Multinational Banks*

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PRELIMINARY AND INCOMPLETE

Abstract

This paper starts by establishing a set of stylized facts about global banks with operations in the United States. First, we show evidence of selection into foreign markets: the parent banks of global conglomerates tend to be larger than national banks. Second, selection by size is related to the mode of foreign operations: foreign subsidiaries of global banks and their parents are systematically larger than foreign branches and their parents, in terms of deposits, loans, and overall assets. Third, the mode of foreign operations affects the response of global banks to shocks and how those shocks are transmitted across countries. We develop a structural model of entry into global banking whose assumptions mimic the institutional details of the regulatory framework in the US. Heterogeneous, profit-maximizing banks decide whether and how to enter a foreign market. While shedding light on the relationship between market access, capital flows, regulation, and entry, the model rationalizes the observed stylized facts and can be used as a laboratory to perform counterfactual analysis.

Keywords: banks, entry, multinational firms.

JEL Classification: F12, F23, F36, G21

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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.”

“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 US 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 existing 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 foreign 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 US bank-level data. 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. This feature allows us to assess whether the mode of entry matters for the extent of the transmission of various shocks across countries. Second, operationally, we calibrate the model and use it to perform a series of counterfactual exercises that shed light on the implications of the current regulation for shock transmission.

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 sub-

\(^1\)See most notably Cetorelli and Goldberg (2011, 2012a,b).
\(^2\)Notable exceptions are Bremus et al. (2013), de Blas and Russ (2013), and Niepmann (2012, 2013).
The existing banking regulation treats branches and subsidiaries differently, 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 are subject to capital requirements only at the level of the global conglomerate. While subsidiaries can issue all types of deposits, branches can only issue uninsured wholesale deposits. Finally, unlike subsidiaries, branches can freely and costlessly transfer funds to and from their parent.3

Our analysis starts by establishing a series of stylized facts about the cross-section of global banks in the US and their responses to shocks. First, we show evidence of selection into foreign markets: the parent banks of global conglomerates tend to be larger than national banks. Second, selection by size is related to the mode of foreign operations: the parent banks of foreign subsidiaries are systematically larger than the parent banks of foreign branches. Also at the affiliate levels, subsidiaries are larger than branches. These size rankings hold in terms of deposits, loans, and overall assets. Third, the mode of foreign operations affects the response of global banks to shocks and how those shocks are transmitted across countries. To study the extent of shock transmission, we analyze the response of US-based affiliates of European banks to the European sovereign debt crisis of 2011. We find that, in the wake of the crisis, US branches of exposed European banks experience a flight in their uninsured deposits, while subsidiaries’ deposits (both insured and uninsured) grow. At the same time, the shortage of funding that branches experience is at least partially filled by intrafirm transfers of funds from their parents: the probability that a US branch receives an intrafirm transfer from the exposed parent increases, and the amount of the transfer increases. At the same time, US branches of exposed European banks decrease their assets in the US, while assets increase in exposed US subsidiaries.

In order to confidently use our framework for policy analysis, we model carefully the institutional differences between branches and subsidiaries, to accurately describe the global banking sector in the US. To keep the analysis as simple as possible, the problem of a bank is modeled as a monopolistically competitive extension of the Monti-Klein model (see Klein, 1971, and Monti, 1972), augmented to include risky loans and capital requirements, and aggregated to an industry equilibrium with heterogeneous banks. The models features the channels of adjustment that we document in the data, and it simple structure allows us to calibrate it and use it for quantitative analysis.

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3Section 2 illustrates the institutional features of the US banking sector. Appendix A summarizes the US banking regulation and the changes it underwent in the past decades.
While able to replicate the features of the cross-section of foreign banks in the US and the differential response to shocks of branches and subsidiaries, the model can be used as a laboratory to perform policy-relevant counterfactual exercises.

[DESCRIPTION OF COUNTERFACTUALS TBA]

[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 then calibrated and used to perform counterfactual exercises in Section 4. Section 5 concludes.

2 Foreign Banks in the US: Stylized Facts

In this section we present a series of facts that motivate the theoretical analysis that follows. We start with a description of the cross-section of foreign banks operating in the US, and then present evidence on how foreign banks respond to shocks depending on their mode of organization in the host country.

2.1 Data

This analysis relies on bank-level data from different sources. Our main source is data from the Quarterly Reports of Condition and Income that every US bank is required to file. These reports are better known as “Call Reports”. In addition to domestic banks, US-based subsidiaries of foreign banks must fill out these reports as well.\footnote{The Federal Financial Institutions Examination Council (FFIEC) collects these data 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. The information about domestic operations is identical across reports for all practical purposes.} We also use the quarterly “Report of Assets and Liabilities of US Branches and Agencies of Foreign Banks” that every branch and agency of a foreign bank is required to file.\footnote{Form FFIEC 002. 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. Branches do not have their own balance sheet, as they are consolidated into the parent institution. Nonetheless, the US regulatory framework requires foreign owned branches and agencies to report their assets and liabilities in the 002 form.} Call Reports data include detailed information about banks’ US operations, and the identity of ultimate owner which allows us to distinguish US-based entities...
belonging to global banks from US national banks.

In order to have a more detailed picture of global banks’ operations at home and abroad, we merge Call Reports data with two additional data sources: SNL Financial, which includes regulatory reporting data and accounting data filed by the foreign parents of US-located subsidiaries and branches, and reported sovereign debt holdings of European banks provided as part of the European Banking Authority’s (EBA) Stress Test information. As a result of this merge, we are left with a sample of 125 parent banks of US-based affiliates. These merged data allow us to present evidence about the response to shocks of different entities belonging to the same global banking conglomerate but located in different countries.

Since the heart of our empirical analysis will focus on global banks’ response to the European Sovereign Debt crisis of 2011, we restrict our sample period to 2007-2013.6

2.2 The Cross-Section of Foreign Banks

The presence of foreign institutions in the US banking market is substantial. Figure 1 shows aggregate data on the population of foreign banking organizations operating in the US. About 20% of the aggregate assets held by banks operating in the US 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.

What are the activities of foreign banking organization (henceforth, FBOs) in the US? The answer is complex, as a foreign bank may enter in the US market under different organizational forms, associated with very different activities and – most importantly – different regulation. A foreign bank may open a subsidiary bank, which is subject to US regulation, raises independent equity, and is subject to capital requirements. A subsidiary bank may accept both wholesale deposits and retail insured deposits (insured by the Federal Deposit Insurance Corporation) and performs the same type of operations than a domestically owned US bank does. Possible capital flows between the subsidiary and the parent must happen at arm’s length. This means that if a

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6The Riegle-Neal Interstate Banking and Branching Efficiency act of 1994 repealed interstate restrictions in the original Bank Holding Company act of 1956. Based on this, studies of the global banking sector in the US should restrict the sample period to post-1995 to avoid capturing market dynamics stirred by the deregulation of interstate banking. Appendix A summarizes the regulatory reforms that have been shaping the US banking industry in recent years, with special focus on those regulations that had an impact on foreign banks operating in the US.
parent wants to transfer funds to or from a subsidiary in the US, there is not a fully internal channel to do so. In our dataset, we count 51 US-based subsidiaries of foreign banks, with total assets of approximately $1.14tn or 7.1% of all bank assets in the US.

