if positive (item 2 minus 5).

depository institutions in the U.S., including small regional and community banks. The selection by size in exporting and multinational manufacturing firms is a common feature in the international trade literature.[6] The figures suggest that a similar mechanism operates in the banking sector.

One of the reasons for branches to be large on average is the net amount due from their related institutions. Part of the differences in assets between branches and subsidiaries can be explained by international transfers within the boundaries of the multinational bank. Figure 4 shows the average asset holdings for the three type of offices. We plot the average assets in branches with and without the net due from their related parties: these intrafirm flows account for about 25% of the average assets in foreign owned branches. Figure 5 shows the evolution of the aggregate net flows to and from related institutions, confirming that throughout the sample period the amounts that parent banks have been borrowing from their foreign branches are much larger than the amounts that foreign branches have been borrowing from their parent banks. This pattern is consistent with the evidence shown by Cetorelli and Goldberg, 2012a,b about foreign branches lending to US parents.

[6]See, among others, Bernard et al. (2009).

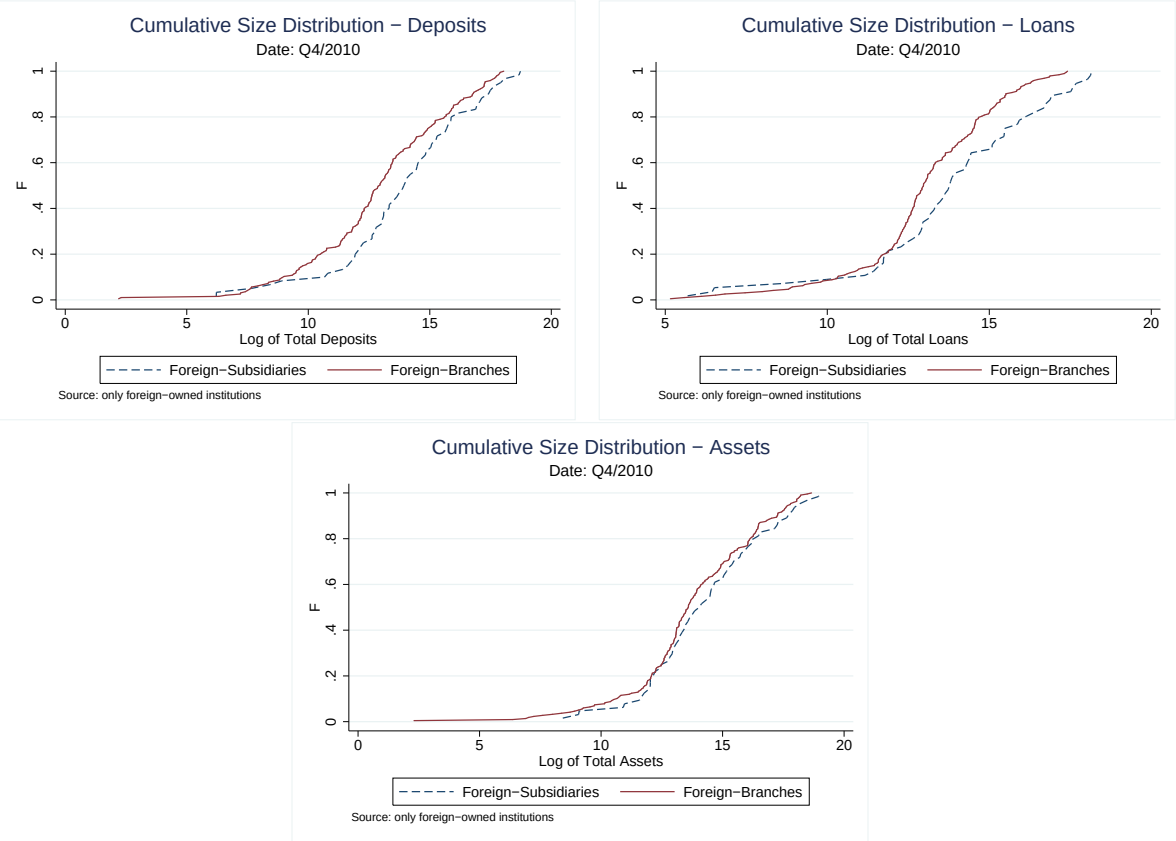

Figure 6: **Size Distributions.** Cumulative distribution functions for deposits, loans, and assets, respectively, held in foreign owned subsidiaries and branches in the fourth quarter of 2010. Data source: U.S. Share Data for U.S. Offices of Foreign Banking Organizations - Selected Assets and Liabilities of Domestic and Foreign Owned U.S. Commercial Banks (state member, non-member and national) plus U.S. Branches and Agencies of Foreign Banks, available on the Federal Reserve Board of Governors website, http://www.federalreserve.gov/releases/iba/fboshr.htm.

