

What are the consequences of global banking for the international transmission of shocks? A quantitative analysis*

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Abstract

We study the consequences of the organization of foreign banks in the United States for the transmission of financial shocks across countries. We start by establishing a set of stylized facts about global banks with operations in the United States. First, we show evidence of selection by size into foreign markets, related to banks' organization mode: 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. Second, the mode of foreign operations affects the response of global banks to shocks and how those shocks are transmitted across countries. To rationalize these facts, we develop a structural model of global banking whose assumptions mimic the institutional details of the US regulatory framework. The model is able to replicate the response of the US banking sector to the European sovereign debt crisis, and we use it as a laboratory to perform counterfactual analysis on the effects of alternative regulatory policies. Our analysis suggests that pervasive subsidiarization, higher capital requirements, or ad-hoc policy interventions would have mitigated the effects of the crisis.

Keywords: banks, entry, multinational firms.

JEL Classification: F12, F23, F36, G21

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1 Introduction

“Spanish-based Santander (...) acquired Sovereign Bank in 2009 as the springboard for its US ambitions, [establishing] 700 branches and ATMs across nine northeastern states (...). Santander is the fourth-largest bank by deposits in Massachusetts and has 1.7 million US customers. ” (The Boston Globe, October 26th 2013)

More than 15 percent 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 S.A. in the quote above, multinational banks make profits and suffer 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 for the extent of the transmission of various shocks across countries. Second, operationally, we calibrate the model to match a set of cross-sectional moments of the US foreign banking sector and show that our calibrated economy generates responses to shocks that are consistent with the actual responses of multinational banks to the European sovereign debt crisis. We then use the model to perform a series of counterfactual exercises that shed light on the implications of the current regulation for the extent of shock transmission.

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

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

²Notable exceptions are Bremus et al. (2013), de Blas and Russ (2013), and Niepmann (2015, 2016).

differently, so that the activities that they 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 global conglomerate level. While subsidiaries can issue all types of deposits, branches can only issue uninsured wholesale deposits. Finally, unlike subsidiaries, branches can freely transfer funds to and from their parent.³

Our analysis starts by establishing a series of stylized facts about the cross-section of global banks in the US and their responses to shocks. First, we show evidence of selection into the US market: the European parents of global conglomerates with affiliates in the US tend to be larger than European banks without operations in the US. 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 deposits, loans, and 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 crisis, 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 only partially compensated by intrafirm transfers of funds from their parents. At the same time, US branches of exposed European banks decreased their assets in the US, while assets increased in exposed US subsidiaries.

Next, 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 several institutional features, like capital requirements and deposit insurance, and aggregated to an industry equilibrium with heterogeneous banks. The model features the channels of adjustment that we document in the data, and its

³Section 2 illustrates in detail the institutional features of the US banking sector. Appendix A summarizes the US banking regulation and the changes it underwent in the past decades. The regulatory oversight of foreign subsidiaries and branches varies across jurisdictions, and may happen both in the home and in the host country. Most advanced economies allow both branches and subsidiaries of foreign banks, with some differences. New Zealand, for example, allows foreign banks to enter only 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 several countries they face capital and liquidity charges, just as subsidiaries. Limits on deposit-taking activities by branches are also pervasive. Starting in July 2016, changes in the regulation of Foreign Banking Organizations have been implemented. These changes are also discussed in Appendix A, and do not affect the approach and classification that we use in this paper.

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 European sovereign debt crisis. 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. To examine 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, European parents use their internal capital market 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, there is no direct effect on their assets and liabilities.

The model is conceptually simple, yet rich in its depiction of the regulatory framework. Given its success at replicating the observed response of FBOs to the European sovereign debt crisis, we use it to simulate the response to the crisis under counterfactual policy scenarios. The results of our exercises suggest that increased capital requirements, the elimination of branching, or an ad-hoc monetary policy intervention would have mitigated the negative effects of the crisis on US aggregate lending. Conversely, the elimination of subsidiarization would have caused an even more severe decline in banking activity in the US.

Our model has also interesting implications about the possible response of FBOs to "large" shocks to their parents. More precisely, the lack of an internal capital markets between parent and subsidiaries implies that, following a "large" shock, a parent bank may decide to repatriate funds by shutting down its subsidiaries overseas. Parents of branches don't have the same incentives, as they can freely repatriate funds through their internal capital market. As an external validation of this mechanism, we show that subsidiaries are more likely to exit than branches, and that exits are more common in periods of declining parent equity positions.