The other most common form of entry is via branching: a branch is also subject to US regulation, but does not raise independent equity. It is only subject to capital requirements at the conglomerate level in its home country (i.e., its assets are consolidated with the ones of the parents when evaluating its capital ratios). Branches may give loans, but accept only non-insured wholesale deposits. Opposite to subsidiaries, branches have the possibility of an intrafirm channel to transfer capital flows to/from the parent, and indeed do display large intrafirm capital flows with their foreign parents (more on this below). In our dataset there are 181 US-based branches of foreign bank, with total assets of approximately $2.4tn, or 15% of all bank assets in the US.

Subsidiaries and branches are the two most relevant forms in which foreign banks enter the US banking system. Jointly, they represent more than 99% of the assets held by foreign-owned banking offices. In terms of business lines, these two forms of entry also entail activities that are
close to those of a traditional bank. In addition to branches and subsidiaries, the data display two more types of organizations. *Edge and agreement corporations* cannot engage in business in the US with US-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.

Which kind of foreign banks enter the US market? We start our description of the foreign banking sector in the US by showing that there is selection by size akin to what we observe for multinational firms in other, non-banking sectors.

Figure 2 illustrates the comparison between European parents of US-based Foreign Banking Organizations and European banks without overseas operations in the US, in terms of various measures of size (loans, deposits, and overall assets) and income. It is evident that the foreign banks that enter the US market through affiliates are larger and more profitable than the ones that do not.\(^7\) The figure further distinguishes parents of foreign subsidiaries from parents of foreign branches, and shows that parents of foreign subsidiaries are on average larger banks compared to parents of foreign branches.

Figure 3 shows that the amount of assets foreign banks hold in the US is positively related to their domestic size. This relationship also supports selection by size if we believe that banks are able to at least partially “transfer” their managerial efficiency when going abroad.

There are large size differences between subsidiaries and branches of FBOs, illustrating that selection by size does not only interests the foreign banking phenomenon as a whole, but is also important depending on the organizational form that the foreign banks take in the US market. Table 1 summarizes the average size of all deposits, loans, and overall assets held by a US branch or subsidiary of a foreign bank. The average subsidiary of a foreign bank is substantially bigger than the average branch in terms of deposits, loans, and overall assets.\(^8\)

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\(^7\)To properly argue about selection by size, we should be comparing foreign parents of US-based FBOs with foreign national banks without operations abroad. Unfortunately, the available data do not allow us to distinguish foreign national banks from foreign parents of FBOs located in countries other than the US. However, we argue that the US is one of the most popular markets for the activities of multinational banks, so it is likely that foreign banks that don’t have operations in the US also don’t have operations in any other foreign market.

\(^8\)The asset side of a bank’s balance sheet includes many types of loans, wholesale (commercial and industrial loans, real estate loans, and loans to other financial institutions) and retail (mortgages, home equity, auto loans, and credit cards). In addition, other assets held by banks are securities (treasuries, residential and commercial mortgage-backed securities, other asset-backed securities, and a small amount of equity) and trading assets. The liabilities side includes
Figure 2: **Foreign Parents vs Foreign National Banks.** Comparison of various size measures of foreign parents of US-based FBOs (subsidiaries and branches) versus foreign banks without overseas operations in the US. Source: SNL data for top tier parents of U.S. branches and subsidiaries from Europe. Sample period: 2007-2013.

Figure 3: **Size of Domestic versus Foreign Assets.** Share of US assets in a parent’s total assets versus the parent’s size. Source: SNL data for top tier parents of U.S. branches and subsidiaries from Europe, 2013.

<table>
<thead>
<tr>
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<th>1997 Q4</th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assets</td>
<td>Loans</td>
<td>Deposits</td>
<td></td>
</tr>
<tr>
<td>Subsidiaries</td>
<td>2781.53</td>
<td>1532.34</td>
<td>2025.82</td>
<td></td>
</tr>
<tr>
<td>Branches</td>
<td>2073.60</td>
<td>827.72</td>
<td>1035.45</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2013 Q4</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assets</td>
<td>Loans</td>
<td>Deposits</td>
<td></td>
</tr>
<tr>
<td>Subsidiaries</td>
<td>24186.11</td>
<td>13632.02</td>
<td>18501.00</td>
<td></td>
</tr>
<tr>
<td>Branches</td>
<td>10723.32</td>
<td>2486.58</td>
<td>5124.31</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 reports size differences two quarters at the beginning and at the end of our sample period. These size differences between foreign branches and subsidiaries are persistent throughout the entire sample period. Moreover, the size differences that appear from the averages in the summary statistics are not driven by a few firms holding extraordinarily large balance sheets. As is evident in Figure 4, deposits, loans, and assets size distributions of foreign subsidiaries first-order stochastically dominate the analogous distributions of foreign branches.

We mentioned above that US-based branches of FBOs display large intrafirm capital flows with their foreign parents. Figure 5 shows the evolution of the aggregate net flows to and from related institutions, confirming that throughout the majority of the sample period (until 2011) 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) and Correa et al. (2013) about foreign branches being a source of funding to their US parents. This pattern sharply reverts at the onset of the European sovereign debt crisis in 2011, a fact that we analyze more in detail in the next section.

To summarize, we documented here a few facts that characterize the cross-section of foreign banks in the US. First, foreign presence in the US banking system is a large phenomenon. Second, global banks are larger, on average, than national banks. Third, foreign banks can enter the US deposits, short-term and long-term debt, and owners’ equity.
Figure 4: **Size Distributions.** Cumulative distribution functions for deposits, loans, and assets, respectively, held in foreign owned subsidiaries and branches in the fourth quarter of 2013. Data source: US Structure Data for US Offices of Foreign Banking Organizations - Selected Assets and Liabilities of Domestic and Foreign Owned US Commercial Banks plus US Branches and Agencies of Foreign Banks.
market by opening subsidiaries or branches. Larger parents tend to open subsidiaries, while smaller parents tend to open branches, and – at the affiliate level – subsidiaries are, on average, larger than branches.