The size differences that the time series plots display are not driven by a few firms holding extraordinarily large balance sheets. As we can observe in the bottom panel of Figure 6, deposits, loans, and assets size distributions of foreign subsidiaries stochastically dominate the analogous distributions of foreign branches.

The differences in assets between foreign subsidiaries and foreign branches are narrower than the differences in loans and deposits. Figure 7 shows the time series of loans as a share of total assets for domestic banks, foreign owned branches, and subsidiaries of foreign banks. The domestic banks have historically the highest ratio of loans to total assets. At first glance, subsidiaries are closer to domestic banks throughout the entire sample, as they are both subject to the same regulations. About 55% of their assets are loans for the time period considered. Branches, on the other hand,

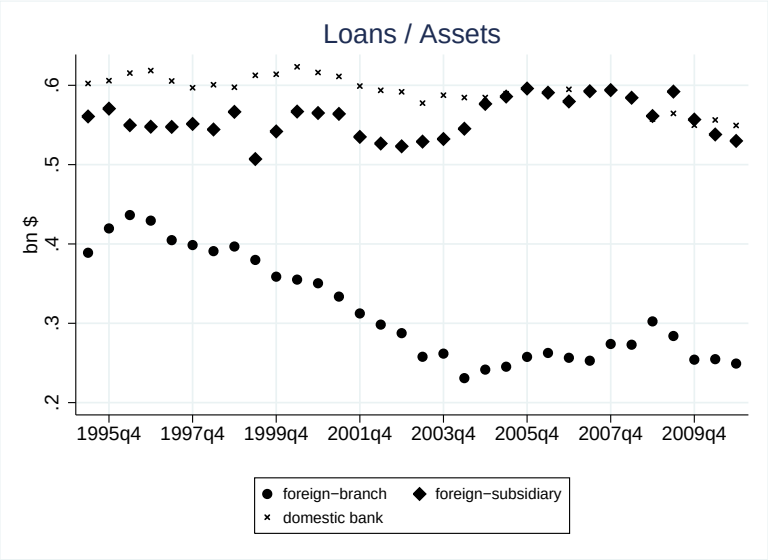

Figure 7: **Loans-to-assets ratio.** Time series of the percentage of loans in the asset side of the balance sheet of the three types of banking offices: domestic banks, foreign subsidiaries, and foreign branches. Data source: Call Reports and FFIEC 002.

display a different portfolio composition. The percentage of loans is much lower than those observed for domestic banks and subsidiaries, between 30 and 40%, more in line with what was observed in investment banks during the last decades. Taking a closer look at the portfolio composition, Figure 8 shows the loan portfolio of the three groups in broad terms. We observe that the loan portfolio of a branch is significantly different than the loan portfolio of a subsidiary and of a domestic bank. In particular, foreign branches do not participate in the real estate markets as actively as foreign subsidiaries and domestic banks. Branches have a 50% share of their assets invested in commercial and industrial loans, while that barely represents 20% of the assets in a domestic bank's or a subsidiary of a foreign bank's balance sheet. Anecdotal evidence and conversations with regulators support the claim that foreign branches behave more similarly to investment banks than to commercial banks.

In sum, we documented that the foreign presence in the U.S. banking system is a large phenomenon. We have highlighted several stylized facts: foreign banks are larger, on average, than domestic incumbents, which is evidence of selection into foreign banking markets. Foreign banks can enter as a subsidiary or as a branch of the parent institution. Subsidiaries are, on average, larger and more similar to the domestic incumbents in their activities compared to branches.

In the next section we introduce a structural model of foreign banking that is consistent with

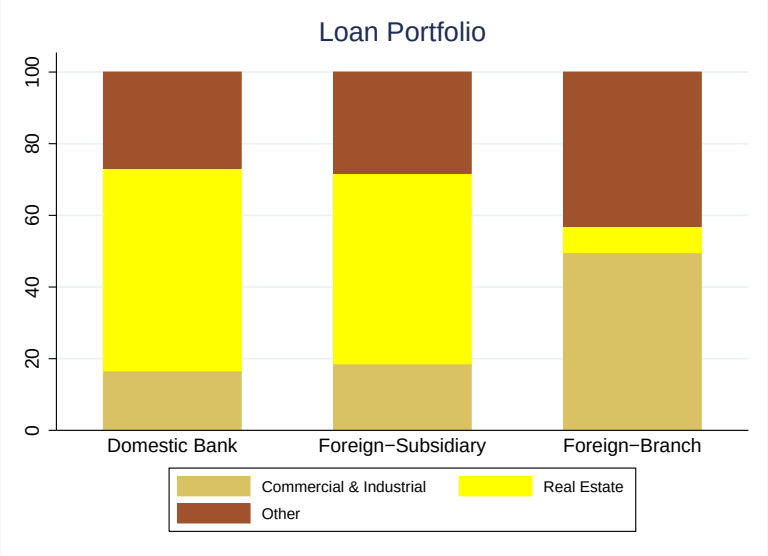

Figure 8: **Loan Portfolio.** Average loan portfolio for each of the three types of banking institutions considered in the paper: domestic bank, foreign-owned subsidiary, and foreign-owned branch. Loans are divided in commercial and industrial (C&I), commercial real estate (CRE), and other loans (fourth quarter of 2010).

the institutional details of the sector and with the evidence presented above.

