To Branch or not to Branch? A Quantitative Evaluation of the Consequences of Global Banks' Organization*

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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. To explain these facts, we develop a structural model global banking whose assumptions mimic the institutional details of the regulatory framework in the US. The model sheds light on the relationship between market access, regulation, and capital flows, and can be used as a laboratory to perform counterfactual analysis on the effects of alternative regulatory policies.

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."*
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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)
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> *"US units of Deutsche Bank and Santander suffered the ignominy of failing US stress tests yet again this year. Santander's US bank is the first to fail the test three years in a row, (...) meaning Santander cannot access the capital to invest in its bigger businesses in Spain, Brazil and Britain. And it cannot even draw a dividend from the unit in the meantime because of Fed stipulations."* (Reuters, June 30th 2016)

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. Several 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 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 regulation and management efficiency. This feature allows us to assess whether the mode of entry matters

[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 (2015, 2016).

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 the extent of 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 subsidiaries. The existing banking regulation treats branches and subsidiaries differently, so that the 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 in the home country. 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] The regulatory oversight of foreign subsidiaries and branches varies across jurisdictions, and may happen both in the home and in the host country.[4] Starting in July 2016, changes in the regulation of Foreign Banking Organizations (henceforth, FBOs) have been implemented. These changes are discussed in Appendix A, and do not affect the approach and classification that we use in this paper.

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, banks of different sizes appear to self-select into different modes of foreign operations: the parent banks of foreign subsidiaries are systematically larger than the parent banks of foreign branches. Also at the affiliate level, subsidiaries are larger than branches. These size rankings hold in terms of average deposits, average loans, and average total 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 cri-

[3]Section 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.

[4]Most advanced economies allow both branches and subsidiaries of foreign banks but, for example, New Zealand allows only foreign banks to enter as subsidiaries. Canadian and Italian banks need approval from their home regulator before opening a branch abroad. Branches, in general, do not have capital requirements, as in the United States, but in Argentina, Bolivia, Brazil, Chile, Ecuador, India, and Korea, branches face capital and liquidity charges, just as subsidiaries. Limits on deposit-taking activities by branches are also pervasive. In Canada, branches are restricted from accepting deposits less than $150,000. In Australia, foreign branches are not permitted to accept deposits less than A$250,000 from individuals or non-corporate institutions, in line with the lack of deposit insurance and retail deposits in foreing branches active in the US.

sis, US branches of exposed European banks experienced a flight in their uninsured deposits, while subsidiaries' deposits (both insured and uninsured) grew. The shortage of funding that branches experienced was, at least partially, filled by intrafirm transfers of funds from their parents: the probability that a US branch received an intrafirm transfer from the exposed parent increased, and the amount of the transfer increased too. At the same time, US branches of exposed European banks decreased their assets in the US, while assets increased in exposed US subsidiaries.

In order to confidently use our framework for policy analysis, we model the institutional differences between branches and subsidiaries to describe accurately 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 model features the channels of adjustment that we document in the data, and its simple structure allows us to calibrate it and use it for quantitative analysis. The model is 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, and can be used as a laboratory to perform policy-relevant counterfactual exercises.

Our baseline quantitative exercise is an analysis of the EU sovereign debt crisis through the lens of the model. In the model, the crisis is isomorphic to a sudden drop in the probability of loan repayment in Europe. This reduces European banks' profits and equity accumulation, decreases their equity to risk-weighted assets ratio, and tightens the banks' buffer on capital requirements. What is the effect of this change on the balance sheet of European banks for the operations of their US-based affiliates? We model deposit supply following the empirical evidence reported in Egan et al. (2017): on the one hand, a tightening in global conglomerates' capital reduces the supply of wholesale deposits, a funding shock for US branches. Faced with solvency problems in their foreign branches, EU parents use the internal capital market of the conglomerate to support foreign branches' profitable lending in the US, but foreign branches decrease their US assets nonetheless. On the other hand, foreign subsidiaries' balance sheets are isolated from the shock that affects their parents. As a result, their assets and liabilities are unaffected. The only way for the parent to reduce the effect of the shocks using resources from its foreign subsidiaries' operations is through restructuring, *i.e.* shutting down the affiliate to repatriate the capital invested overseas. Indeed, in our sample, a larger percentage of foreign subsidiaries exit the US market compared with the percentage of branches exiting.

So which form of multinational banking better mitigates the effect of financial shocks? The answer depends on whether the objective is to minimize disruptions to aggregate banking flows or to reduce contagion across countries. Subsidiarization isolates banks' balance sheets by location, hence minimizes contagion. However, by not providing a fluid internal capital market to the conglomerate, it does not provide an effective instrument to dampen the global effect of shocks, resulting in possible reorganizations and exits. Conversely, parent-branch conglomerates can take advantage of their internal capital market and smooth the effect of the shock across countries, and reduce its global impact.

The model is conceptually simple, yet rich in its depiction of the regulatory framework. This feature makes it amenable to counterfactual analysis about potential changes in global banking regulation.

This paper is related to a large empirical literature that studies the role of global banks as vehicles of shock transmission across countries. Goldberg (2009) nicely sets the ground for the discussion of this topic. In a seminal contribution, Peek and Rosengren (2000) have shown the role of US-based branches of Japanese banks in transmitting the effect of the Japanese banking crisis to the US. In a similar spirit, Cetorelli and Goldberg (2011) document a decline in cross-border lending and in lending from foreign affiliates of global banks into emerging economies in the wake of the 2007-2009 financial crisis. Cetorelli and Goldberg (2012a,b) point to the presence of the internal capital markets of global banking conglomerates as a channel that strongly contributed to spread financial shocks during the 2007-2009 crisis. The possibility of parents and branches to transfer funds across borders but within the boundaries of the bank holding company is a feature of primary importance in the framework that we present in this paper.

By presenting stylized facts about the features distinguishing multinational banks from domestic ones, our analysis is also closely related to Claessens et al. (2001) and Niepmann (2016). Goldberg (2016) illustrates the deep complexity underlying the organization of multinational banks' operations through their foreign affiliates. Our structural model simplifies away most of this complexity by focusing on two possible, alternative forms of foreign banking: branching and subsidiarization. In this dimension, our work is related to Cerutti et al. (2007), Dell'Ariccia and Marquez (2010), Fiechter et al. (2011), and Danisewicz et al. (2015). Some of the facts that we report, related to changes in foreign branches' balance sheets in the wake of the European sovereign debt crisis, are present also in Correa et al. (2016). We explicitly compare changes in branches' balance sheets to (the lack of) changes in the balance sheets of subsidiaries.

This paper is related to a small but growing literature using tools from international trade theory to study the operations of multinational banks. The seminal paper by Eaton (1994) sets directions for structural research on this topic, but the first contributions to this agenda are contained in the pioneering work by Niepmann (2016, 2015). While Niepmann (2015) is mostly concerned with identifying the factors that drive bilateral cross-border banking flows at the country-level, our framework shares with Niepmann (2016) the emphasis on banks' heterogeneity within country and on the role of selection to understand aggregate outcomes in the global banking sector. Niepmann (2016) studies the features distinguishing banks that engage in cross-border lending/borrowing from multinational banks. Our analysis focuses on modeling multinational banks' organization through branching *versus* subsidiarization. The role of banks' heterogeneity is also prominent in de Blas and Russ (2013) and Bremus et al. (2013), who show evidence of granularity in the banking sector and carefully model the determination of banks' mark-ups.[5] Finally, this paper shares with Corbae and D'Erasmo (2013) the emphasis on using quantitative analysis to understand features of the banking data.

There has been an increasing concern about the unintended effects of policy actions across borders. Global banks play an important role in the transmission of these effects across borders. Berrospide et al. (2017) conducts an empirical analysis of the spillovers of national banking regulations across borders. They find that tighter banking regulation shifts lending away from countries where the tightening occurs. In particular, subsidiaries and branches of banks domiciled in the tightening country play an important role in the transmission mechanism. A similar argument is made in Ongena et al. (2018), in which they study the transmission of U.S. monetary policy across borders through U.S. global banks' lending abroad. They find evidence consistent with a global bank lending channel.

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.

[5]Banks' mark-ups are constant in our framework to preserve tractability of the bank problem.

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 are 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.[6] 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.[7] 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 56 European banks that are ultimate owners of US-based affiliates. We consolidate at the ultimate owner level all the offices of the same type (i.e., all subsidiaries and all branches). 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 core of our empirical analysis focuses on global banks' response to the European

[6]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 FFIEC 041. The information about domestic operations is identical across reports for all practical purposes.

[7]Form FFIEC 002 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, and they do not have a capital account either. Nonetheless, the US regulatory framework requires foreign owned branches and agencies to report their assets and liabilities in the FFIEC 002 form. Foreign owned branches are not required to report income statement variables.