Finally, our model highlights the ability to mitigate the transmission of financial shocks across

countries that different organizational forms present. 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, smooth the effect of shocks across countries, and reduce their global impact.

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 transferring 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 changes in the balance sheets of subsidiaries, or the lack thereof.

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 (2015, 2016). 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 abstracts from cross-border banking and 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.⁴ Finally, this paper shares with Corbae and D'Erasmus (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, and global banks play an important role in the international transmission of shocks. Berrospide et al. (2017) conduct an empirical analysis of the spillovers of national banking regulation 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), who study the transmission of US monetary policy across borders through US global banks' lending abroad. We contribute to this literature by examining the potential effects of alternative banking regulations in our quantitative analysis.

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 US market. Section 3 develops a simple model that illustrates the decisions that multinational banks face. The model is then calibrated and used to perform counterfactual exercises in Section 4. Section 5 concludes.

2 Foreign Banks in the United States: 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.

⁴Banks' mark-ups are constant in our framework to preserve tractability of the bank problem.

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 (“Call Reports”). In addition to domestic banks, US-based subsidiaries of foreign banks must fill out these reports as well.⁵ 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.⁶ Call Reports data include detailed information about banks’ US operations, and the identity of the ultimate owner which allows us to distinguish US-based entities belonging to global banks from US national banks.

In order to have a full picture of global banks’ operations at home and abroad, we merge Call Reports data with two additional data sources: SNL Financial, which provides 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 Sovereign Debt crisis of 2011, we restrict our sample period to 2007-2013.⁷

2.2 The Cross-Section of Foreign Banks

The presence of foreign institutions in the US banking market is substantial. Between 15 and 20 percent of the aggregate assets held by banks operating in the US belongs to banking offices that are ultimately owned by a foreign parent. Foreign owned banking offices account for about 20

⁵The Federal Financial Institutions Examination Council (FFIEC) collects these data in two different reporting forms: FFIEC 031 and FFIEC 041. Banks with foreign offices must file the FFIEC 031 form and banks with only domestic offices must file the FFIEC 041 form. The information about domestic operations is identical across reports for all practical purposes.

⁶Form 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.

⁷Appendix 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.

percent of total deposits and between 20 and 30 percent of total commercial and industrial loans in the US (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 for most purposes operates as a domestically owned US banking entity. Subsidiaries are subject to US regulation, raise independent equity, and are subject to independent capital requirements. A subsidiary bank may accept both wholesale deposits and retail insured deposits (insured by the Federal Deposit Insurance Corporation, FDIC henceforth). Possible capital flows between the subsidiary and the parent must happen “at arm’s length”, in the form of loans, equity injections, or 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.⁸ In our data set, we count 47 US-based subsidiaries of foreign banks, with total assets of approximately \$1.16tn or 7.1 percent 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.*, branch assets are consolidated with the parent assets when evaluating the conglomerate’s capital ratio). Branches may give loans, but accepts only non-insured wholesale deposits.⁹ Contrary to subsidiaries, branches have the possibility of an intrafirm channel to transfer capital flows to/from the parent, and indeed do display large intrafirm capital flows with their foreign parents (more on this below). In our data set there are 182 US-based branches of foreign banks, with total assets of approximately \$2.19tn, or 15 percent 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 percent of the assets held by foreign-owned banking offices. In terms of business lines, these two forms of entry also entail activities that are

⁸Equity injections are rare and subject to the home regulator. Equity flows to the parent are in the form of dividend distributions, which are limited by earnings and are typically semiannual. Recently, these distributions are even more limited by the performance in the stress testing exercise, if the subsidiary has more than \$50 billion in assets.

⁹Branches do not have their own balance sheet, as they are consolidated into the parent institution, do not have a capital account, and are not required to report income statement variables. Nonetheless, the US regulatory framework requires foreign owned branches and agencies to report their assets and liabilities in the FFIEC 002 form.

close to those of traditional banks.¹⁰

We start our description of the foreign banking sector in the US by showing that there is selection by size akin to what is observed for multinational firms in other, non-banking sectors. Figure 1 illustrates the comparison between European parents of US-based FBOs and European banks without overseas operations in the US, in terms of loans, deposits, and overall assets.¹¹ It is evident that the foreign banks that enter the US market through affiliates are larger than the ones that do not.¹² 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 banks compared to parents of foreign branches.