2.3 Foreign Banks’ Response to Shocks

In this subsection, we use the EU sovereign debt crisis of 2011 as a natural experiment to analyze global banks’ response to shocks and the extent to which global banks are vehicles of shock transmission across countries. The analysis in this section is similar in spirit to the one in Correa et al. (2013), but with an emphasis on the distinction between foreign subsidiaries and foreign branches. In a nutshell, we find that, after the European sovereign debt crisis: 1) US-based branches of exposed European banks decrease their assets in the US while US-based subsidiaries of exposed European banks do not experience a drop in assets; 2) the probability that a US branch receives an
intrafirm transfer from the exposed parent increases, and the amount of the transfer increases; and
3) there is a flight in the uninsured deposits of US branches of exposed European parents, while
the deposits of US subsidiaries of exposed European parents are not affected.

We establish these facts by using our merged data set. We classify a bank as exposed if it has
positive Greek, Italian, Irish, Portuguese, or Spanish (GIIPS) sovereign debt holdings. For this
exercise, we use quarterly data from 2007:Q2 to 2013:Q4. Our results are robust to alternative
definitions of exposed banks.9

We start by assessing the differential response of branches versus subsidiaries by looking at
assets. For this purpose, we run the following regression:

\[ a_{e,b,t} = \alpha + \beta_1 \text{Crisis}_t + \beta_2 \text{Sub}_e + \beta_3 \text{Exp}_{e,b} + \ldots \]
\[ \gamma_1 \text{Crisis}_t \times \text{Sub}_e + \gamma_2 \text{Crisis}_t \times \text{Exp}_{e,b} + \gamma_3 \text{Crisis}_t \times \text{Exp}_{e,b} \times \text{Sub}_e + \delta_b + \varepsilon_{e,b,t} \] (1)

where \( a_{e,b,t} \) is the log of total assets of entity \( e \) belonging to bank \( b \) at time \( t \), and an entity is either
a US-based branch or a US-based subsidiary part of a banking conglomerate \( b \). The variable \( \text{Crisis}_t \)
is a dummy taking value 1 for all years after 2011 (included), while the variable \( \text{Exp}_{e,b} \) is a dummy
taking value 1 when parent bank \( b \) of entity \( e \) is exposed to GIIPS debt. \( \text{Sub}_e \) is a dummy variable
taking value 1 if entity \( e \) is a subsidiary.

The results are reported in Table 2 and show that, after the European sovereign debt crisis,
US branches of exposed European banks decrease their assets in the US, while US subsidiaries of
exposed European banks increase their assets.

Given that the sovereign debt crisis hit the balance sheets of the European parents of these
banks, one could think that the drop in assets of their US-based branches was associated with a
internal transfer of resources from the US to Europe. To establish whether this is the case, it is
instructive to look more closely into the change of sign of branches’ intrafirm flows that the data
display around the year of the sovereign debt crisis, 2011. Simply looking at the raw data, it is
evident from Figure 6 that the sign reversal in intrafirm capital flows between parents and branches
is mostly due to FBOs whose parents were exposed to the crisis.

9For robustness, we performed the empirical analysis reported in this section also using the following alternative
definitions of “exposed parent”: i) classify a bank as exposed if it has (GIIPS) sovereign debt holdings above the
median, ii) classify a bank as exposed if from a country in the Euro zone; and iii) classify a bank as exposed if
European.
Table 2: Intensive Margin of Assets of Branches versus Subsidiaries

<table>
<thead>
<tr>
<th></th>
<th>ln(Total Assets)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crisis</td>
<td>0.458***</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
</tr>
<tr>
<td>Sub</td>
<td>-0.356***</td>
</tr>
<tr>
<td></td>
<td>(0.044)</td>
</tr>
<tr>
<td>Exp</td>
<td>2.719***</td>
</tr>
<tr>
<td></td>
<td>(0.308)</td>
</tr>
<tr>
<td>Crisis × Sub</td>
<td>-0.597***</td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
</tr>
<tr>
<td>Crisis × Exp</td>
<td>-1.024***</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
</tr>
<tr>
<td>Crisis × Exp × Sub</td>
<td>1.329***</td>
</tr>
<tr>
<td></td>
<td>(0.093)</td>
</tr>
<tr>
<td>Constant</td>
<td>20.64***</td>
</tr>
<tr>
<td></td>
<td>(0.159)</td>
</tr>
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</tr>
<tr>
<td>No. of Obs.</td>
<td>4489</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.113</td>
</tr>
</tbody>
</table>

To establish more accurately this sharp distinction between the activities of exposed versus non-exposed banks with foreign branches, we run the following regressions:

$$T_{e,i,t} = \alpha + \beta_1 \text{Crisis}_t + \beta_2 \text{Exp}_{e,b} + \beta_3 \text{Crisis}_t \times \text{Exp}_{e,b} + \varepsilon_{e,i,t}$$  \hspace{1cm} (2)

where $T_{e,i,t}$ is either a dummy variable taking value one if parent bank $b$ has a claim on branch $e$’s assets in period $t$, or the size of the intrafirm transfer of parent bank $b$ to branch $e$ at time $t$. The other variables have been defined above.

The results are reported in Table 3, and show that at the onset of the European Sovereign debt crisis, both the intensive and the extensive margin of the intrafirm transfer between parent and branch are affected for those conglomerates whose parent is exposed to GIIPS debt. The probability that a US branch receives an intrafirm transfer from the exposed parent increases, and also the amount of the transfer increases.

So we have a drop in assets in US branches accompanied by a transfer of resources from the already exposed European parents to their branches. In order to shed light on this apparent puzzle, we examine the funding side of US FBOs’ balance sheets. To do so, we run regressions of deposits
on a set of dummies analogous to the ones used previously:

\[ d_{e,b,t} = \alpha + \beta_1 \text{Crisis}_t + \beta_2 \text{Sub}_e + \beta_3 \text{Exp}_{e,b} + ... \]

\[ \gamma_1 \text{Crisis}_t \times \text{Sub}_e + \gamma_2 \text{Crisis}_t \times \text{Exp}_{e,b} + \gamma_3 \text{Crisis}_t \times \text{Exp}_{e,b} \times \text{Sub}_e + \delta_b + \varepsilon_{e,i,t} \quad (3) \]

where \( d_{e,i,t} \) is the log of total deposits of entity \( e \) at time \( t \). We run two separate regressions for wholesale uninsured deposits, which are held by both branches and subsidiaries, and retail insured deposits, which are only accepted by subsidiaries.\(^\text{10}\) The results are shown in Table 4. Wholesale deposits in branches owned by exposed parents suffered a large and significant decline with respect to those in subsidiaries owned by exposed parents. At the same time, retail deposits in exposed subsidiaries do not fall.

The results of this analysis depict a scenario where distress among some European parents was

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\(^{10}\)Deposits in subsidiaries are classified as retail if they are under the FDIC threshold: $100,000 until 2005 and $250,000 thereafter. Wholesale deposits are those above the FDIC threshold, and deposits in branches are all considered wholesale. The reason for running separate regressions is that the nature of the deposits is substantially different across types. Current regulations, as described above, prevent foreign branches to accept insured retail deposits while subsidiaries may accept insured retail deposits and wholesale deposits.
Table 3: Intensive and Extensive Margin of Intrafirm Transfers between European Parents and their US Branches.