Sovereign Debt crisis of 2011, we restrict our sample period to 2007-2013.[8]

2.2 The Cross-Section of Foreign Banks

The presence of foreign institutions in the US banking market is substantial. 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 in hands of foreign owned banking offices range from 15% of total deposits to 30% of total commercial and industrial loans (see Figure C.1 in the Appendix for more details).

What are the activities of foreign banking organizations (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, as equity injections, or as capital distributions (dividends). This means that if a parent wants to transfer funds to or from a subsidiary in the US, there is not a fluid internal channel to do so. Equity injections are rare and subject to the home regulator. Dividend distributions are limited by earnings and are typically semiannual. In our data set, we count 47 US-based subsidiaries of foreign banks, with total assets of approximately $1.16tn or 7.1% of all bank assets in the US. Out of these 47 subsidiaries, 17 are ultimately owned by a European bank, with $0.68tn in assets.

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 accepts only non-insured wholesale deposits. Opposite to subsidiaries, branches have the possibility of an intrafirm channel

[8]The 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. For this reason, when presenting long-term trends in the global banking sector in the US, we use a longer sample period, spanning the years 1995-2015. 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.

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 data set there are 182 US-based branches of foreign banks, with total assets of approximately $2.19tn, or 15% of all bank assets in the US. Out of these 182 US-based branches, 62 are ultimately owned by a European bank, with $1.19tn in assets.

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 1 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.[9] Niepmann (2016) presents evidence of a similar pecking order based on bank efficiency (computed as the ratio of overhead costs to total assets). Multinational banks appear to be systematically more efficient than domestic banks. The model that we present in the next section features a positive relationship linking bank efficiency and bank size, to be consistent with both Niepmann (2016)'s observations and with Figure 1. The figure further distinguishes parents of foreign subsidiaries from parents of foreign branches, and shows that parents of foreign subsidiaries are on average larger

[9]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 other foreign markets.

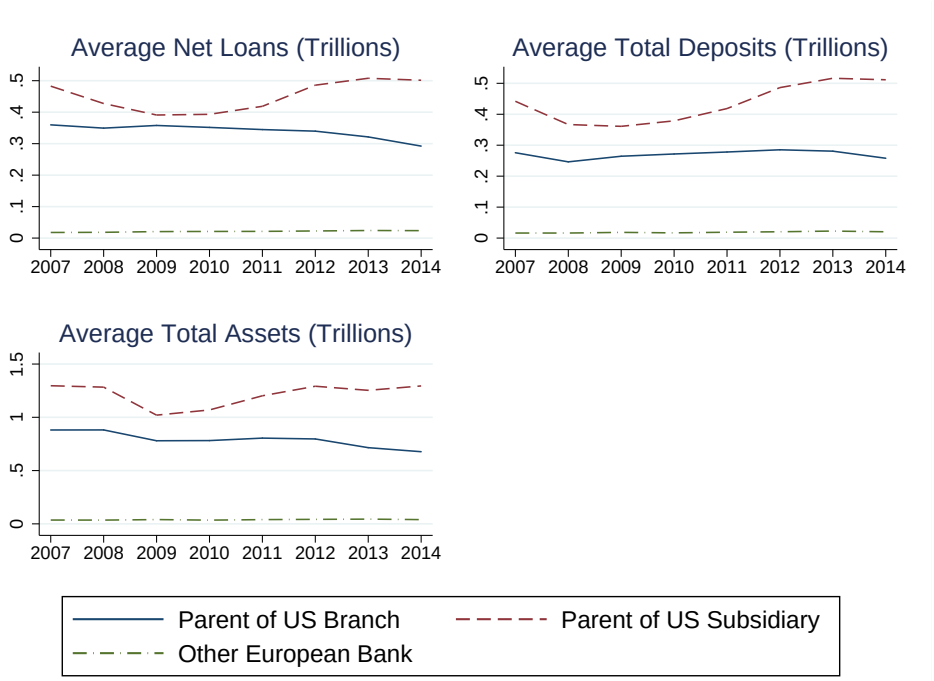

Figure 1: **Foreign Parents vs Foreign National Banks.** Comparison of various size measures of foreign parents of US-based FBOs (subsidiaries and branches) versus foreign banks without overseas operations in the US. Source: SNL data for top tier parents of U.S. branches and subsidiaries from Europe. Data are in trillions of US dollars.

banks compared to parents of foreign branches.

Figure 2 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.

At the affiliate level, there are large size differences between subsidiaries and branches of FBOs. Figure 3 reports the average size of 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[10]. Size differences are persistent over the sample period, and are not driven by a few firms holding extraordinarily large balance sheets: the deposits, loans, and assets size distributions of foreign subsidiaries first-order stochastically dominate the analogous distributions of foreign branches (see Figure C.2 in Appendix

[10]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 deposits, short-term and long-term debt, and owners' equity.

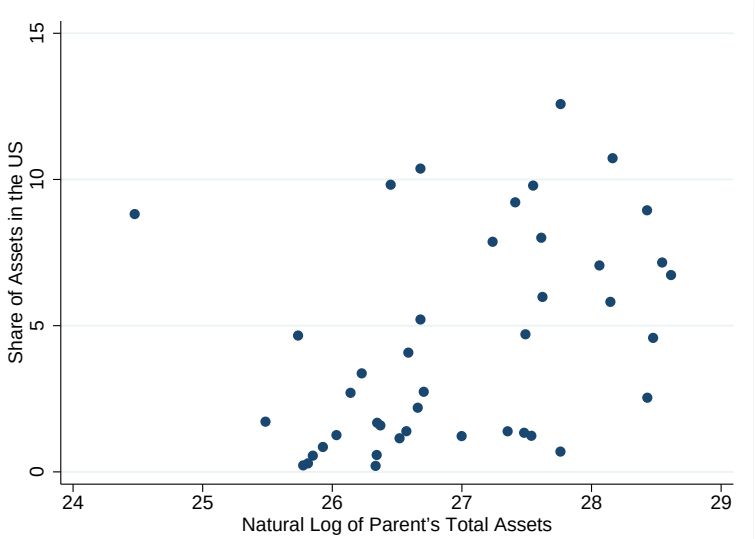

Figure 2: **Size of Domestic versus Foreign Assets.** Share of US assets in a parent's total assets versus the parent's size. Source: SNL data for top tier parents of U.S. branches and subsidiaries from Europe, 2013.

C).

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, larger foreign parents tend to enter the US market by opening subsidiaries while smaller foreign 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 Cetorelli and Goldberg (2012b) and Correa et al. (2016), 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

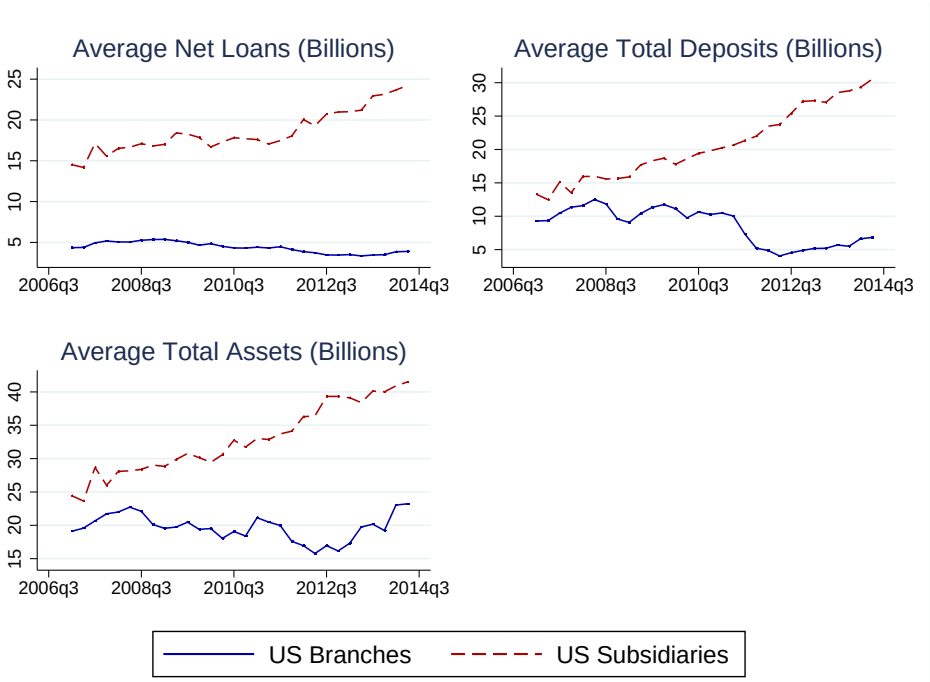

Figure 3: **U.S.-Based Branches and U.S.-Based Subsidiaries of Foreign Banks.** Comparison of various size measures of US-based subsidiaries and branches of foreign banking organizations. Data source: US Structure Data for US Offices of Foreign Banking Organizations - Selected Assets and Liabilities of Domestic and Foreign Owned US Commercial Banks plus US Branches and Agencies of Foreign Banks. Data are in billions of US dollars.