3 A Simple Model of Foreign Banking

We introduce here a simple model that sets the ground for the quantitative analysis developed in the next sections. The model is useful to introduce the main trade-offs that a bank faces when deciding whether and how to sell in a foreign country. Banks in the model operate in several interconnected markets, each subject to different extents of uncertainty. Once the problem of a bank is well understood, we will incorporate in a dynamic and stochastic model of the banking sector in Section 4. The full model will be able to depict banks' state-contingent decisions as responses to various shocks and their consequences for the banking sector on aggregate.

3.1 Setup

The model economy is composed by two countries, Home and Foreign. Variables referring to the Foreign country are denoted by an asterisk ($*$). The Home and Foreign countries are each populated by a large mass of banks operating there. In addition, each bank may open an affiliate abroad,

either as a branch or as a subsidiary, so becoming the parent of a multinational bank.

We assume that each bank has market power in the loans market, originating from some kind of differentiation (spatial or product). Moreover, banks are heterogeneous in the efficiency with which they manage their activities, and operate under monopolistic competition in the loans market. For simplicity, the other markets in which a bank operates are assumed to be perfectly competitive. We do not model domestic entry: all banks operate and (due to monopoly power) make non-negative profits in their Home market. In addition, each bank may also enter the Foreign country if it can make non-negative profits there as well.

The time horizon is of two periods. At the beginning of $t = 0$, each bank raises equity and interbank debt (which can be negative), and accepts deposits. On the assets side, it issues loans and makes risky investments. We use the term investments to refer generically to the trading book activities, i.e., securities, securities lending, repo markets, etc. We consider trading book activities riskier than traditional banking book activities, i.e., loans and deposits. At the beginning of period $t = 1$, with a certain probability of default $(1 - p)$ the loans may be delinquent and not repay the principal. The bank collects the interest and payments of the loans (if they are not delinquent) and investments, and at the end of the period the bank is liquidated: the profits, loan repayments (if not delinquent), and investment gross returns minus deposit and debt repayments are returned to the equity holders.

During each period, banks need to pay a cost to manage deposits, loans, and investments, described by the convex cost function $a \cdot C(D, L, I)$ where D denotes deposits, L denotes loans, and I denotes investment. Bank-specific efficiency a affects the management cost multiplicatively, so that "low a" banks are more efficient than "high a" banks.

Banks that accept deposits have to pay a deposit insurance premium every period. The FDIC determines the deposit insurance premium (or "assessment") on a risk basis. A bank's assessment is calculated by multiplying its assessment rate AR by its assessment base, where a bank's assessment base is equal to its average consolidated total assets minus its average tangible equity (definition from the Dodd-Frank Act). Hence the total premium F_p is given by:

$$F^p = AR \cdot (L + I - \mathbb{1}_{M<0} M - E) \approx f_p \cdot D$$

where the last term comes from the bank's resource constraint (see below) and parameter f_p is given by the assessment rate:

	I	II	III	IV	Total
Assessment Rate (pct. points)	5 to 9	14	23	35	5 to 35

Finally, banks are subject to capital requirements every period, *i.e.* there is a lower bound on the capital ratio that they are allowed to sustain:

$$\frac{E}{\omega_L L + \omega_I I} \geq k$$

where $k = 0.04$ under Basel II regulation in the U.S., and $k = 0.06$ under Basel III, for example. The parameters ω_L and ω_I are appropriate weights that reflect the riskiness of loans and investment. These weights are usually determined by the appropriate regulator (in the U.S. case, by the Federal Deposit Insurance Corporation, or FDIC).[7]

When a bank enters the Foreign market, it transfers his efficiency a to his affiliate. Entering the Foreign market involves a sunk cost, that is higher if the bank enters with a subsidiary compared to when it enters with a branch: $F_s > F_b > 0$. If a bank enters as a subsidiary, the Foreign subsidiary performs exactly the same operations as the parent: it accepts deposits, issues loans, makes investments, borrows/lends on the interbank market, and raises independent equity. The operating costs are also modeled in the same way. Conversely, if a bank enters as a branch, the activities of the affiliate differ from the ones of the parent. While the parent bank can accept all kinds of deposits (both wholesale and retail), branches only accept wholesale deposits and they are not subject to deposit insurance. Branches do not raise independent equity and they are not subject to capital requirements. Finally, there exist an intrafirm channel linking the assets and liabilities of the parent and the ones of the branch: parents of offshore branches can borrow from or lend to their branches at no cost. This intrafirm transfer characterizes the activities of parent-branch pairs, but is not allowed between parents and subsidiaries, who can trade only at arm's length via the interbank market.[8]

[7] Uncertainty is essential to model the banks' optimal decisions. In a model without uncertainty, where loans are always repayed and there are no runs on deposits, there would be no need of capital requirements or of deposit insurance. For this reason, parent banks, branches and subsidiaries would all be solving the same problem. Zero arbitrage would make the equilibrium rates equal across markets.