<table>
<thead>
<tr>
<th></th>
<th>prob($T &gt; 0$)</th>
<th>$T$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crisis</td>
<td>0.024</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>(0.045)</td>
<td>(0.377)</td>
</tr>
<tr>
<td>Exp</td>
<td>-1.06***</td>
<td>-8.014***</td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(0.536)</td>
</tr>
<tr>
<td>Crisis × Exp</td>
<td>1.324***</td>
<td>15.15***</td>
</tr>
<tr>
<td></td>
<td>(0.096)</td>
<td>(0.791)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.631***</td>
<td>-0.955***</td>
</tr>
<tr>
<td></td>
<td>(0.03 )</td>
<td>(0.255)</td>
</tr>
</tbody>
</table>

No. of Obs. 4732 4372

$R^2$ 0.068 0.094

Table 4: Intensive Margin of retail deposits vs. wholesale deposits.

<table>
<thead>
<tr>
<th></th>
<th>Retail</th>
<th>Wholesale</th>
</tr>
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<tbody>
<tr>
<td>Crisis</td>
<td>0.378***</td>
<td>0.968***</td>
</tr>
<tr>
<td></td>
<td>(0.063)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>Sub</td>
<td></td>
<td>3.569***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.083)</td>
</tr>
<tr>
<td>Exp</td>
<td>1.755***</td>
<td>1.429***</td>
</tr>
<tr>
<td></td>
<td>(0.657)</td>
<td>(0.464)</td>
</tr>
<tr>
<td>Crisis × Sub</td>
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<td>-1.235***</td>
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<tr>
<td></td>
<td></td>
<td>(0.107)</td>
</tr>
<tr>
<td>Crisis × Exp</td>
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<td>-0.321***</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(0.112)</td>
</tr>
<tr>
<td>Crisis × Sub × Exp</td>
<td>1.026***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.181)</td>
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<tr>
<td>Constant</td>
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<td>15.55***</td>
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<tr>
<td></td>
<td>(0.376)</td>
<td>(0.22)</td>
</tr>
<tr>
<td>bank FE</td>
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<td>YES</td>
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No. of Obs. 1136 4065

$R^2$ 0.116 0.376
associated with a flight of uninsured deposits in their foreign branches in the US. The reaction of the funding side of branches has the effect of changing the direction of intrafirm banking flows: foreign branches appeared to be a source of funding to their parents until 2011, while after the crisis parents acted as a source of funding to their branches. This evidence indicates that foreign branches appear to transmit shocks across countries more than subsidiaries, whose institutional arrangements have the effect of isolating them from potential distress affecting their parents.

In the next section we introduce a structural model of foreign banking that is consistent with the institutional features of the foreign banking sector in the US and with the empirical evidence presented up to here.

3 A 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 with its own features. Our model is a monopolistically competitive extension of the Monti-Klein model (see Klein, 1971, and Monti, 1972), augmented to include risky loans and capital requirements, and aggregated to an industry equilibrium with heterogeneous banks. The model enables us to understand 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. In addition, each bank may open an affiliate in the other country, either as a branch or as a subsidiary, so becoming the parent of a multinational bank.

We first model the maximization problem of a bank conditional on its international status: national bank (N), parent (PS) + subsidiary (S), parent (PB) + branch (B). Once the tradeoffs driving optimal banks’ decisions conditional on status are well understood, we model selection into international status. A bank enters the foreign market if by doing so it makes higher profits than from operating only domestically.
When the economy starts, each bank is endowed with a common amount of equity $E_0$. In the domestic market, each bank offers one-period loans ($L$), which with a certain probability of default ($1 - p$) may be delinquent and not repay the principal. Each bank also accepts deposits ($D$), and borrows/lends in the interbank market ($M$). We assume that each bank has market power in the loans market, originating from some kind of differentiation (spatial or product). This differentiation, together with customers’ love for variety of banking products (to be specified later) is the rationale for the coexistence of many banks in the economy. Banks are heterogeneous in the efficiency with which they manage their activities, and operate under monopolistic competition in both the loans and the deposits market. For simplicity, the interbank market is 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.

During each period, banks need to pay a cost to manage deposits and loans described by the convex cost function $a \cdot C(D, L)$. The bank-specific efficiency parameter $a$ is the source of heterogeneity across banks, and it affects the management cost function multiplicatively, so that “low $a$” banks are more efficient than “high $a$” banks. In addition, banks that accept retail 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 $f_p$ 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 $IP$ is given by:

$$IP = f_p \cdot (L + 1_{M>0}M - E) \approx f_p \cdot D$$

where the last term comes from the bank’s resource constraint (see below). The assessment rates $f_p$ used range from 0.025% to 0.45% of total assets, and are reported in Table 5.

<table>
<thead>
<tr>
<th>Assessment Rate</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Total</th>
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</thead>
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<tr>
<td></td>
<td>2.5</td>
<td>9</td>
<td>18</td>
<td>30</td>
<td>2.5</td>
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<td></td>
<td>5</td>
<td>24</td>
<td>23</td>
<td>45</td>
<td>45</td>
</tr>
</tbody>
</table>

Table 5: FDIC assessment rates by risk categories, in basis points. Source: https://www.fdic.gov/deposit/insurance/assessments/proposed.html.

Finally, banks are subject to capital requirements every period, i.e. there is a lower bound on

---

$^{11}$Initial equity could also differ across banks, but this would not affect the qualitative results of the model. Over time, equity accumulation is related to bank efficiency: more efficient banks accumulate equity faster. A common initial equity does not affect the accumulation pattern and reduces the set of parameters to be calibrated.
the capital ratio that they are allowed to sustain:

\[
\frac{E}{\omega_L L + \omega_M \mathbb{1}_{\{M \geq 0\}} M} \geq k
\]  

(4)

where the value of \( k \) is set in the US under the Basel II/ Basel III regulations. The parameters \( \omega_L \) and \( \omega_M \) are appropriate weights that reflect the riskiness of loans and investment. These weights are determined by the regulatory agencies (in the US case, by the Federal Reserve, FDIC, and Office of the Comptroller of the Currency).\(^\text{12}\)

When a bank enters the Foreign market, it transfers his efficiency \( 1/a \) to the new affiliate. Entering the Foreign market involves a fixed 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, holds independent equity, and it is subject to capital requirements on its own. 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. Branches do not raise independent equity and they are not subject to capital requirements. In the data, parent banks and subsidiaries can accept all kinds of deposits (both wholesale and retail), while branches only accept wholesale deposits and they are not subject to deposit insurance. For simplicity, in the model we assume that parent banks and subsidiaries only hold insured deposits, while branches only hold uninsured deposits. Following Egan et al. (2015), we assume that the supply of uninsured deposits is less elastic than the supply of insured deposits, and that uninsured deposits are sensitive to some measure of “distress” of the banking corporation, while insured deposits are not.