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 Greek, Italian, Irish, Portuguese, or Spanish (GIIPS) sovereign debt holdings above the sample median. For this exercise, we use quarterly data from 2007:Q2 to 2013:Q4. Our results are robust to alternative definitions of exposed banks.[11]

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

$$a^e_{b,t} = \alpha + \beta_1 \text{Crisis}_t + \beta_2 \text{Exp}_b + \beta_3 \text{Crisis}_t \times \text{Exp}_b + \delta_c + \varepsilon^e_{b,t} \quad (1)$$

where $a^e_{b,t}$ is the log of total assets of entity e belonging to bank b at time t. An entity is either a US-based branch or a US-based subsidiary part of a banking conglomerate b. We run the regression separately for branches and for subsidiaries. The variable Crisis_t is a dummy taking value 1 for all years after 2011 (included), while the variable Exp_b is a dummy taking value 1 when parent bank b of entity e is exposed to GIIPS debt. δ_c denotes parent country fixed effects, indicating that the results exploit variation in asset holdings across banks from the same host country and at the same moment in time. The results are reported in Table 1 and show that, after the European sovereign debt crisis, US branches of exposed European banks decrease their assets in the US, while the assets of US subsidiaries of exposed European banks are unaffected.[12]

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. The left panel of Figure 4 shows the evolution of the aggregate net flows to and from related institutions. Throughout the majority of the sample period (until 2011) the amounts that parent banks have been borrowing from their foreign branches

[11] For 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 positive GIIPS sovereign debt holdings, ii) classify a bank as exposed if from a country in the Euro zone. We define exposure using these coarse dummies rather than using directly exposure levels as explanatory variables because exposure to GIIPS sovereign debt holdings is very small as a share of these banks' balance sheets: among exposed parents, the mean exposure is only 3.07% of assets, while the median is 1.7%. For this reason, we don't think that variation in the intensive margin of exposure drives the different responses of banks to the crisis. The chain of events in 2010 resulted in a contagion of fears of sovereign default in the GIIPS countries which at the same time fuelled the concerns about the stability of the Euro and the Euro zone more broadly.

[12] For robustness, we also run the regression pooling branches' and subsidiaries' observations and identifying differential responses to the crisis via triple interaction terms. The results are unchanged. We prefer to present here the results of the two separate regressions to make easier the interpretation of the coefficients of interest.

Table 1: Intensive Margin of Assets, Branches versus Subsidiaries

	ln(Total Assets)	
	Subsidiaries	Branches
Crisis	0.103	0.133
	(0.115)	(0.223)
Exp	1.983***	1.674**
	(0.351)	(0.724)
Crisis × Exp	0.0847	-0.622**
	(0.234)	(0.231)
Country FE	Yes	Yes
No. of Obs.	914	2,683
R^2	0.585	0.288

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. (2016) 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. The right panel of Figure 4 illustrates the intrafirm flows broken down between exposed and non exposed banks. It is evident from the figure that the sign reversal in intrafirm capital flows between parents and branches is mostly due to FBOs whose parents were exposed to the crisis.

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

$$T^e_{b,t} = \alpha + \beta_1 \text{Crisis}_t + \beta_2 \text{Exp}_b + \beta_3 \text{Crisis}_t \times \text{Exp}_b + \delta_c + \varepsilon^e_{b,t} \quad (2)$$

where $T_{e,b,t}$ 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 2, 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 far we documented a drop in assets in US branches accompanied by a transfer of resources

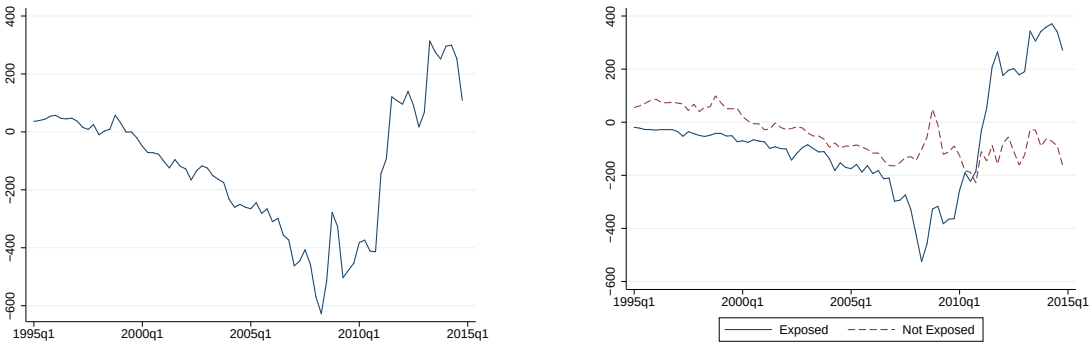

Figure 4: **Net intrafirm flows for foreign branches.** Net due from and net due to related parties. Data source: Report of Assets and Liabilities of US Branches and Agencies of Foreign Banks (FFIEC 002). The items reported here are *Net due from related depository institutions* and *Net due to related 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). All values are expressed in billions.

Table 2: Intensive and Extensive Margin of Intrafirm Transfers between European Parents and their US Branches.

	prob($T > 0$)	T
Crisis	0.283***	1,354
	(0.0522)	(1,301)
Exp	-0.854***	-11,320***
	(0.100)	(3,577)
Crisis × Exp	0.949***	18,315***
	(0.170)	(5,081)
Constant	0.0810***	
	(0.0296)	
Country FE	No	Yes
No. of Obs.	3,000	2,976
R^2	0.0333	0.176

Table 3: Intensive Margin of Wholesale and Retail Deposits, Branches versus Subsidiaries

	Subsidiaries		Branches
	ln(Retail Deposits)	ln(Wholesale Deposits)	ln(Wholesale Deposits)
Crisis	0.403***	0.000503	0.106
	(0.154)	(0.138)	(0.241)
Exp	1.740***	1.581***	2.323***
	(0.469)	(0.421)	(0.309)
Crisis × Exp	0.480	0.189	-1.340***
	(0.312)	(0.283)	(0.346)
Country FE	Yes	Yes	Yes
No. of Obs.	914	906	2,382
R^2	0.454	0.463	0.244

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:

$$d^e_{b,t} = \alpha + \beta_1 \text{Crisis}_t + \beta_2 \text{Exp}_b + \beta_3 \text{Crisis}_t \times \text{Exp}_b + \delta_c + \varepsilon^e_{i,t} \quad (3)$$

where $d^e_{i,t}$ is the log of total deposits of entity e at time t. We run three separate regressions: one for retail insured deposits, which are only accepted by subsidiaries, one for wholesale uninsured deposits held by subsidiaries, and one for wholesale uninsured deposits held by branches.[13]

The results are shown in Table 3. Retail deposits in exposed subsidiaries appear to be unaffected by the crisis. More interestingly, the flight in wholesale deposits that other papers have documented appears to be uniquely due to branches owned by exposed parents, who suffered a large and significant decline. At the contrary, wholesale deposits in subsidiaries owned by exposed parents increase. Other papers[14] documented the flight in wholesale deposits during the European sovereign debt crisis, but highlighted the responsiveness of wholesale deposits without taking into account the organizational form of the banks accepting them. The results shown in Table 3 suggest that the flight interested only those deposits that were into branches, indicating that the less regulated organizational form was perceived as less stable from large wholesale depositors.

[13]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.

[14]See Correa et al. (2016), Egan et al. (2017).

The results of this analysis depict a scenario where distress among some European parents was 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 started acting 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 section. The model is useful to introduce the main trade-offs that a bank faces when deciding whether and how to operate in a foreign country. Banks in the model are active 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 given amount of equity $\bar{E}_0$. 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, 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:

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

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 4.

Table 4: FDIC assessment rates by risk categories, in basis points. Source: https://www.fdic.gov/deposit/insurance/assessments/proposed.html.

	I	II	III	IV	Total
Assessment Rate	2.5 to 9	9 to 24	18 to 23	30 to 45	2.5 to 45

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:

$$\frac{E}{\omega_L L + \omega_M \mathbb{1}_{\{M \geq 0\}} M} \geq k \tag{4}$$

where the value of k is set in the US under the Basel II/ Basel III regulations. The parameters ω_L and ω_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).

When a bank enters the Foreign market, it transfers its 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: $F_s > F_b > 0$. The fixed costs of opening a subsidiary may include the cost of setting up a network of affiliates, acquiring customers, and learn about the regulatory framework of the host country. As branches' activities are somehow more limited compared to subsidiaries', we assume that the fixed cost of branching is lower than the one of subsidiarization. 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. (2017), 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 absent between parents and subsidiaries, which can trade only at arm's length via the interbank market.