[8] In the no-uncertainty case, the presence of the intrafirm transfer and the lower fixed cost of entry make branches weakly cheaper than subsidiaries, implying an equilibrium with pervasive branching and no subsidiaries.

3.2 The Parent-Subsidiary Pair

Since there are no internal transfers between parent and subsidiary, we can solve their problems separately. A parent bank chooses the optimal amounts of loans, deposits, investment, and equity to maximize its lifetime expected profits from loans and investments minus the costs of handling its operations, subject to resource constraints and capital requirements.

The maximization problem of a bank is:

$$\begin{aligned} \max_{L,I,D,M,E} \quad & pr_L(L) \cdot L - (1-p)L + \bar{r}^I I - r^D D - r^M M - aC(D,L,I) - f_p \cdot D \\ s.t. \quad & M + D + E = L + I \quad \text{(resource constraint)} \\ & \frac{E}{\omega_L L + \omega_I I} \geq k \quad \text{(capital requirement).} \end{aligned} \tag{1}$$

The term $r_L(L)$ denotes a downward sloping demand for loans. In each period, investment gives an average return $\bar{r}_I$. r_D and r_M denote the interest rates paid on deposits D and on interbank borrowing M, respectively. Each bank optimally sets his interest rate on loans and takes the other rates $\bar{r}_I$, r_D and r_M as given. We will use r_D as a numeraire, while r_M will be pinned down by equilibrium conditions on the interbank market. The rate on investments $\bar{r}_I$ will be treated as exogenous and will be a source of shocks in our quantitative analysis.

We assume that in equilibrium the capital requirement is always binding: $E = k(\omega_L L + \omega_I I)$ so that the amount of interbank borrowing is: $M = (1 - k\omega_L)L + (1 - k\omega_I)I - D$. The first order conditions of this problem are:

$$[L] \quad p\left[\frac{\partial r_L(L)}{\partial L} L + r_L(L)\right] = a\frac{\partial C}{\partial L} + (1-p) + r_M(1 - k\omega_L) \tag{2}$$

$$[I] \quad \bar{r}_I = a\frac{\partial C}{\partial I} + r_M(1 - k\omega_I) \tag{3}$$

$$[D] \quad r_M = r_D + a\frac{\partial C}{\partial D} + f_p \tag{4}$$

The first order conditions are intuitive. Banks choose the optimal levels of loans such that the marginal revenue from loans is equal to the marginal cost of loans management and of the external borrowing necessary to finance said loans, plus the expected marginal loss from delinquent

loans. Similarly, the expected return of investment must be equal to the sum of the marginal cost of investment management and external borrowing. Deposits are set such that the sum of interests, deposit insurance premium and marginal costs of deposit management must be equal to the reduction in the marginal cost of external borrowing that the bank incurs by financing loans and investments via deposits.

Due to the presence of market power in the loans market and the absence of fixed costs of production, every bank makes positive profits in its Home market. When establishing a subsidiary abroad, a bank must solve an identical profit maximization problem to solve for the optimal size of loans L^*, investments I^*, deposits D^*, equity E^*, and external borrowing M^* that the subsidiary will undertake in the host country. Moreover, entering a Foreign market with a subsidiary entails a fixed cost F_s. As a result, a bank will consider entering the Foreign market with a subsidiary if and only if the said subsidiary is solvent in the Foreign market, once the fixed costs of entry are accounted for.

A foreign subsidiary is solvent in the Foreign market if at the end of the time horizon the returns of its activity are enough to compensate the equity holders:

$$\Pi_s^* + pL^* + I^* - M^* - D^* \geq E^* + F_s \tag{5}$$

where Π_s^* denotes the expected present discounted value of profits of a foreign subsidiary. By substituting the resource constraints into this condition, one obtains:

$$\Pi_s^* \geq (1-p)L^* + F_s \tag{6}$$

which indicates that the expected profits of the subsidiary must be enough to cover entry costs and expected losses.

3.3 The Parent-Branch Pair

When a parent bank enters the Foreign market with a branch, the possibility of intrafirm transfers links the decisions of the parent and of the branch. A parent-branch pair solves:

$$\begin{aligned}
\max_{\substack{L,I,D,M,E \\ L^*,I^*,D^*,M^*,T}} \quad & pr_L(L)\cdot L-(1-p)L+\bar{r}_I I-r_D D-r_M M-aC(D,L,I)-f_p\cdot D+... \\
& pr_L^*(L^*)\cdot L^*-(1-p)L^*+\bar{r}_I^* I^*-r_D^w D^*-r_M^* M^*-aC(L^*,I^*)-F_b \\
s.t. \quad & M+D+E+T=L+I \quad \text{(parent's resource constraint)} \\
& \frac{E}{\omega_L L+\omega_I I}\geq k \quad \text{(parent's capital requirement)} \\
& M^*+D^*=L^*+I^*+T \quad \text{(branch's resource constraint)}
\end{aligned} \tag{7}$$

where T denotes the intrafirm transfer between the parent and the branch two ($T>0$ when the branch is lending to the parent).