At the affiliate level, there are large size differences between subsidiaries and branches of FBOs. Figure 2 reports the average size of deposits, loans, and overall assets held by a US branch or subsidiary of a European bank. The average subsidiary of a foreign bank is substantially bigger than the average branch in terms of deposits, loans, and overall assets. 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 the Appendix).

Finally, Figure C.3 in the Appendix shows that the amount of assets foreign banks hold in the US is positively related to their domestic size, indicating that banks that are “big” in their home

¹⁰In 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.

¹¹The assets 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.

¹²To 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 don’t have significant operations in other foreign markets either.

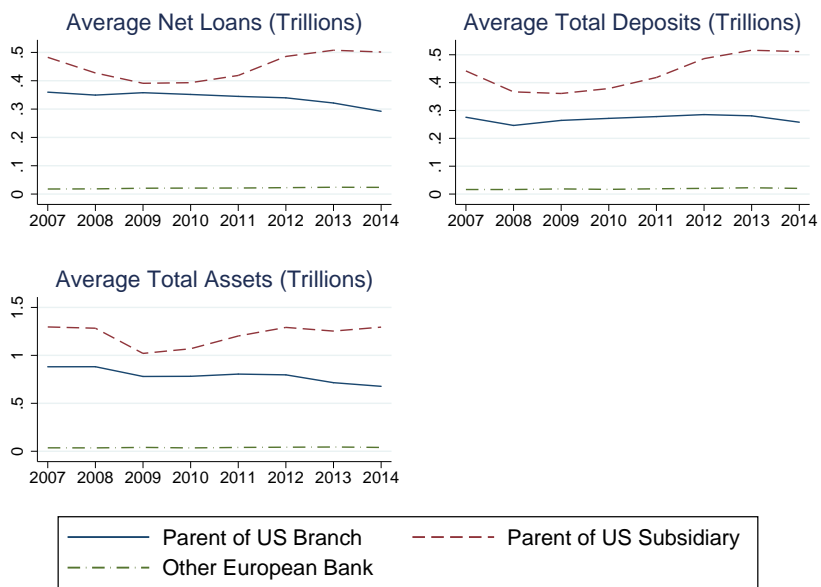


Figure 1: **Foreign Parents vs Foreign National Banks.** Comparison of size measures of foreign parents of US-based FBOs (subsidiaries and branches) versus foreign banks without overseas operations in the US. Source: SNL data for top tier parents of US branches and subsidiaries from Europe. Data are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

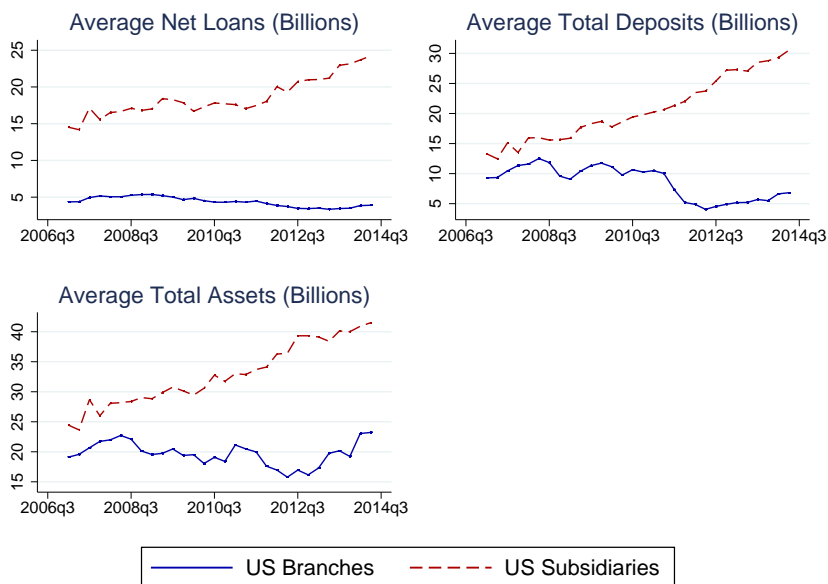


Figure 2: **US-Based Branches vs US-Based Subsidiaries of Foreign Banks.** Comparison of size measures of US-based subsidiaries and branches of FBOs. Data source: US Structure Data for US Offices of Foreign Banking Organizations - Selected Assets and Liabilities of Domestic and Foreign Owned US Commercial Banks plus US Branches and Agencies of Foreign Banks. Data are in billions of US dollars.

country also have large foreign operations. This fact motivates an important assumption of the model, whereby banks transfer their efficiency to their foreign affiliates.