3.2 National Banks

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

$$\begin{aligned} \max_{L,D,M} \quad & p \cdot r_L(L) \cdot L - (1-p)L + r_M M - r_D(D) \cdot D - aC(D,L) - f_p \cdot D \qquad (5) \\ s.t. \quad & E + D \geq L + M \qquad \text{(resource constraint)} \\ & \frac{E}{\omega_L L + \omega_M \mathbb{1}_{\{M \geq 0\}} M} \geq k \quad \text{(capital requirement)} \end{aligned}$$

where $r_L(L)$ denotes a downward sloping demand for loans, and $p \in (0,1)$ 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 ω_L and ω_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.[15] For this reason, we assume that the equilibrium in "normal times" is one where 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:

$$\begin{aligned} [L] \quad & p\left[\frac{\partial r_L(L)}{\partial L} L + r_L(L)\right] = a\frac{\partial C}{\partial L} + (1-p) + r_M \\ [D] \quad & \left[\frac{\partial r_D(D)}{\partial D} D + r_D(D)\right] + a\frac{\partial C}{\partial D} + f_p = r_M \end{aligned}$$

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

[15] In Section 4 we report evidence about the fact that banks in our sample have equity over risk-weighted assets ratios well above the capital requirements set by the regulators.

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 marginal cost of borrowing 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:

$$L_N^u = \left\{ \frac{\varepsilon}{p(\varepsilon - 1)} [(1 - p) + r_M + a c_L] \right\}^{-\varepsilon} A \tag{6}$$

$$D_N^u = \left\{ \frac{\vartheta}{(\vartheta + 1)} [(r_M - a c_D - f_p] \right\}^{\vartheta} B, \tag{7}$$

while a bank's maximal profits are:

$$\pi_N = r_M E + H_1(\varepsilon, p)[(1 - p) + r_M + a c_L]^{1-\varepsilon} A + H_2(\vartheta)(r_M - a c_D - f_p)^{1+\vartheta} B \tag{8}$$

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. Their analytical solution is contained in Appendix D.

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,

with two caveats: first, upon establishing the subsidiary – a transfer of equity $s_E E$ is made in order for the subsidiary to have some initial capital. As a result, the parent's equity reduces to $(1-s_E)E$ upon establishing the subsidiary. Subsequently, the two entities accumulate equity independently. Second, operating a foreign subsidiary also entails a fixed cost $F_S > 0$. Hence a parent-subsidiary pair solves:

$$\begin{aligned}
\max_{\substack{L,D,M \\ L^*,D^*,M^*}} \quad & pr_L(L)\cdot L - (1-p)L + r_M M - r_D(D)\cdot D - aC(D,L) - f_p \cdot D + ... \\
& p^* r_L^*(L^*)\cdot L^* - (1-p^*)L^* + r_M M^* - r_D^*(D^*)D^* - aC(D^*,L^*) - f_p \cdot D^* - F_S \qquad (9) \\
s.t. \quad & (1-s_E)E + D \geq L + M \\
& s_E E + D^* \geq L^* + M^* \\
& \frac{(1-s_E)E}{\omega_L L + \omega_M \mathbb{1}_{\{M\geq 0\}} M} \geq k \\
& \frac{s_E E}{\omega_L L^* + \omega_M \mathbb{1}_{\{M^*\geq 0\}} M^*} \geq k
\end{aligned}$$

where asterisks denote foreign market variables. Notice that all markets are segmented, except for the interbank market, which is a frictionless international market, clearing at the rate r_M. Banks take this rate as given, and r_M it is determined in industry equilibrium. We also assume that the deposit insurance premium, the capital requirement, and the risk weights on assets are symmetric across countries.

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:

$$
\begin{aligned}
\max_{\substack{L,D,M,T \\ L^*,D^*}} \quad & pr_L(L)\cdot L-(1-p)L+r_M M-r_D(D)\cdot D-aC(D,L)-f_p\cdot D+ \\
& ...p^* r^*_{L^*}(L^*)\cdot L^*-(1-p^*)L^*+r_M M^*-r^{*w}_D\left(D^*_w;\left(\frac{E}{k\cdot RWA}\right)\right)\cdot D^*_w+ \\
& ...-aC(D^*_w,L^*)-F_B \qquad (10) \\
s.t. \quad & E+D\geq L+M+T \\
& D^*_w+T\geq L^* \\
& \frac{E}{\omega_L(L+L^*)+\omega_M \mathbb{1}_{\{M\geq 0\}}M}\geq k
\end{aligned}
$$

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. First, the balance sheet of a branch is effectively "merged" with the one of its parent: branches do not raise independent equity, don't operate independently in the interbank market[16], and can transfer funds to/from the parent at no cost (T). As a result, if a branch has excess funding, it may transfer funds to the parent to finance its domestic lending (as it appears in the pre-crisis period). Viceversa, a parent can fund its branch in the event of a shortage of deposits (as it appears in the post-crisis period). Second, the lack of independent equity requirements for branches implies that they are subject to capital requirements only at the level of the entire conglomerate. Finally, on the liabilities side, they can only accept uninsured wholesale deposits. The term $r^{*w}_D\left(D^*_w;\left(\frac{E}{k\cdot RWA}\right)\right)$ is the supply of wholesale deposits. We rely on the estimates by Egan et al. (2017) 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

[16] All interbank activity M is managed by the parent.

form for the demand of uninsured deposits:

$$D_w^* = ({r^*}_D^w)^{\vartheta_w} \log\left(\frac{E}{k \cdot RWA}\right) B \tag{11}$$

where $\vartheta_w < \vartheta$ 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.

The parent-branch pair problem 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.

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 the foreign market implies that there are endogenous, equilibrium distributions of banks operating in each country, which we denote with $G(a)$, $G^*(a)$.

The interest rate in the interbank market is given by market clearing:

$$\int M(a; r_M) G(a) da + \int M^*(a) G^*(a; r_M) da = 0. \tag{12}$$

Each bank starts with a given level of equity E_0, and accumulates equity over time through reinvested profits:

$$E_{t+1} = E_t + \pi_t. \tag{13}$$

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 1) 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, there needs to be a trade-off between the fixed versus variable costs of branching versus subsidiarization. Particularly, one obtains the observed 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, as illustrated in Figure 5.

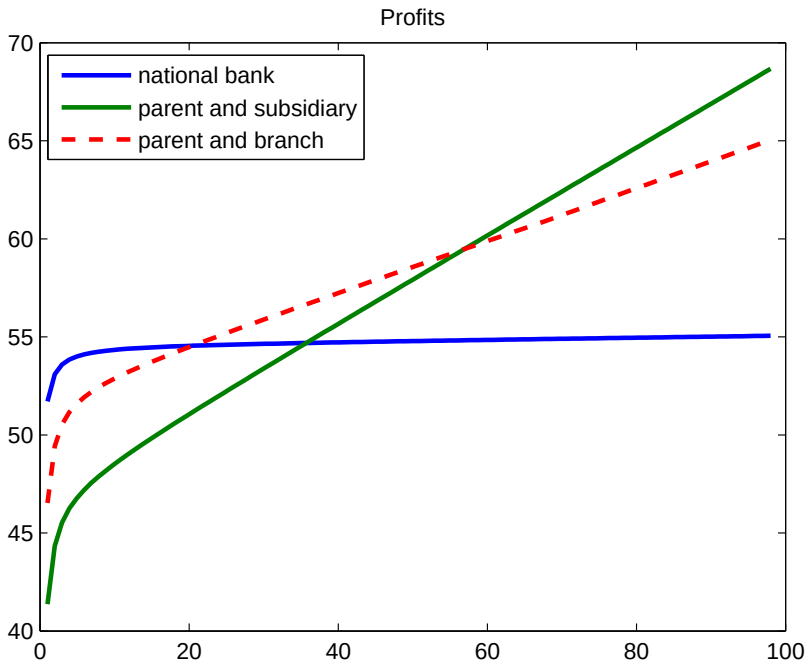

Figure 5: **Selection.** Selection by efficiency/size into international and organizational status.

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 the variable cost of operating a subsidiary is smaller than the variable cost of operating a branch. As a result, 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 variable cost) than the parent-branch pair. Hence 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 issue 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 Quantitative Analysis

In this section, we quantify the model in order to use it 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 distribution of loans to discipline the parameters of the banks' efficiency and equity distribution. Third, we use the model to jointly calibrate the remaining parameters by matching some moments of interest. Since we want to calibrate the pre-sovereign debt crisis economy, all data moments of interest are for the year 2010.

We calibrate directly the parameters p, f_p, k, ω_L, ω_M, ϑ, ϑ_w, 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

Parameter	Definition	Value	Source
p	prob. of loan repayment	0.99	World Bank
f_p	insurance premium	0.001	FDIC
k	capital requirement	0.045	Basel II/III
ω_L, ω_M	weights for RWA	0.5, 0.1	Basel II/III
s_E	subsidiary's equity share	0.11	Call Reports
ϑ, ϑ_w	elasticities of retail and wholesale dep. supply	0.56, 0.16	Egan et al. (2017)

Table 5: **Direct Calibration**. Parameters are matched to moments for the year 2010.