The profit function reflects the institutional restrictions that make branches differ from banks and subsidiaries. Branches do not raise independent equity and can only accept uninsured wholesale deposits. As a consequence, the interest rate they pay on deposits is different from the one paid by banks and subsidiaries. We assume $r_D^w > r_D + f_p$: since branches are not insured, deposits are riskier and command a higher interest rate. We consider both interbank and investment markets to be national, so that the rates in the Foreign country ($\bar{r}_I^*$ and r_M^*) may potentially differ from the ones in the Home country. The term F_b indicates the fixed cost that a parent must bear to open a branch abroad.

The first order conditions for the parent bank are identical to (2)-(4). The first order conditions for the branch are given by:

$$[L^*] \quad p\left[\frac{\partial r_L^*(L^*)}{\partial L^*}L^*+r_L^*(L^*)\right]=a\frac{\partial C}{\partial L^*}+(1-p)+r_M^* \tag{8}$$

$$[I^*] \quad \bar{r}_I^*=a\frac{\partial C}{\partial I^*}+r_M^* \tag{9}$$

$$[D^*] \quad r_M=r_D^w+a\frac{\partial C}{\partial D^*} \tag{10}$$

The economic intuition associated with conditions (8)-(10) is identical to the one of the first

order conditions of the parent. The intrafirm transfer is a costless funding option that the parent-branch pair has in the scenario in which either the parent or the branch (but not both) need to borrow in the interbank market. The two linked entities clear as much as possible of their imbalances internally, and go to the interbank market for the remaining funding needs.

A parent bank will consider entering the Foreign market with a branch if and only if the said branch is solvent in the foreign market, once the fixed costs of entry are accounted for. A foreign branch is solvent in the foreign market if at the end of the time horizon it can cover the fixed costs of entry with its profits net of repayments:

$$\Pi_b^* + pL^* + I^* + T - M^* - D^* \geq F_b \tag{11}$$

where Π_b^* denotes the expected present discounted value of profits of a foreign branch. By substituting the resource constraints into this condition, one obtains:

$$\Pi_b^* \geq (1-p)L^* + F_b \tag{12}$$

which indicates that the expected profits of the branch must be enough to cover entry costs and expected losses.

3.4 What to Take Away

We believe that the simple toy-model developed in this section is a useful tool to understand the trade-offs that banks face when entering foreign markets. Consistent with the evidence reported in Section 2, fixed costs and monopolistic competition in the Foreign market imply that foreign branches and subsidiaries are larger (on average) than the incumbent firms. The observed size differences between branches and subsidiaries shown in Figures 2-4 can also easily be reproduced by the model. The fact that subsidiaries raise equity to fund their activities (the capital requirements) implies that they have lower borrowing needs (and hence lower marginal costs) than branches in both the loans and investment markets. As a result, subsidiaries are larger than branches both in terms of loans and investment. Similarly, since we assume that $r_D^w > r_D + f_p(k)$, branches have higher marginal costs than subsidiaries also in the deposit market, hence also the size of their deposits is smaller. Overall, branches have higher marginal costs than subsidiaries in all three markets in which they operate, but higher sunk costs due to the assumption that $F_b < F_s$, which

determines selection of less efficient and smaller banks into being branches and selection of more efficient and bigger banks into subsidiaries.

Appropriately parameterized, the model can also generate the observed differences in the portfolio composition of banks. According to Figure 7, branches exhibit lower loans-to-asset ratios than subsidiaries, indicating a higher share of investments in their portfolios. In the model, loans-to-asset ratios depend on the elasticity of loans demand and on the weights that the regulator imposes when computing risk-weighted assets. In a world without capital requirements, selection alone delivers the desired differences in loans-to-assets ratios. In our quantitative analysis, we will calibrate the parameters of the model to match the differential in loans-to-assets ratios quantitatively.

Finally, the model generates intrafirm transfers between parent banks and branches. In the next section we will show how the sign of the intrafirm transfer depends on which part of the conglomerate is hit by shocks. The intrafirm transfer is a mechanism to improve the solvency of the separate parts of the multinational banks, allowing the parent to manage liquidity shocks, but at the same time facilitating the transmission of shocks across countries.

4 Foreign Banking Dynamics: A Quantitative Framework

In this section we nest the problem of an individual bank that we just described into a dynamic model of the banking industry.