2.3 Foreign Banks' Response to Shocks

In this subsection, we use the European 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 an exposed parent increases, and the amount of the transfer increases; and 3) there is a flight of uninsured wholesale deposits from the US branches of exposed European parents, while both the insured and uninsured deposits of US subsidiaries of exposed European parents are not affected.

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

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

where $a_{b,t}^e$ is the natural log of total assets of entity e belonging to bank b at time t . An entity is either an aggregate of US-based branches or an aggregate of US-based subsidiaries belonging to 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 Greek, Italian, Irish, Portuguese, or Spanish (GIIPS) sovereign debt.¹³ δ_c denotes parent country fixed effects,

¹³We classify a bank as exposed if it has GIIPS sovereign debt holdings above the sample median. Our results are robust to alternative definitions of exposed banks. In particular, 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 (median) exposure is only 3.07 percent (1.7 percent) of assets. 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.

Table 1: **Intensive Margin of Assets.** Branches versus Subsidiaries.

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

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.¹⁴

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 an internal transfer of resources from the US to Europe. The left panel of Figure 3 shows the evolution of the aggregate net flows to and from related institutions. From 1995 to 2011, the amounts that parent banks have been borrowing from their foreign branches are much larger than the amounts that foreign branches have been borrowing from their parent banks. This pattern is consistent with the evidence shown by Cetorelli and Goldberg (2012a,b) and Correa et al. (2016) about foreign branches being a source of funding to their US parents. The pattern sharply reverts at the onset of the European sovereign debt crisis in 2011. The right panel of Figure 3 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.¹⁵

We run the following regressions to establish more precisely the sharp distinction between

¹⁴For 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.

¹⁵Figure C.4 in the Appendix illustrates the breakdown of intrafirm flows by origin country.



Figure 3: **Net intrafirm flows for foreign branches.** The plot shows the difference between *Net due from related depository institutions* and *Net due to related depository institutions* (items 2 and 5, respectively, from the “Schedule RAL - Assets and Liabilities”). Data source: Report of Assets and Liabilities of US Branches and Agencies of Foreign Banks (FFIEC 002). Data are in billions of US dollars.

intrafirm flows of exposed versus non-exposed banks with foreign branches:

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

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 parents are 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 from the already exposed European parents to their branches. To shed light on this apparent puzzle, we examine the funding side of US FBOs' balance sheets by running regressions of deposits on a set of dummies that are analogous to the ones previously used :

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

where $d_{i,t}^e$ is the natural log of total deposits of entity e at time t . We run three separate regressions:

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

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

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.¹⁶

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 unique of branches owned by exposed parents, which suffered a large and significant decline. On the contrary, wholesale deposits in subsidiaries owned by exposed parents increase. Other papers¹⁷ document the flight of wholesale deposits during the European sovereign debt crisis, but didn't highlight the different responses depending on the organizational form of the banks accepting them. Table 3 suggests that the flight affected only those deposits that were held in branches, indicating that the less regulated organizational form was perceived as less stable by large wholesale depositors.

The results of this analysis depict a scenario in which distress among some European parents was associated with a flight of uninsured deposits from 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

¹⁶Deposits 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.

¹⁷See Correa et al. (2016), Egan et al. (2017).

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

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

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 illustrates the main trade-offs that a bank faces when deciding whether and how to operate in a foreign country. We extend the Monti-Klein model (see Klein, 1971, and Monti, 1972) to a setting with monopolistic competition among heterogeneous banks, featuring the institutional characteristics of different bank types. The model enables us to understand banks' decisions as responses to various shocks and their consequences for the banking sector on aggregate, and lays the ground for the quantitative analysis developed in the next section.

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 (*). Each country is 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.

In order to examine the effect of shocks like the European Sovereign Debt crisis, we develop the model in two periods. In the first period, each bank chooses whether and how to operate in the foreign market, makes profits, and accumulates equity. At the end of the first period, an unexpected shock hits the economy, affecting equity accumulation and banks' decisions in the second period.

We start by modeling the maximization problem of a bank conditional on its international status: national bank, parent + subsidiary, or parent + branch. 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.

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 markets. For simplicity, the interbank market is assumed to be perfectly competitive. We do not model domestic entry: all banks operate and 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 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. Moreover, each bank is endowed with a given amount of equity $E(a)$, which is a function of bank efficiency.