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.[17] Based on these observations, we set the probability of loan repayment (in normal times) to 0.99 $(1 - 0.0025 \times 0.006)$.

We quantify the insurance premium f_p following the FDIC assessment rates described in Table 4.[18] Assessment rate vary from 0.025% to 0.45%, so we choose a value in this range: $f_p = 0.1\%$.

We set the capital requirement to $k = 0.045$, the Basel III capital requirement of common equity over risk-weighted assets. The Basel II/Basel III regulation also gives guidelines on the weights used to compute risk-weighted assets: we choose $\omega_L = 0.5$ based on corporate, retail, and residential mortgage exposures, and $\omega_M = 0.1$ based on risk weights for exposures to U.S. depository institutions and credit unions.

Egan et al. (2017) provide structural estimates of the elasticity of deposit supply for both the retail and wholesale market in the US. Since the way in which we model deposit supply is a special parametric form of what they estimate, we use their estimated elasticities and set $\vartheta = 0.56$ and $\vartheta_w = 0.16$.

Finally, in our dataset, subsidiaries' equity is on average 11% of the equity of the parent. As such, we calibrate $s_E = 0.11$. Table 5 summarizes the parameters that we calibrate directly from the data. We also assume that these parameters are symmetric across countries.

In order to discipline the elasticity of loan demand ε and the parameters of the banks' efficiency distribution, we start by observing that we cannot reject the hypothesis that the empirical distribu-

[17] Source: http://www.newyorkfed.org/research/staff_reports/sr190.pdf.
[18] Data source: https://www.fdic.gov/deposit/insurance/assessments/proposed.html.

tion of interest revenues from loans is log-normal. Is it possible to show that if the banks' efficiency distribution is log-normal with mean μ and standard deviation σ, the distribution of interest revenues from loans is approximately log-normal with mean $\mu_L = (\varepsilon - 1)\mu + \log\left[\left(\frac{\varepsilon c_L}{p(\varepsilon-1)}\right)^{1-\varepsilon} A\right]$ and standard deviation $\sigma_L = (\varepsilon - 1)\sigma$.[19] Maximum likelihood estimates (MLE) of the parameters of the empirical distribution of interest revenues from loans deliver $\mu_L = 19.78$ and $\sigma_L = 1.93$. Hence we model banks' efficiency as a random draw from a log-normal distribution whose parameters are calibrated such that:

$$\begin{aligned} \mu_L &= (\varepsilon - 1)\mu + \log\left[\left(\frac{\varepsilon c_L}{p(\varepsilon - 1)}\right)^{1-\varepsilon} A\right] = 5.96 \\ \sigma_L &= (\varepsilon - 1)\sigma = 1.93. \end{aligned}$$

Banks are heterogeneous both in their efficiency level and in the equity they are endowed with. Given that we observe non-binding capital requirements in the data, we target a pre-crisis calibrated economy that is populated by unconstrained banks. Also the empirical distribution of equity is well-approximated by a log-normal. Since the model abstracts from uses of equity other than loans, we assume that each bank's equity position pre-crisis is drawn from the same distribution as loans, scaled by the capital requirement (k=.045) plus a 9% capital buffer. We impose this buffer as the 2008-2010 period coincides with the institution of stress testing. As banks were getting ready to pass stress testing, their equity over risk-weighted ratios increased in this period (see Figure C.3 in the Appendix). We parameterize the buffer as the average hypothetical worst loss of a bank under stress. This assumption ensures that banks are "far" from the constraint in the pre-crisis equilibrium.

It remains to calibrate the relative management cost of loans versus deposits c_L/c_D, the elasticity of loan demand ε, the aggregate parameters of loan demand and deposit supply in each country (A, A^*, B, B^*, B_w, and B_w^*), and the fixed entry costs F_S, F_B. These are parameters that we cannot calibrate directly, so we make some symmetry assumptions and use the model to choose values for these parameters such to match some relevant moments from the data. More precisely, we assume that c_L/c_D and ε are symmetric across countries, that the relative sizes of the loans, retail deposits, and wholesale deposits across countries are the same: $A/A^* = B/B^* = B_w/B_w^*$, and that fixed costs imply the same distribution of banks by type in each country. Symmetry assumptions also imply a link between the relative sizes of the loans markets and the subsidiary's equity share, so

[19] See Appendix E for details.

that we are left with seven parameters to be calibrated (c_L/c_D, ε, A^*, B^*, B^*_w, F_S, and F_B), for which we choose the following set of target moments:

1. relative size of average branch/ average subsidiary, in terms of loans;
2. relative size of average branch/ average subsidiary, in terms of deposits;
3. relative presence of foreign branches versus foreign subsidiaries;
4. share of U.S. loans extended by subsidiaries or branches of foreign banking organizations;
5. average interest rate on retail deposits;
6. average interest rate on loans;
7. average interbank market rate.

The average foreign subsidiary in our data has loans equal to 3.87 times the loans of the average branch, and deposit equal to 1.81 times the deposits of the average branch. In our merged data set, subsidiaries account for about a third of U.S.- based F.B.O.s, and in turn F.B.O.s account for about 30% of total loans extended in the U.S. 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 retail deposits we use rates on checking accounts, at 0.12%. We use LIBOR to pin down the value of the interbank market interest rate, at 0.92%006. Finally, loans in the the model encompass a variety of products including C&I, mortgages, home equity, and personal loans. We take an average among these rates in the data and set our target for average interest rates on loans to 6.28%.

Table 6 reports the calibrated parameters. Our calibration reveals a moderate elasticity of loans demand, $\varepsilon = 2.6$, corresponding to an average mark-up of 64%. The reported fixed costs imply that the cost of opening a subsidiary (branch) is equal to 32% (35%) of the average profits of the subsidiary (branch) itself.

Table 7 reports the model-generated moments alongside the corresponding moments in the data.

Despite its conceptual simplicity, the model is hard to compute because of the occasionally binding constraints and consequent presence of corner solutions. As such, it is hard to talk precisely about identification. This said,, numerical simulations of the model suggest that the relative number of subsidiaries versus branches and the share of loans issued by F.B.O.s are very sensitive to the

Parameter	Definition	Value
c_L/c_D	Unit Management Cost	15.5
ε	Elasticity of Loan Demand	2.6
A^*	Loan Demand Shifter	31.9
B^*	Retail Deposit Demand Shifter	3.15×10^5
B_w^*	Wholesale Deposit Demand Shifter	1.04×10^4
F_S	Fixed Cost of Subsidiarization	624
F_B	Fixed Cost of Branching	534

Table 6: Calibrated Parameters.

Moment	Data	Model
Average subsidiary loans/branch loans	3.87	2.41
Average subsidiary deposits/branch deposits	1.81	4.31
Nr. of subsidiaries/Nr. of branches	0.31	0.32
Share of U.S loans issued by F.B.O.s	30%	41%
Avg Interest Rate On Deposits	0.12%	0.37%
LIBOR One-Year Interbank Rate	0.92%	1.57%
Avg Interest Rate on Loans	6.28%	8.70%

Table 7: Moments, Model versus Data.

calibration of the fixed costs. Moments related to relative size are important to quantify cost and market size parameters.

4.2 Global Banks' Organization and the European Sovereign Debt Crisis

In this section, we use the calibrated model to perform a comparative statics exercise with the goal of illustrating the consequences of the European sovereign debt crisis for the global banking sector. In this exercise, we model the EU sovereign debt crisis as a sudden drop in the probability of loan repayment in Europe (p decreases). We show that model-generated changes in the activities of national banks, parent-branch pairs, and parent-subsidiary pairs are qualitatively similar to what we observe in the data.[20]

Figure 5 illustrates the selection into international status that the unconstrained equilibrium of the calibrated model generates. The least efficient banks remain national, while the most efficient

[20] As the quantitative match of the moments from the data is still in progress, the analysis is only qualitative at this point.

	Branches	Subsidiaries
Average Parent Equity	0.66	0.45
Average Transfers	1.04	
Average Wholesale Deposits	0.72	1.00
Average Loans	0.99	1.19

Table 8: Response to a loan repayment in the model. Percentage change relative to baseline pre-crisis economy.

become global. Among global banks, the most efficient banks enter as subsidiaries and the least efficient enter as branches (which also implies that subsidiaries are larger than branches).

To simulate the European Sovereign Debt crisis, we introduce an unexpected drop in the probability of loan repayment (to $p' = 0.94$), after banks have decided their optimal amounts of loans and deposits based on the baseline value of p. The induced change in banks' revenues reduces equity accumulation at the end of the period and implies that European banks and European parents of global banks reduce their buffer on capital requirements (E/RWA decreases). As a consequence, wholesale deposit supply in US-based branches decreases due to depositors' fears about the health of the conglomerate.[21] Branches experience a funding shock, reduce their loans, and their demand for borrowing increases. As a result, branches borrow intrafirm from their parents ($T > 0$) to stay afloat. At the same time, the balance sheet of US-based subsidiaries is unaffected by the shock that happens in Europe.