Let $\mathcal{L}$ ($\mathcal{L}^*$) denote aggregate loans demand in the Home (Foreign) market. We assume aggregate loans demand to be exogenous, and to evolve over time according to the following geometric Brownian motions:

$$\frac{d\mathcal{L}}{\mathcal{L}} = \mu dt + \sigma dz \tag{13}$$

$$\frac{d\mathcal{L}^*}{\mathcal{L}^*} = \mu^* dt + \sigma^* dz^* \tag{14}$$

where $\mu, \mu^* \geq 0$, $\sigma, \sigma^* > 0$ and dz, dz^* are the increments of two standard Wiener processes with correlation $\rho \in [-1, 1]$. The idea behind a stochastic process for aggregate loans is the following: we can construct an economy where agents maximize consumption over time and income fluctuates according to some stochastic process. If we assume that agents need banks to smooth consumption over time, loans demand will also follow a stochastic process. The problem then is simply to

construct an income process such the the resulting loans processes are described by (13) and (14). For now we abstract from this and we simply impose loans demand to be exogenous. We also assume that international loans markets are incomplete: consumers in the Home (Foreign) country can only borrow from firms that are located in their own country. Foreign banking will weaken this restriction by allowing consumers to borrow from foreign banks once they choose to locate in their home country.

There are many possible kinds of loans in the economy: personal loans, credit cards, car loans, mortgages and so on. We assume that each bank in a country specializes in a distinct kind of loan and is the sole provider of it. Loans are perceived as imperfect substitutes, and aggregate to total loan demand through a CES aggregator:

$$\mathcal{L} = \left(\int L^{1-1/\eta} dL \right)^{\eta/(\eta-1)}$$

where $\eta > 1$.

Each country is populated by a continuum of banks of total mass n (n^*), which operate under a monopolistically competitive market structure. Each firm produces a differentiated loan variety L taking the aggregate loan demand as given. Each bank's technology is as described in Section 3, where the only feature differentiating banks is the bank-specific efficiency a, which scales up or down the bank's management cost function. a is a random draw from a distribution $G(a)$ ($G^*(a)$ for the foreign market).[9] For tractability, we assume that the management cost function $C(D, L, I)$ is separable in its arguments, linear in L and quadratic in D and I.

These assumptions ensure that interest rates on loans are independent of aggregate loans demand, and that each bank's profits in a country are a linear affine function of aggregate loans $\mathcal{L}$. Recall that we assumed that sunk costs of entry are larger for a bank that enters the foreign market as a subsidiary compared to a bank that enters as a branch, and that interest rates on wholesale deposits are higher than the sum of interest rates on retail deposits plus the deposit insurance premium that a subsidiary needs to pay. These assumptions are enough to ensure sorting by efficiency in different levels of international engagement: the most efficient banks will enter the foreign market as subsidiaries, less efficient banks will enter the foreign market as branches, and the least efficient ones will operate only in their domestic market.

[9] For quantitative purposes, we can also extend the model to consider a bank specific efficiency parameter evolving over time: this will be useful to simulate the effect of bank-specific shocks to the economy.

We start by considering an economy where the only shocks are aggregate shocks to loans demand as described by (13)-(14). We will then extend the model to consider shocks to the probability of loans repayment p and to the interest rate on investment $\bar{r}^I$.

Let $\mathcal{V}_i(a, \mathcal{L}, \mathcal{L}^*)$ denote the value of a bank with efficiency a, when aggregate loan demand in the two markets is described by $(\mathcal{L}, \mathcal{L}^*)$. The index i denotes the international status of the bank: $i \in \{N, B, S\}$ where N denotes a national bank who only operates in its Home market, B denotes a multinational bank that operates in the foreign market through branches, and S denotes a multinational bank that operates in the foreign market through subsidiaries.[10]

We solve the model along the lines of Dixit (1989). We parameterize the model such that all banks are active in their domestic market and make positive profits there. Domestic activities are not directly affected by the realization of foreign loan demand $\mathcal{L}^*$. Similarly, the decision of whether to enter the foreign market is not directly affected by the realization of domestic loan demand $\mathcal{L}$. For this reason, we can express the value function as:

$$\mathcal{V}_i(a, \mathcal{L}, \mathcal{L}^*) = \mathcal{S}(a, \mathcal{L}) + V_i(a, \mathcal{L}^*) \tag{15}$$

where $\mathcal{S}(a, \mathcal{L})$ is the expected present discounted value of profits from domestic activities, which is independent on the bank's international status, and $V_i(a, \mathcal{L}^*)$ is the expected present discounted value of profits from foreign activities for a bank in status i.

Over a generic time interval Δt, the two components of the value function for a bank that is currently operating only in its domestic market can be expressed as:

$$\mathcal{S}(a, \mathcal{L}) = \pi_N(a, \mathcal{L}) + E[\mathcal{S}(a, \mathcal{L}')|\mathcal{L}] \tag{16}$$

$$V_N(a, \mathcal{L}^*) = \max\left\{E[V_N(a, \mathcal{L}^{*\prime})|a, \mathcal{L}^*]\ ;\ V_B(a, \mathcal{L}^*) - F_B\ ;\ V_S(a, \mathcal{L}^*) - F_S\right\} \tag{17}$$

where $\pi_N(a, \mathcal{L})$ denotes the maximal domestic profits of the bank, solution of problem (1).