Finally, there exists 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.

\(^{12}\)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 equilibrium interest rates equal across markets.
3.2 National Banks

A national bank chooses the optimal amounts of loans $L$, interbank activity $M$, and deposits $D$ to maximize its profits:

$$\max_{L,D,M} \quad pr_L(L) \cdot L - (1 - p)L + r_M M - r_D(D) \cdot D - aC(D, L) - f_p \cdot D$$

s.t. $E + D \geq L + M$ (resource constraint)

$$\frac{E}{\omega_L L + \omega_M 1_{(M \geq 0)} M} \geq k$$ (capital requirement)

where $r_L(L)$ denotes a downward sloping demand for loans, and $p$ is the probability of loan repayment. $r_D(D)$ is an upward sloping supply of insured deposits, while $r_M$ is the interbank rate, which the bank takes as exogenous, but is endogenously determined in industry equilibrium. Each bank maximizes the profits generated by its activities subject to two constraints. First, assets must not exceed liabilities (the resource constraint). Second, equity over risk-weighted assets must be above a given threshold that the regulators establish (the capital requirement $k$). The weights $\omega_L$ and $\omega_M$ are also set by the regulators and are meant to quantify the different degrees of riskiness of the different assets in the banks’ balance sheets.

In “normal times”, we observe in the data that banks choose to operate with a buffer on their capital requirements, i.e., capital requirements are normally not binding. For this reason, we solve the model in “normal times” assuming that the resource constraint binds, while the capital requirement does not. We refer to this solution of the model as the “unconstrained equilibrium”. The unconstrained equilibrium is characterized by an interior solution for $(L, D)$, described by the following first-order conditions:

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

$$[D] \quad \left( \frac{\partial r_D(D)}{\partial D} + r_D(D) \right) + a \frac{\partial C}{\partial D} + f_p = r_M$$

while the resource constraint pins down interbank activity: $M = E + D - L$.

The first order conditions are intuitive. A bank chooses the optimal amount of loans such that the marginal revenue from loans is equal to the marginal cost of loans management plus the expected marginal loss from delinquent loans plus the opportunity cost of alternatives forgone, namely loans to other financial institutions in the interbank market. Similarly, deposits are set
such that their “total” marginal cost, inclusive of management cost and insurance premium, is
equal to the return from lending funds in the interbank market.

To get closed-form solutions for the variables of interest, we make a few additional parametric
assumptions. We assume a constant elasticity loan demand function: \( L(r_L) = r_L^{-\varepsilon} A \), where \( \varepsilon > 1 \)
is the elasticity of loan demand, and \( A \) is a parameter describing the aggregate size of the loans
market. Similarly, we assume a constant elasticity deposit supply function: \( D(r_D) = r_D^{\vartheta} B \), where
\( \vartheta > 0 \) is the elasticity of deposit supply, and \( B \) is a parameter describing the aggregate size of the
deposits market. For tractability, we also assume a linear separable management cost function:
\( C(D, L) = c_L L + c_D D \) where \( c_L, c_D > 0 \). Under these assumptions, loans and deposits in the
unconstrained equilibrium are given by:

\[
L_N^u = \left\{ \frac{\varepsilon}{p(\varepsilon - 1)} [(1 - p) + r_M + ac_L] \right\}^{-\varepsilon} A \quad (6)
\]

\[
D_N^u = \left\{ \frac{\vartheta}{(\vartheta + 1)} [(r_M - ac_D - f_P)] \right\}^\vartheta B, \quad (7)
\]

while a bank’s maximal profits are:

\[
\pi_N = r_M E + H_1(\varepsilon, p) [(1 - p) + r_M + ac_L]^{1-\varepsilon} A + H_2(\vartheta)(r_M - ac_D - f_P)^{1+\vartheta} B \quad (8)
\]

where \( H_1(\cdot) \) and \( H_2(\cdot) \) are functions of model parameters only. Hence optimal banks’ profits are
increasing in bank efficiency \( 1/a \) and in the bank’s equity \( E \).

Shocks to the economy may induce situations where the capital constraint of a national bank
is binding. We will refer to this scenario as “stressful times”. During stressful times, banks’ choose
the profit-maximizing levels of assets and liabilities subject to a binding capital requirement.

The constrained equilibrium has two possible configurations, depending on whether the bank
borrows or lends in the interbank market. We present these below.

1. **Constrained equilibrium with interbank lending.**

   If the bank is a lender in the unconstrained equilibrium \( M_N^u > 0 \), it could be also a lender
   in the constrained one. In this scenario, both customer loans and interbank loans enter the
   expression for risk-weighted assets, so that \( M_N^c = \frac{E}{\omega_M k} - \frac{\omega_L}{\omega_M} L_N^c \). Deposits adjust to clear the
resource constraint: \( D^c_N = \left( 1 - \frac{\omega_L}{\omega_M} \right) L^c_N - \left( 1 - \frac{1}{\omega_M k} \right) E \)

while constrained loans solve:

\[
L^c_N = \left\{ \frac{\varepsilon}{p(\varepsilon - 1)} \left[ (1 - p) + \frac{\omega_L}{\omega_M} r_M + acL + (ac_D + f_p) \left( 1 - \frac{\omega_L}{\omega_M} \right) + \ldots \right] \right\}^{-\varepsilon} A. \quad (9)
\]

If the resulting \( M^c > 0 \), these conditions characterize the constrained equilibrium. Otherwise, the constrained equilibrium will be one with interbank borrowing (see below).

2. Constrained equilibrium with interbank borrowing.

If the constrained equilibrium found above is inconsistent, or if the bank is a borrower in the unconstrained equilibrium, it will be a borrower also in the constrained equilibrium.

Under this scenario, the amount of loans is the maximum that the capital requirement allows:

\[
L^c_N = E/(\omega_L k), \quad (10)
\]

deposits remain at their unconstrained value, \( D^c_N = D^u_N \), while interbank borrowing clears the resource requirement:

\[
M^c_N = D^c_N + \left( 1 - \frac{1}{\omega_L k} \right) E. \quad (11)
\]
3.3 The Parent-Subsidiary Pair

Given that foreign-owned subsidiaries are *de facto* US banks, a parent-subsidiary pair solves virtually the same profit maximization problem as a national bank in each market in which it operates:

\[
\max_{L, D, M} \quad pr_L(L) \cdot L - (1 - p) L + r_M M - r_D(D) \cdot D - aC(D, L) - f_p \cdot D + ...
\]

\[
p^* r^*_L(L^*) \cdot L^* - (1 - p^*) L^* + r^*_M M^* - r^*_D(D^*) D^* - ...
\]

\[
aC(D^*, L^*) - f_p \cdot D^* - F_s
\]

where asterisks denote foreign market variables. The problem of a parent of a subsidiary is identical to the problem of a national bank except for the fact that – upon establishing the subsidiary – a transfer of equity \( s_E E \) is made in order for the subsidiary to have some initial capital. Subsequently, the two entities accumulate equity independently. Notice that operating a foreign subsidiary also entails a fixed cost \( F_s > 0 \). Initial equity of the subsidiary is written sloppily in the problem.