Table 8 displays the results of this exercise as percentage changes from the baseline pre-crisis economy.

This simple exercise is qualitatively consistent with the changes in branches and subsidiaries' balance sheets that we documented in Section 2, and provides some guidance about the implications of different organizational forms for the transmission of shocks across countries. On the one hand, as already shown by Cetorelli and Goldberg (2012a,b), branches act as vehicles of shock transmission across countries through their internal capital market, but they are the organizational form that minimizes the aggregate, global consequences of a negative shock. On the other hand, subsidiaries are isolated from shocks to their parents, but the lack of adjustment mechanisms among different units of the corporation makes banks that own subsidiaries less resilient to the shock. So what should the regulators do? The answer depends on whether policy priorities are more concerned

[21] Recall that the wholesale deposit supply function is sensitive to the magnitude of the buffer between the equity over risk-weighted assets ratio and the capital requirement.

with limiting the transmission of shocks across countries or with the stability of large, systemically important banks.

4.3 Counterfactual Analysis

Section to be added.
Content (in progress):

- Analysis of the sovereign debt crisis under counterfactual scenarios:
  - only subsidiarization allowed;
  - only branching allowed;
  - higher capital requirements.
- Comparative statics: changes in the baseline economy equilibrium with respect to changes in capital requirements.
- Analysis of intensive versus extensive margin adjustments: subsidiary and parent exit.

5 Conclusions

In this paper we studied how different organizational forms of global banking shape the transmission of shocks across countries. Our analysis focused on the endogenous choice of banks to serve foreign markets via branching or subsidiarization.

We started by establishing a series of stylized facts about the cross-section of global banks and their response to the European sovereign debt crisis. Informed by the data, we developed a micro-founded structural model of foreign entry in the banking sector. The model is designed to mimic the institutional details of the banking industry and to be consistent with the aforementioned stylized facts. 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 explain the economic channels through which banks' mode of entry matters for the extent of the transmission of various shocks across countries.

In order to study the effects of the Europen sovereign debt crisis through the lens of the theory, we calibrate the model and use it to perform a series of exercises that shed light on the implications of the current regulation for the extent of shock transmission.

Our most important finding clarifies the relationship between global banks' organization and shock transmission. We show that subsidiarization isolates banks' balance sheets by location, hence minimizes contagion. However, by not providing an internal capital market to the conglomerate, it does not provide it with any instrument to dampen the global effect of shocks, resulting in possible reorganizations and exits. Conversely, branching can take advantage of an internal capital market within the corporation and smooth the effect of the shock across countries, so reducing its global impact.

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Appendix

A The Regulatory Framework: History and Current Status

Edge Act 1919

The Edge Act amended section 25 of the Federal Reserve Act, allowing national banks to engage in international banking. Each bank was required to be properly capitalized and enter into an agreement with the Federal Reserve System as to the type of activities it would undertake. Upon Federal Reserve approval, banks set up subsidiaries that were allowed to undertake foreign banking activities that the parent banks were not legally permitted to undertake. At this point in time, only U.S. Banks could establish Edge Act corporations.

McFadden Act of 1927

Prior to 1927, national banks had to operate within a single building while, in many states, state banks were allowed to operate multiple branches. In order to end this advantage, the McFadden Act allowed national banks to operate branches within the city or town they were headquartered, if state law allowed this right to state banks. Not allowing national banks the right to open branches in multiple states led to a significant impact of this law becoming prohibiting interstate branching. Since foreign banks and Edge Act corporations did not fall under the jurisdiction of this law, they were the only banking organizations that could legally own branches in multiple states.

Banking Act of 1933 (Glass-Steagall)

The Glass-Steagall Act substantially reformed the American banking system, with three provisions having a large effect on the competitive landscape facing foreign banks. The most commonly cited provision of the Glass-Steagall Act is the separation of commercial banking from investment banking, a requirement foreign banks avoided until 1978. The act also created the Federal Deposit Insurance Corporation (FDIC), which insured bank deposits up to $2,500, then quickly increased to $5,000. This provision required all Federal Reserve member banks to become stockholders in the FDIC but did not allow foreign banks to become stockholders. Another provision extended the branching rights of national banks to fully mirror the rights of state banks in the state the are

headquartered, an extension of the rights granted in the McFadden Act which applied to foreign banks after 1978.

International Banking Act of 1978 (IBA)

The IBA instituted the principle of national treatment, where foreign banks were subject to the same regulatory restrictions and benefits as domestic banks whenever possible. Prior to the act, the branches of foreign banks were not subject to restrictions of federal law, such as those on interstate banking (McFadden) and separation of commercial and investment operations (Glass-Steagall), and were not required to meet the reserve requirements of the Federal Reserve. However, they were ineligible for FDIC insurance, making it hard to compete for retail deposits. Foreign Subsidiaries were already under federal regulatory authority. The act required foreign banks to choose a home state, then they were subject to the laws of that state and could not set up branches or subsidiaries in any other states. They also became subject to federal laws including Glass-Steagall, ending competitive advantages they previously had over domestic banks. All foreign banks that accepted retail deposits were now required to become part of the FDIC insurance system, but they did have the option to opt out by not accepting retail deposits. These banks were now subject to the reserve requirements set by the Federal Reserve and subject to their examinations or that of a similar banking authority. The act also allowed foreign banks to open Edge Act corporations, adding another organizational form for foreign banking activity in the U.S.

Depository Institutions Deregulation and Monetary Control Act (DIDMCA) of 1980

DIDMCA expanded the influence of the Federal Reserve to all depository institutions, as opposed to only the approximately 40 percent of banks that were currently members of the Federal Reserve System. This meant non-member banks had to meet the reserve requirements and assets and liabilities reporting requirements set by the Federal Reserve, similar to how the IBA applied these requirements to US operations of foreign banks. These new requirements also allowed all depository institutions the benefits of membership in the Federal Reserve System, including use of the discount window, a first for both foreign banks and non-member banks.

Foreign Bank Supervision Enhancement Act (FBSEA) of 1991

The FBSEA, part of the Federal Deposit Insurance Corporation Improvement Act, prohibited new foreign bank branches in the U.S. from access to FDIC system and deposit insurance. This created a major operating difference from a foreign bank opening a new subsidiary, which were still able to offer deposit insurance. The act also expanded the Federal Reserves authority to supervise and regulate foreign banks. The Federal Reserve could now examine any foreign owned banking entity in the U.S., which were now required to be examined annually by state or federal regulators, and was allowed greater privilege to information about the parent companies. The act also allowed the Federal Reserve to terminate any unsafe foreign banking entity, whether it had a state or federal licence. To form a new banking entity in the U.S., a foreign bank now needed the approval of the Federal Reserve independent of licence.

Riegle-Neal Interstate Banking and Branching Efficiency Act (IBBEA) of 1994

The IBBEA overturned the McFadden Act by allowing interstate banking. Prior to this act, many states passed laws allowing banks from other states to operate within their state under specified conditions. The IBBEA set up a national framework to allow interstate banking under a standardized set of rules. States were given the choice of whether to opt-in or out of the Act. All states but Montana and Texas opted in for interstate entrance via acquisition, later to opt in in 2002 and 1999 respectively, while few states, only 13 initially, opted in for branching via de novo establishment, up to 22 by 2005. The act required a bank to get Federal Reserve approval before beginning interstate operations. For foreign owned banks, this legislation meant a parent bank could set up branches in multiple states, or a subsidiary would be allowed to open branches in multiple states.

New IHC Regulation (IBBEA) of 2016

Starting in July, 2016, a Foreign Bank Organization (FBO) with more than $50bn in US assets is required to designate an Intermediary Holding Company (IHC) that holds the FBO's ownership interest in any of the US subsidiaries. The IHC is then subject to the regulatory requirements of any US Bank Holding Company. Interestingly enough, branches are left out of the IHC regulation and branch assets do not count towards the thresholds, nor are subject to US regulatory requirements

like DFA Stress Testing, Basel III capital requirements, etc. They remain subject to regulation in their home country.

B Data Description

U.S. Office-Level Data

Our office-level data comes from two different forms, FFIEC 031 and FFIEC 002. FFIEC 031 is formally known as Consolidated Reports of Condition and Income for a Bank with Domestic and Foreign Offices, often referred to as Call Reports. This is our source of data on the financial positions of foreign owned subsidiaries. FFIEC 002 is formally known as Report of Assets and Liabilities of U.S. Branches and Agencies of Foreign Banks, and is our source of data on the financial positions of foreign owned branches.