While (16) simply tracks the evolution of domestic activities, the right hand side of (17) expresses the bank's possible choices. If it remains a national bank, it gets the continuation value from not changing status. If it decides to enter the foreign market with a branch (subsidiary) it gets the value of the corresponding foreign activity V_B (V_S) minus the sunk cost of entry F_B (F_S). Similarly,

[10] Notice that the cost structure and the nature of uncertainty imply that if a bank decides to enter the foreign market, it will do so either with branches or with subsidiaries, but it will never adopt the two strategies at the same time.

the present discounted value of profits from foreign activities of a multinational bank is:

$$V_B(a, \mathcal{L}^*) = \max \left\{ \pi_B(a, \mathcal{L}^*) + E[V_B(a, \mathcal{L}^{*\prime}) | \mathcal{L}^*] \ ; \ V_N(a, \mathcal{L}^*) \right\} \tag{18}$$

in case of branching, and:

$$V_S(a, \mathcal{L}^*) = \max \left\{ \pi_S(a, \mathcal{L}^*) + E[\cdot V_S(a, \mathcal{L}^{*\prime}) | \mathcal{L}^*] \ ; \ V_N(a, \mathcal{L}^*) \right\} \tag{19}$$

in case of subsidiarization.

Notice that the continuation values of multinational banks also include the profit flows $\pi_B(a, \mathcal{L}^*)$, $\pi_S(a, \mathcal{L}^*)$ from foreign market activities. There are no costs of exiting the foreign market: if a bank decides to exit, its value is simply that of a national bank.

In Appendix C we show that the value functions $\mathcal{S}(a, \mathcal{L})$, $V_i(a, \mathcal{L}^*)$ for $i \in \{N, B, S\}$ take the form:

$$\mathcal{S}(a, \mathcal{L}) = \frac{\pi_N(a, \mathcal{L})}{r_M} \tag{20}$$

$$V_N(a, \mathcal{L}^*) = A_N(a)\mathcal{L}^{*\alpha} + B_N(a)\mathcal{L}^{*\beta} \tag{21}$$

$$V_B(a, \mathcal{L}^*) = A_B(a)\mathcal{L}^{*\alpha} + B_B(a)\mathcal{L}^{*\beta} + \frac{\pi_B}{r_M^*} \tag{22}$$

$$V_S(a, \mathcal{L}^*) = A_S(a)\mathcal{L}^{*\alpha} + B_S(a)\mathcal{L}^{*\beta} + \frac{\pi_S}{r_M^*} \tag{23}$$

where α and β are the roots of:[11]

$$\frac{1}{2}\sigma^{*2}\xi^2 + (\mu^* - \frac{1}{2}\sigma^{*2})\xi - r_M = 0.$$

$A_i(a)$ and $B_i(a)$ $(i \in \{N, B, S\})$ are firm-specific, time-varying parameters to be determined, depending on the empirical patterns of entry and exit that we observe in the data. We impose $A_N(a) = 0$ since for low realizations of loan demand, the value of entering in the foreign country should be near zero.

The value functions in (21)-(23) preserve some intuition. The last term of (22) and (23) captures the stream of profits should the bank remain in the current status permanently. The exponential terms capture the option value component for α and β less than zero and bigger than one, respec-

[11] $\alpha < 0$, $\beta > 1$.

tively. In (21), as loan demand grows in the foreign country, if B_N is positive, it be comes more and more attractive to enter. The bank still needs to decide whether to enter via a branch or a subsidiary, which is a function of the bank's productivity. Conversely, we can see in (22) and (23) is that, if loan demand shrinks in the foreign country, the option value of exiting increases, due to the negative exponent.

We impose value matching and smooth pasting conditions to obtain the coefficients of the value functions and the thresholds in aggregate loan demand that trigger the foreign expansion of a bank using either a branch or a subsidiary. Given the discrete nature of the problem, these thresholds represent the policy function for the banks. We solve numerically for the coefficients and the thresholds.

Once we have solved for the parameters of the value functions in the continuation region, our objective is to simulate an economy with a large number of domestic banks and simulate the stochastic process describing aggregate loan demand in each country. Every period, the model delivers the banks' endogenous decision of foreign exit and entry by type and the flows of deposits, loans, trading activities, interbank borrowing and intrafirm transfers. In our model, banks' domestic and foreign profits depend on the mode of entry. We do impose some functional form assumptions. The management cost function is assumed to be:

$$C(D, L, I) \equiv \beta_L L + \frac{\beta_I I^2}{2} + \frac{\beta_D D^2}{2} \tag{24}$$

and management efficiency $x \equiv 1/a$ is distributed according to $G(x) = 1 - b^{\vartheta} x^{-\vartheta}$.