Given that the country-level profit functions associated with the two entities forming the pair are identical, the equilibrium for each entity of a parent-subsidiary pair takes the same exact form as the equilibrium for a national bank, with the appropriate equity levels, both in the unconstrained and in the constrained case.

3.4 The Parent-Branch Pair

When a parent bank enters the Foreign market with a branch, the possibility of intrafirm transfers between parent and branch and the aggregate capital requirement link the decisions of the two entities. A parent-branch pair solves:
\[
\max_{L,D,M,T} \quad pr_L(L) \cdot L - (1-p) L + r_M M - r_D(D) \cdot D - aC(D, L) - f_p \cdot D + \\
\ldots p^* r^*_L(L^*) \cdot L^* - (1-p^*) L^* + r^*_M M^* - r^*_D(D) \cdot D^w \left( \frac{E}{k \cdot RWA} \right) \cdot D^w + \\
\ldots - aC(D^w, L^*) - F_B
\]  

\[
s.t. \quad E + D \geq L + M + T \]
\[
D^w + T \geq L^* + M^*
\]
\[
\frac{E}{\omega_L(L + L^*) + \omega_M 1_{(M + M^*) \geq 0}(M + M^*)} \geq k
\]

where \(F_B > 0\) is the fixed cost of operating a foreign branch, and \(T\) is the intra-firm transfer between parent and branch (\(T > 0\) when the parent is lending to the branch).

The profit function reflects the institutional restrictions that make branches different from national banks and subsidiaries. Branches do not raise independent equity and they are subject to capital requirements only at the level of the entire conglomerate. Moreover, on the liabilities side, they can only accept uninsured wholesale deposits. The term \(r^*_w(D^*_w; (E/k \cdot RWA))\) is the supply of wholesale deposits. We rely on the estimates of Egan et al. (2015) and assume that the demand for uninsured, wholesale deposits is less elastic than the one for insured retail deposits, and that wholesale deposits are sensitive to some measure of “distress” of the banking organization.

Our model-based measure of distress is inversely related to the buffer in the capital requirement that banks hold in normal times, given by equity over risk-weighted assets (RWA) divided by the capital requirement \(k\). When \(\frac{E}{k \cdot RWA} = 1\), the capital requirement is binding and the bank experiences maximum distress. Distress decreases as \(\frac{E}{k \cdot RWA}\) grows bigger than one. Based on these assumptions, we choose the following functional form for the demand of uninsured deposits:

\[
D^*_w = (r^*_w)_{D^*_w} \vartheta \log \left( \frac{E}{k \cdot RWA} \right) B
\]

where \(\vartheta < \vartheta\) is the elasticity of uninsured deposits. This functional form implies that the quantity of deposits supplied falls as the buffer on the capital requirement decreases, and that there is a complete deposits flight \((D^*_w = 0)\) when the capital requirement is binding.

Due to this higher riskiness compared to safe retail deposits, the interest rate on wholesale deposits is higher than the one paid by banks and subsidiaries on retail deposits. More precisely,
we assume that overall wholesale deposits are costlier than retail deposits \( r^*_D > r^*_D + f_p \) (the interest rate on wholesale deposits is higher than the rate on retail deposits plus the insurance premium).

The parent-branch pair equilibrium is complicated by the fact that the problems of the two entities must be solved jointly, and that the conglomerate must keep into account how each variable affects the aggregate capital requirement. The presence of the intrafirm transfer \( T \) implies that the conglomerate is subject to a unique resource constraint: \( M + M^* = D + D^*_w - L - L^* \). Activities in the interbank market in each country are perfect substitutes, so based on the values of \( r_M \) and \( r^*_M \) the conglomerate decides in which country to borrow or lend and possibly transfers resources across countries through the intrafirm transfer.

Deposits and loans solve:

\[
\begin{align*}
p(\varepsilon - 1) \left( \frac{1}{\varepsilon} A^{\frac{1}{\varepsilon}} - 1 \right) &= \frac{\vartheta_D}{1 + \frac{\vartheta_D}{1 + \vartheta_w}} \frac{1}{\vartheta_w} \left[ \log \left( \frac{E}{k \cdot RW A} \right) \right]^{\frac{1 + \vartheta_D}{\vartheta_w}} \cdot \frac{\vartheta_D - (M + M^*) \geq 0}{\vartheta_M} \frac{\vartheta_D}{RW A} \\
p^*(\varepsilon - 1) \left( \frac{1}{\varepsilon} A^{\frac{1}{\varepsilon}} - 1 \right) &= \frac{\vartheta_D}{1 + \frac{\vartheta_D}{1 + \vartheta_w}} \frac{1}{\vartheta_w} \left[ \log \left( \frac{E}{k \cdot RW A} \right) \right]^{\frac{1 + \vartheta_D}{\vartheta_w}} \cdot \frac{\vartheta_D - (M + M^*) \geq 0}{\vartheta_M} \frac{\vartheta_D}{RW A} \\
\frac{\vartheta_w + 1}{\vartheta_w} D_{w}^{\frac{1}{\vartheta_w}} \left[ \log \left( \frac{E}{k \cdot RW A} \right) \right]^{\frac{1}{\vartheta_w}} B^{\frac{1}{\vartheta_w}} &= \frac{\vartheta_D}{1 + \frac{\vartheta_D}{1 + \vartheta_w}} \frac{1}{\vartheta_w} \left[ \log \left( \frac{E}{k \cdot RW A} \right) \right]^{\frac{1 + \vartheta_D}{\vartheta_w}} \cdot \frac{\vartheta_D - (M + M^*) \geq 0}{\vartheta_M} \frac{\vartheta_D}{RW A}
\end{align*}
\]

where \( RW A = \omega_L (L + L^*) + \omega_M 1_{(M + M^*) \geq 0} (M + M^*) \) and \( \bar{r} = r_M \) if \( r_M \geq r^*_M \) and the conglomerate is lending or if \( r_M < r^*_M \) and the conglomerate is borrowing, otherwise \( \bar{r} = r^*_M \).

As in the case of national banks, the constrained equilibrium has two possible configurations, depending on whether the conglomerate borrows or lends in the interbank market. We present those below.