We complemented this data with the Federal Reserve Board Structure and Share Data for U.S. Offices of Foreign Banks. The Structure Data is U.S. office-level data of foreign banking organizations covering selected variables from the FFIEC 031 and FFIEC 002, including "top-tier" foreign parent bank and country, as well as U.S. office type and assets. This allowed us to identify the two types of organizational forms that are the object of this study, branches and subsidiaries. We defined as "branches" both uninsured federal branches and uninsured state branches. "Subsidiaries" encompass state member banks, state non-member banks, national banks, state savings banks, and federal savings banks in the data. The Share Data contains summary statistics on the fraction and level of total assets, commercial and industrial loans, total loans or deposits in domestic owned banks, foreign owned banks (subsidiaries) and foreign owned branches and agencies.

Balance sheet data for subsidiaries in our sample are contained in the form FFIEC 031. Specifically, we construct retail deposits as the sum of *rconf049*, the amount of deposits (excluding retirement accounts) of $250,000 or less, and *rconf045*, the amount of retirement deposits of $250,000 or less. Wholesale deposits are given by the sum of *rconf051*, the amount of deposits (excluding retirement) above $250,000, and *rconf047*, the amount of retirement deposits above $250,000. The sum of wholesale and retail deposits gives our measure of total deposits. *rcfd2122* (loans and leases net of unearned income) measures total net loans. Finally, *riad4340* (net income or loss attributable to the bank) is our measure of net income.

The form FFIEC 002 provides additional information on branches. Specifically, wholesale deposits are given by *rcon1653* (total deposits and credit balances in transaction accounts of the branch). *rcfd2122* (loans and leases net of unearned income) is our measure of total net loans. The intrabank transfer is computed using data on flows of funds between parent and branches: *rcfd2944* reports the balance due to their parent institution and *rcfd2154* the balance due from their parent institution.

European Bank Level Data

SNL.com is our data source on European banks. Using bank names, we were able to match this data with the parents of U.S. offices in the structure data: there are 56 European "top-tier" parent banks in our structure data sample. The variables we use from SNL.com are total assets (SNL Keyfield 132264), total deposits (132288), total net loans (132214), net income (132740), interest earned on loans (132532) and interest expense on deposits (133820.)

Exposure Data

Exposures for "top-tier" are contained in the European Banking Authority (EBA) stress test data, which reports each bank's total value of holdings of sovereign debt in each country. Only 50 of our 56 European parents participated in these stress tests. For this reason, we construct two different definitions of exposure of a parent bank. According to our baseline definition, any parent bank with positive holdings of government debt from Portugal, Ireland, Italy, Greece or Spain is considered exposed and all other parent banks are not. An alternative definition considers any parent bank in a country using the Euro to be exposed, while all other parent banks are not. This second definition does not require EBA stress test data.

C Additional Empirical Evidence

In this Appendix we report more observations from the data in support of the broad patterns that we documented in the main text.

Figure C.1 shows aggregate data on the population of foreign banking organizations operating in the US.

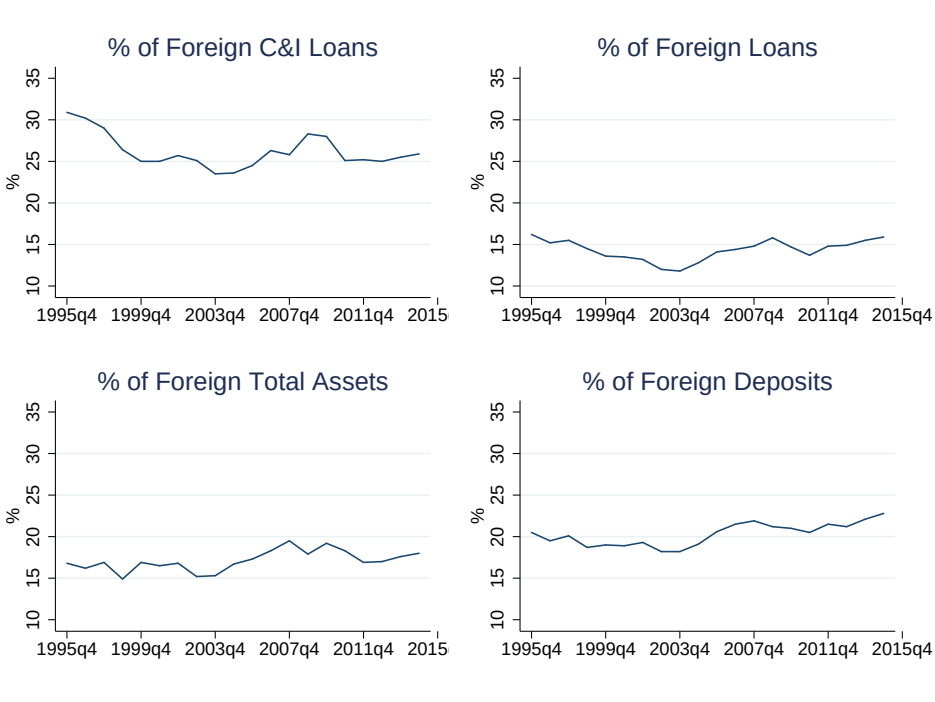

Figure C.1: Percentage of assets, commercial and industrial loans, total loans, and deposits held in foreign owned banking institutions in the U.S. Data source: Structure Data for US Offices of Foreign Banking Organizations - Selected Assets and Liabilities of Domestic and Foreign Owned US Commercial Banks plus US Branches and Agencies of Foreign Banks.

In Section 2 we have shown large size differences between the branches and the subsidiaries of foreign banks. Figure C.2 illustrates that these size differences are not driven by a few firms holding extraordinarily large balance sheets, but hold throughout the banks' size distributions: the deposits, loans, and assets size distributions of foreign subsidiaries first-order stochastically dominate the analogous distributions of foreign branches.

The calibration analysis presented in Section 4 argues that European parents' equity broadly increased after the introduction of stress testing, but dropped at the onset of the sovereign debt crisis. Figure C.3 illustrates these trends.

Finally, for completeness, Table C.1 reports the list of European parents included in our sample in 2010, together with the number of branches and subsidiaries that each bank had at that point, and with the share of assets in each of the two organizational forms.

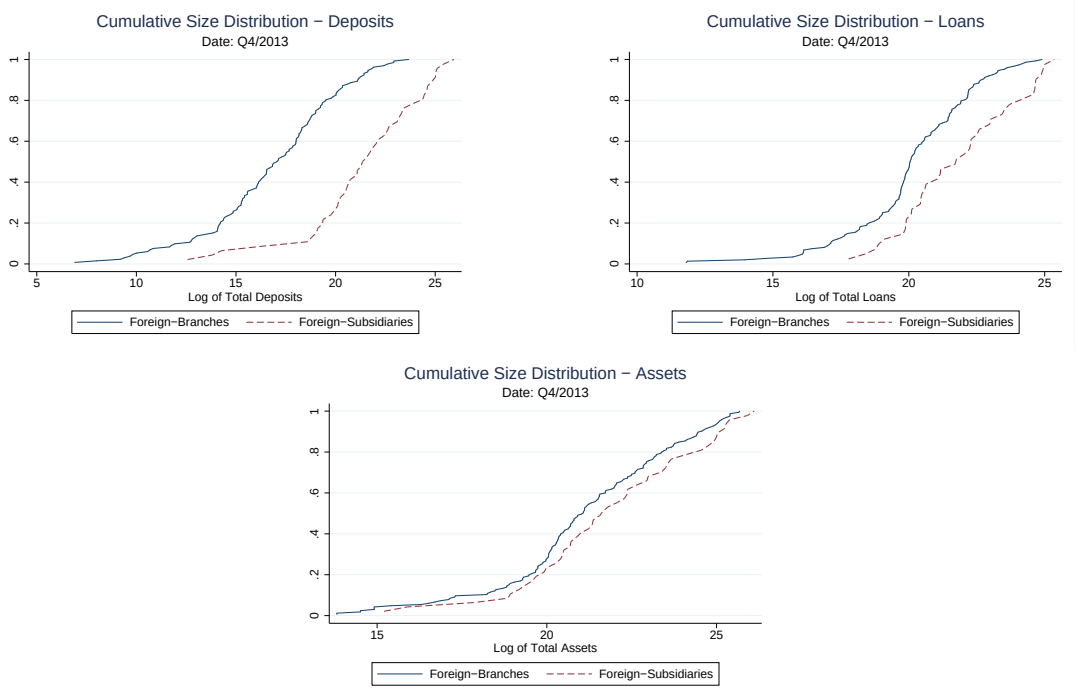

Figure C.2: **Size Distributions.** Cumulative distribution functions for deposits, loans, and assets, respectively, held in foreign owned subsidiaries and branches in the fourth quarter of 2013. Data source: US Structure Data for US Offices of Foreign Banking Organizations - Selected Assets and Liabilities of Domestic and Foreign Owned US Commercial Banks plus US Branches and Agencies of Foreign Banks.