4.1 Calibration

We parameterize the model and generate an economy with a large number of domestic banks.[12] Then we simulate the stochastic process describing aggregate loan demand in each country.

Every period, the solution of the model delivers: banks' endogenous decisions of foreign entry (by type), banks' endogenous decisions of exit from the foreign market (by type), banks' domestic and foreign flows of deposits, loans, investment, interbank borrowing, and intrafirm transfers, banks' domestic and foreign profits depending on the mode of entry, and banks' domestic and foreign risk

[12] Functional form assumptions: $C(D, L, I) \equiv \beta_L L + \frac{\beta_I I^2}{2} + \frac{\beta_D D^2}{2}$ and management efficiency $x \equiv 1/a$ distributed according to $G(x) = 1 - b^{\vartheta} x^{-\vartheta}$.

Parameter	Definition	Value	Source
Revenue and cost parameters			
p	prob. of loan repayment	0.96	World Bank
η	elasticity of loan demand		
β_L, β_I, β_D	param. of cost function		
k	capital requirement	(0.04, 0.08)	Basel II/III
ω_L, ω_I	weights for RWA		
f_p	insurance premium	(0.005, 0.035)	FDIC
F_S, F_B	sunk entry costs		
Rates			
r_I	av. return on investment	0.1	SP 500
r_D	int. rate on retail deposits	0.0025	one-year CD
r_D^w	int. rate on whol. deposits	0.006	LIBOR
Banks efficiency distribution			
ϑ	shape parameter	$.5\eta$	emp. loans size distrib.
b	location parameters	1	normalization
Brownian motions			
μ, μ^*	drift	0	no growth
σ, σ^*	st.dev.	0.06	st. dev. of loans
ρ	correlation	(-1,1)	corr. of loans
$\mathcal{L}_0$, $\mathcal{L}_0^*$	initialization		

Table 2: Calibration

exposure (computed theoretically as the covariance of a bank's profits with domestic loan demand).

In order to parameterize the model, we choose some parameter values directly from empirical observations, and we calibrated the remaining parameters through a simulated method of moments procedure. More precisely, we calibrate directly the parameters p, k, f_p, r_I, r_D, r_D^w, ϑ, b, μ, μ^*, σ, σ^*, ρ.

The remaining 10 parameters (η, β_L, β_I, β_D, ω_L, ω_I, F_S, F_B, $\mathcal{L}_0$, $\mathcal{L}_0^*$) are calibrated jointly to match the following moments from the data: the average interest rates on loans, the relative size of deposits and loans in branches compared to subsidiaries, the relative loans-to-assets ratios in branches compared to subsidiaries, the percentages of branches and subsidiaries in the total number of banks in the US, and entry and exit dynamics: average share of national banks that become branches (subsidiaries) each year, and average share of branches (subsidiaries) exiting each year. Table 2 summarizes the calibration.

5 Numerical Results

In this section we exploit the theoretical model to answer counterfactual questions. The solution the model consists of value functions and policy functions that determine the behavior of bank holding companies in the presence of loan demand shocks. Since we take quantity demanded as given, the changes in equilibrium will be captured through the effect of the extensive margin and endogenous market structure on prices, i.e., interest rates for different type of loans, on the variety of loans, and on the interbank market equilibrium. The model is calibrated to match foreign entry and exit dynamics, numbers of branches and subsidiaries of foreign companies and the corresponding asset shares, and distribution of loan types across the different agents (domestic, foreign branches, and foreign subsidiaries).

In a nutshell, the model predicts that more productive bank holding companies expand via subsidiaries after a series of positive shocks to foreign demand, while less productive bank holding companies expand via subsidiaries. The resulting endogenous market structure and number of players affect the prices of the retail and wholesale deposits, prices of heterogeneous loans and prices and quantities of interbank loans. We use the equilibrium prices for loans to identify the effects of the changes in industry structure on credit markets.

The model also allows us to identify the effects of a demand shock on the risk exposure of banks. We derive analytically the risk exposure of a bank and quantify the effects of a demand shock. Banks heterogeneity results in cross sectional differences in risk exposures and, thus, in asset prices –value– of the banks.

With this mechanism in mind and the model calibrated to market structure dynamics, we are able to evaluate the effects of changes in policies regarding foreign banks on the equilibrium of credit markets, holding demand constant. The policies that we evaluate are changes in deposit insurance rules for foreign branches, changes in capital requirements for foreign subsidiaries, and elimination of the possibility of opening either branches or subsidiaries altogether.

Use the model to evaluate the following counterfactual scenarios:

- changes in deposit insurance and capital requirements rules;
- extending interbank transfers to subsidiaries;
- elimination of the possibility of opening branches or subsidiaries.

Extensions:

- stochastic rates of return on investments;
- shocks to deposits supply.

Numerical results *TBA*

6 Conclusions

TBA

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Appendix

A The Regulatory Framework: History and Current Status

TBA

B Data Description

TBA

C Derivation of the Solution of the Model

TBA