1. **Constrained equilibrium with interbank lending.**

   If the conglomerate is a lender in the unconstrained equilibrium, it could be also a lender in the constrained one. In this scenario, both customer loans and interbank loans enter the expression for risk-weighted assets, so that total interbank market activity is given by:

\[
M + M^* = \frac{E}{\omega_M k} - \frac{\vartheta_D}{\vartheta_M} (L + L^*).
\]
The binding capital requirement drives the flight of branches’ wholesale deposits: \( D^*_w = 0 \), while retail deposits adjust to clear the resource constraint:

\[
D = \left(1 - \frac{\omega L}{\omega M}\right) (L + L^*) - \left(1 - \frac{1}{\omega M k}\right) E. \tag{20}
\]

Constrained loans solve the remaining first-order conditions, the conglomerate does all interbank lending in the country where \( r_M \) is higher and transfers intrafirm the funds it needs to clear the resource constraint in each market.

If the resulting \( (M^c + M^{*c}) > 0 \), the equations above characterize the constrained equilibrium. Otherwise, the constrained equilibrium will be one with no interbank activity (see below).

2. Constrained equilibrium with interbank borrowing.

If the constrained equilibrium found above is inconsistent, or if the conglomerate is a borrower in the unconstrained equilibrium, the conglomerate is a borrower in the constrained equilibrium.

Under this scenario, the total amount of loans is the maximum that the capital requirement allows:

\[
L + L^* = E/(\omega_L k), \tag{21}
\]

the parent’s retail deposits remain at their unconstrained value, while the binding capital requirement drives the flight of branches’ wholesale deposits: \( D^*_w = 0 \). Interbank borrowing clears the aggregate resource constraint:

\[
M + M^* = \left(1 - \frac{1}{\omega_L k}\right) E + D + D^*_w. \tag{22}
\]

The conglomerate does all interbank borrowing in the country where \( r_M \) is lower and transfers intrafirm the funds it needs to clear the resource constraint in each market.

3.5 Industry Equilibrium and Equity Accumulation

Each country is populated by continuum of banks, who draw their bank-specific efficiency \( 1/a \) from the exogenous distributions \( F(a), F^*(a) \). Selection into foreign market implies that there are endogenous, equilibrium distributions of banks operating in a country, which we denote with \( G(a), G^*(a) \).
The interest rates on the interbank market are given by market clearing, so $r^M$ and $r^{M^*}$ are such that:

\begin{align}
\int M(a)G(a)da &= 0 \quad \text{(23)} \\
\int M^*(a)G^*(a)da &= 0 \quad \text{(24)}
\end{align}

All banks start with the same level of equity $E_0$, and accumulate equity over time through reinvested profits:

$$E_{t+1} = E_t + \pi_t.$$ \hfill (25)

Finally, banks exit the market if they reach negative equity: if $E_t < 0$ for a national bank or for the parent of a conglomerate, the entire bank shuts down, while if $E_t < 0$ for a subsidiary, only the subsidiary shuts down.

### 3.6 Selection: Matching Cross-Sectional Facts

The simple model developed in this section is a useful tool to understand the tradeoffs that banks face when entering foreign markets. The combination of bank-level efficiency with fixed and variable costs of operation delivers selection of individual banks into the three possible international/organizational statuses: national banks, parent + subsidiary pairs, and parent + branch pairs.

The fixed costs associated with foreign operations imply that the most efficient and large banks become multinational banks, consistently with what we observe in the data (see Figure 2) and with the features of multinational corporations in other sectors (see Bernard et al. (2009)). For the model to generate selection by size across the different organizational modes of multinational banking, we need to impose some relationship between the fixed versus variable costs of branching versus subsidiarization. Particularly, one obtains selection of the most (least) efficient and biggest (smallest) global banks into subsidiarization (branching) if subsidiarization is associated to lower variable costs but higher fixed costs than branching (see Figure 7).

To achieve this result, we do two things. First, we assume that the fixed cost associated with operating a foreign subsidiary is higher than the fixed cost associated with operating a foreign branch: $F_S > F_B$. Second, we parameterize the deposit supply in such a way that – keeping the
amount of deposit constant – wholesale deposits command interest rates that are higher than the interest rates on retail deposits plus the deposit insurance premium: \( r_{D}^{*\text{w}} > r_{D}^{*} + f_{p} \).

Under these restrictions, it is immediate to show that the profit functions of the parent/subsidiary pair and of the parent/branch pair are increasing in bank efficiency \( 1/a \), with the parent/subsidiary pair having a lower intercept (due to higher fixed cost) but a higher slope (due to the lower marginal cost of deposits). As a result the model delivers selection of the most efficient banks into global banks, and among global banks the most (least) efficient ones operate in the foreign market through subsidiaries (branches).

In the model, differences in efficiency directly translate into differences in the size of deposits, loans, and overall assets. The first-order conditions imply that more efficient banks issues more loans, accept more deposits, and have overall more assets than less efficient banks. Coupled with selection by efficiency into different modes of entry, the model is consistent with the stylized facts we observe in the data: foreign subsidiaries are larger than foreign branches in terms of loans, deposits, and overall assets.
4 Numerical Analysis (in progress)

In this section, we give quantitative content to the model in order to make it amenable for counterfactual analysis. We start by calibrating the model so that it is consistent with the cross-sectional stylized facts that we reported in Section 2. The calibrated model is a good description of the foreign banking sector in the US, and it is able to reproduce the differential response of global banks with different organizational structure to the shock we studied empirically, the European sovereign debt crisis. To answer a set of policy-relevant questions, we perform a series of counterfactual exercises that shed light on the strength and weaknesses of the current regulation.

4.1 Calibration

Our calibration exercise proceeds in three steps. First, a subset of the parameters of the model can be directly matched to empirical observations or to previous studies. Second, we use the empirical distributions of loans and deposits to calibrate the banks’ efficiency distribution and the loans elasticity of demand. Third, we use the model to jointly calibrate the remaining parameters by matching some moments of interest.

We calibrate directly the parameters $p$, $f_p$, $k$, $\omega_L$, $\omega_M$, and $s_E$.

In our model, one minus the probability of loan repayment is equivalent to the bank expected loss per dollar, which in turn is given by the probability of default times loss given default (one minus the recovery rate). The recovery rate is calibrated to a standard value of 40%, which in case of default implies $(1 - p) = 0.4$. In times of no default, we calibrate the probability of default to a baseline value of 2.5%. This is an approximate middle-range measure based on estimated probabilities of default on sovereign debt for institutions with credit ratings varying from AAA to BB.\textsuperscript{13} Based on these observations, we set the probability of loan repayment (in normal times) to 0.99, and we consider scenarios of distress where it can drop down to 0.6.