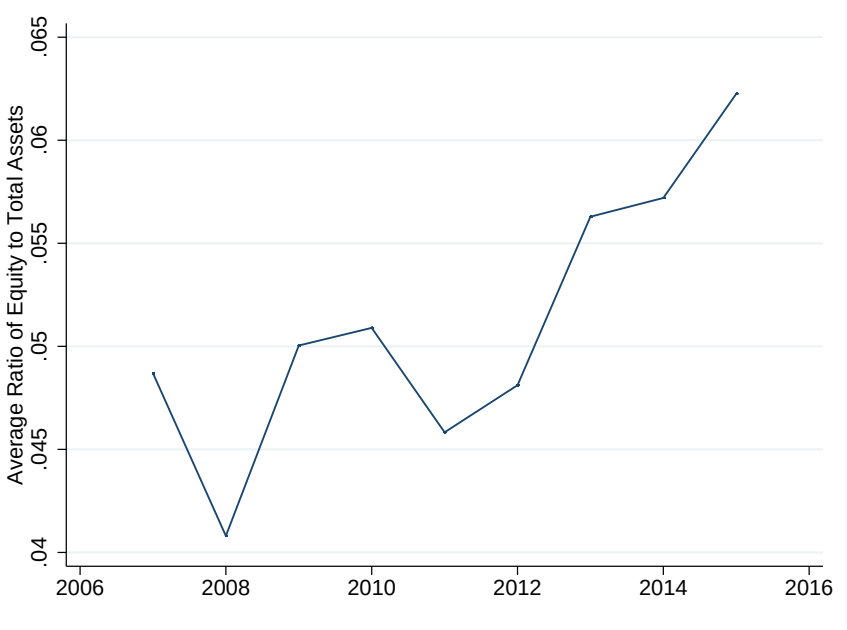

Figure C.3: **Parent Equity over Assets.** Average equity over assets held in European parents of foreign banking organizations in the U.S.

Bank Name	nr. of subs	nr. of branches	% of assets in subs.	% of assets in branches
Allianz Se	0	2	0	100
Allied Irish Banks, P.L.C.	2	1	96.11	3.89
Banco Bilbao Vizcaya Argentaria, S.A.	1	1	72.31	27.69
Banco Comercial Portugues, S.A.	1	0	100	0
Banco De Sabadell, S.A.	2	1	64.92	35.08
Banco Popular Espanol, S.A.	1	0	100	0
Banco Santander, S.A.	0	3	0	100
Barclays Plc	1	2	14.08	85.92
Bayerische Landesbank	0	1	0	100
Bnp Paribas	2	5	36.15	63.85
Bpce	0	1	0	100
Caisse Federale De Credit Mutuel	0	1	0	100
Caixa De Aforros De Vigo, Ourense E Pontevedra	0	1	0	100
Caixa Geral De Depositos, S.A.	0	1	0	100
Bancaja	0	1	0	100
Caja De Ahorros Y Monte De Piedad De Madrid	1	0	100	0
Cooperatieve Centrale Raiffeisen-Boerenleenbank B.A.	1	1	12.09	87.91
Credit Agricole Corporate And Investment Bank	0	2	0	100

Continued on next page

Table C.1 – *Continued from previous page*

Bank Name	nr. of subs	nr. of branches	% of assets in subs.	% of assets in branches
Credit Suisse Group	0	1	0	100
Deutsche Bank Aktiengesellschaft	2	1	26.93	73.07
Dexia S.A.	0	1	0	100
Dnb Nor Asa	0	1	0	100
Dz Bank Ag Deutsche Zentral-Genossenschaftsbank	0	1	0	100
Erste Group Bank Ag	0	1	0	100
Espirito Santo Control S.A.	1	2	24.14	75.86
Fondazione Monte Dei Paschi Di Siena	0	1	0	100
Governor And Company Of The Bank Of Ireland, The	0	1	0	100
Hsbc Holdings Plc	3	0	100	0
Hsh Nordbank Ag	0	1	0	100
Hypo Real Estate Holding Ag	0	1	0	100
Intesa Sanpaolo S.P.A.	0	1	0	100
Kbc Bank Nv	0	1	0	100
Landesbank Baden-Wuerttemberg	0	1	0	100
Landesbank Hessen-Thuringen Girozentrale	0	1	0	100
Lloyds Banking Group Plc	0	2	0	100
Niedersaechsischer Sparkassen- Und Giroverband	0	1	0	100
Nordea Bank Ab (Publ)	0	2	0	100
Nrw.Bank	0	1	0	100
Piraeus Bank S.A.	1	0	100	0
Royal Bank Of Scotland Group Plc, The	2	4	62.66	37.34
Skandinaviska Enskilda Banken Ab (Publ)	0	1	0	100
Societe Generale	0	2	0	100
Standard Chartered Plc	0	2	0	100
Svenska Handelsbanken Ab (Publ)	0	1	0	100
Swedbank Ab	0	1	0	100
Ubs Ag	1	7	32.48	67.52
Unicredit S.P.A.	0	2	0	100

Table C.1: List of European Parents in our sample. Data for 2010.

D Solution of the Model

D.1 Constrained Equilibrium in National Banks

In the model, the constrained equilibrium has two possible configurations, depending on whether the bank borrows or lend in the interbank market. We describe both 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: $D_N^c = \left(1 - \frac{\omega_L}{\omega_M}\right) L_N^c - \left(1 - \frac{1}{\omega_M k}\right) E$ while constrained loans solve:

$$\begin{aligned} L_N^c \;=\; & \left\{ \frac{\varepsilon}{p(\varepsilon-1)} \left[(1-p) + \frac{\omega_L}{\omega_M} r_M + a c_L + (a c_D + f_p) \left(1 - \frac{\omega_L}{\omega_M}\right) + ... \right.\right. \\ & \left.\left. \frac{\vartheta}{\vartheta+1} \left[\left(1 - \frac{\omega_L}{\omega_M}\right) L_N^c - \left(1 - \frac{1}{\omega_M k}\right) E \right]^{1/\vartheta} B^{-1/\vartheta} \left(1 - \frac{\omega_L}{\omega_M}\right) \right] \right\}^{-\varepsilon} A. \end{aligned} \tag{D.1}$$

   If the resulting $M^c > 0$, these conditions characterize the constrained equilibrium. Otherwise, the constrained equilibrium will be one with interbank borrowing.

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:

$$L_N^c = E/(\omega_L k), \tag{D.2}$$

   deposits remain at their unconstrained value, $D_N^c = D_N^u$, while interbank borrowing clears the resource requirement:

$$M_N^c = D_N^c + \left(1 - \frac{1}{\omega_L k}\right) E. \tag{D.3}$$

E Details of the Calibration Procedure

We discuss here some details of the calibration of the model.

E.1 Calibrating Banks' Efficiency Distribution

We start by assessing which parametric distribution better approximates the empirical distribution of interest revenues from loans. We estimate the parameters of said distribution under the alternate assumptions of Pareto, log-normal, Fréchet, and Weibull. With the estimated distributions, we run Anderson-Darling tests of the hypothesis that each of these parametric distributions well approximates the empirical distribution. While we can reject that the distribution of interest revenues from loans is Pareto, Fréchet and Weibull, we cannot reject the hypothesis that the distribution is log-normal. Based on this, we need to establish a theoretical linkage between the distribution of interest revenues from loans and the banks' efficiency distribution.

Assume that bank efficiency $x \equiv 1/a$ is distributed log-normal: $\log(x) \sim \mathcal{N}(\mu, \sigma)$. In the unconstrained equilibrium, revenues from domestic loans are:

$$r_L \cdot L = \left[\frac{\varepsilon}{p(\varepsilon-1)}[ac_L + r_M + (1-p)]\right]^{1-\varepsilon} A. \tag{E.1}$$

Assuming that the term $(r_M + 1 - p)$ is "small" relative to ac_L, revenues from loans can be approximated as:

$$r_L \cdot L \approx \left[\frac{\varepsilon}{p(\varepsilon-1)}ac_L\right]^{1-\varepsilon} A = Ha^{1-\varepsilon} = Hx^{\varepsilon-1}$$

where $H \equiv \left[\frac{\varepsilon c_L}{p(\varepsilon-1)}\right]^{1-\varepsilon} A$. Hence:

$$\log(r_L \cdot L) \approx \log(H) + (\varepsilon - 1)\log(x)$$

where $\log(x) \sim \mathcal{N}(\mu, \sigma)$ implies that $\log(r_L \cdot L) \sim \mathcal{N}(\mu_L, \sigma_L)$. As a result, the distribution of interest revenues from loans can be approximated by a log-normal distribution with parameters:

$$\mu_L = (\varepsilon - 1)\mu + \log(H) \tag{E.2}$$

$$\sigma_L = (\varepsilon - 1)\sigma. \tag{E.3}$$

The MLE estimates conditional on the distribution of the interest revenues from loans being log-

normal deliver $\mu_L = 19.78$ and $\sigma_L = 1.93$. Then we impose that $\mu_L = (\varepsilon - 1)\mu + \log(H) = 19.78$ and $\sigma_L = (\varepsilon - 1)\sigma = 1.93$ in the calibration.