We quantify the insurance premium $f_p$ following the FDIC assessment rates described in Table 5.\textsuperscript{14} Assessment rate vary from 0.025% to 0.45%, so we choose a value in the middle of this range: $f_p = 0.2\%$.

We set the capital requirement to $k = 0.08$. This can be interpreted by the average capital

\textsuperscript{13}Source: http://www.newyorkfed.org/research/staff_reports/sr190.pdf.
\textsuperscript{14}Data source: https://www.fdic.gov/deposit/insurance/assessments/proposed.html.
Table 6: Direct Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Value</th>
<th>Source</th>
</tr>
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<tbody>
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<td>$p$</td>
<td>prob. of loan repayment</td>
<td>0.99, 0.6</td>
<td>World Bank</td>
</tr>
<tr>
<td>$f_p$</td>
<td>insurance premium</td>
<td>0.002</td>
<td>FDIC</td>
</tr>
<tr>
<td>$k$</td>
<td>capital requirement</td>
<td>0.08</td>
<td>Basel II/III</td>
</tr>
<tr>
<td>$\omega_L, \omega_M$</td>
<td>weights for RWA</td>
<td>1, 0.2</td>
<td>Basel II/III</td>
</tr>
<tr>
<td>$s_E$</td>
<td>subsidiary’s equity share</td>
<td>0.06</td>
<td>Call Reports</td>
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</tbody>
</table>

requirement of 5%, as set by the Basel II/Basel III regulation, augmented by a surcharge for large institutions. The Basel II/Basel III regulation also gives guidelines on the weights used to compute risk-weighted assets: we choose $\omega_L = 1$ based on corporate, retail, and residential mortgage exposures, and $\omega_M = 0.2$ based on exposures to U.S. depository institutions and credit unions.\(^{\text{15}}\)

Finally, in the model we assume that subsidiaries’ initial equity is provided by a transfer from the parent. We quantify the magnitude of this transfer by comparing subsidiaries’ equity with the parent’s equity, and set $s_E = 0.06$. Table 6 summarizes the parameters that we calibrate directly.

We draw from methods commonly used in the quantitative trade literature to calibrate the efficiency distribution of banks and the elasticity of loan demand. The large concentration and skewness of the banks’ size distribution suggests that it can be well approximated by a Pareto distribution. We start by assuming that bank efficiency $1/a$ is distributed Pareto with shape parameter $\phi$. The implied size distributions of interest revenues from loans and interest expenses on deposits are then also well approximated by Pareto distributions with shape parameters $\phi/(\varepsilon - 1)$ and $\phi/(1 + \vartheta)$, where $\varepsilon$ is the elasticity of loan demand and $\vartheta$ is the elasticity of retail deposit supply.\(^{\text{16}}\) Under the Pareto assumption, the size distribution can be estimated empirically as a log-linear relationship between the rank of a bank in the size distribution (with smaller numbers associated to bigger banks) and its size.

Figure 8 plots the log-rank versus log-size relationship for interest revenues from loans and interest expenses on deposits held by European parents of foreign owned U.S.-based subsidiaries and branches in the fourth quarter of 2013. The plots appear linear for a big portion of the size range, supporting the use of Pareto distributions. Given that we cannot separately identify the efficiency dispersion parameter $\phi$ from the elasticity parameters $\varepsilon$, $\vartheta$, and $\vartheta_w$, we take values for the elasticities of deposit supply from Egan et al. (2015) and set $\vartheta = 0.56$ and $\vartheta_w = 0.16$. Then

\(^{\text{15}}\)Data source: http://www.usbasel3.com/tool/.

\(^{\text{16}}\)Appendix B discusses this approximation.
we use the slope of the log-rank versus log-size relationship for deposits to identify $\phi$: since we find $\phi/(1+\vartheta) = 0.43$, then $\phi = 0.67$. Finally, we use the slope of the log-rank versus log-size relationship for loans together with the estimated value of $\phi$ to identify $\varepsilon$: since we find $\phi/(\varepsilon - 1) = 0.46$, then $\varepsilon = 2.46$.\footnote{Notice that the estimated value of $\phi$ implies an efficiency distribution with infinite mean.} Table 7 summarizes this portion of the calibration.

It remains to calibrate the parameters of the management cost function $c_L$, $c_D$, the aggregate parameters of loan demand and deposit supply, $A$ and $B$, the fixed entry costs $F_S$, $F_B$, and the common initial equity $E_0$. These are parameters that we cannot directly match to magnitudes in the data, so we use the model to choose values for these parameters such to match some relevant moments from the data. We choose the following set of target moments:

1. average buffer on capital requirement;

Table 7: Calibration from Size Distributions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\vartheta$</td>
<td>elasticity of loan demand</td>
<td>2.46</td>
<td>Estimation of loans size distrib.</td>
</tr>
<tr>
<td>$\vartheta_w$</td>
<td>elasticity of retail dep. supply</td>
<td>0.56</td>
<td>Egan et al. (2015)</td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>elasticity of wholesale dep. supply</td>
<td>0.16</td>
<td>Egan et al. (2015)</td>
</tr>
<tr>
<td>$\phi$</td>
<td>shape param. of efficiency distrib.</td>
<td>0.67</td>
<td>Estimation of deposits size distrib.</td>
</tr>
</tbody>
</table>

Figure 8: Estimating the Size Distributions. Plots of log-rank on log-size for interest expenses on deposits and interest revenues from loans held by European banks in the fourth quarter of 2013. Data source: SNL Financial.
Given that we observe non-binding capital requirements in the data, it is important that the model replicates the existence of a buffer between equilibrium equity over risk-weighted assets and the capital requirement set by the Basel regulation. We compute this buffer as the difference between Tier 1 capital ratios and the regulatory required capital (8%), and set our target to a value of 16%, observed in the data in 2013. This moment is closely tied to the initial equity parameter $E_0$. The average foreign subsidiary in our data has loans equal to 5.48 times the loans of the average branch, and deposit equal to 3.51 times the deposits of the average branch. Moreover, in our data set there are 51 subsidiaries and 181 branches, so subsidiaries account for 22% of FBOs in the US. These moments related to relative size and relative frequency help to pin down the cost parameters $c_L$, $c_D$, $F_S$, and $F_B$. Finally, interest rates are endogenous in the model, but we use some targets from the data to get sensible numbers for them. As a target for the average interest rate on retail deposits, we use the interest rate on one-year CDs, equal to approximately 0.0025. As a target for the average interest rate on wholesale deposits we use LIBOR, equal to approximately 0.006. Finally, when we think about loans we want the model to encompass a variety of products including car loans, mortgages, and credit cards. Targeted rates on loans should then be in the interval 5-20%.

(MATCH STILL IN PROGRESS)

4.2 Counterfactual Analysis

TBA
5 Conclusions

TBA

References


Appendix

A The Regulatory Framework: History and Current Status

TBA

B Derivations and Proofs

TBA