In order to assess the importance of banking policies for the response to shocks, we model deposit insurance and capital requirements. All banks accepting retail deposits have to pay deposit insurance to the FDIC. The FDIC determines the deposit insurance premium (IP), or assessment, on a risk basis. A bank's assessment is calculated by multiplying its assessment rate by its assessment base, where a bank's assessment base is equal to its average consolidated total assets minus its average tangible equity. The assessment rate is a function expressing the bank's ability

to withstand funding and asset stress, so we assume it is a function of bank’s equity and liabilities:

$$IP(D, L, M) = \underbrace{f_p(D, M^-, E(a))}_{\text{assessment rate}} \cdot \underbrace{(L + M^+ - E(a))}_{\text{assessment base}} \quad (4)$$

where M^+ (M^-) denotes interbank lending (borrowing).¹⁸

Banks are subject to capital requirements every period, *i.e.* there is a lower bound on the equity to risk-weighted assets ratio that they are allowed to sustain:

$$\frac{E(a)}{\omega_L L + \omega_M M^+} \geq k \quad (5)$$

where the value of k is set in the US under the implementation of the Basel II/ Basel III Accords. The parameters ω_L and ω_M are appropriate weights that reflect the riskiness of loans and investment, and are determined by the regulatory agencies (in the US case, by the Federal Reserve, FDIC, and Office of the Comptroller of the Currency).

Based on the evidence in Section 2, we assume that, 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 the Foreign market as a subsidiary, the subsidiary performs exactly the same operations as the parent: it accepts retail deposits, issues loans, makes investments, borrows/lends on the interbank market, holds independent equity, and it is subject to capital requirements on its own. We also assume that it faces operating costs analogous to the ones of the parent.

Conversely, if a bank enters the Foreign market by opening a branch, the activities of the affiliate differ from the ones of the parent. Branches do not raise independent equity, they are not subject to capital requirements, and can only accept uninsured wholesale 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 a measure of “distress” of the banking corporation, while insured deposits are not.

¹⁸Appendix D contains more institutional details about the calculation of deposit insurance assessments.

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:

$$\begin{aligned} \max_{L,D,M} \quad & p \cdot r_L(L) \cdot L - (1 - p)L + r_M M - r_D(D) \cdot D - aC(D, L) - IP(D, L, M) \quad (6) \\ \text{s.t.} \quad & E(a) + D \geq L + M \quad (\text{resource constraint}) \\ & \frac{E(a)}{\omega_L L + \omega_M M^+} \geq k \quad (\text{capital requirement}) \end{aligned}$$

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 retail deposits,¹⁹ 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 the capital requirement k . Notice also that the bank management cost and its equity depend on bank efficiency, which is the exogenous source of heterogeneity in the model.

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.²⁰ 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) ,

¹⁹In the data, parent banks and subsidiaries can accept all kinds of deposits, both wholesale and retail. For simplicity, in the model we assume that parent banks and subsidiaries only hold retail deposits. The results are robust to the removal of this simplifying assumption.

²⁰Figure C.5 in the Appendix shows that banks in our sample have equity over risk-weighted assets ratios well above the capital requirements set by the regulators.

described by the following first-order conditions:

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

where the functions' arguments have been omitted to ease the notation. The resource constraint pins down interbank activity: $M = E(a) + D - L$.

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 and deposit insurance plus the expected marginal loss from delinquent loans plus the opportunity cost of alternatives forgone, namely loans to other financial institutions in the interbank market. Similarly, deposits are set such that their “total” marginal cost, inclusive of management cost and insurance premium, is equal to the marginal cost of borrowing in the interbank market. Making some simple parametric assumptions, in Appendix D we illustrate that a bank’s maximal profits are an increasing function of bank’s efficiency $1/a$ and of bank equity $E(a)$.

Shocks to the economy may induce situations where the capital constraint of a national bank is binding. We refer to this scenario as the “constrained equilibrium” of the model, and present details of its solution 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 $s_E E(a)$ is made in order for it to have some initial capital. 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:

$$\begin{aligned} \max_{\substack{L, D, M \\ L^*, D^*, M^*}} \quad & pr_L(L) \cdot L - (1 - p)L + r_M M - r_D(D) \cdot D - aC(D, L) - IP(D, L, M) + \dots \\ & p^* r_L^*(L^*) \cdot L^* - (1 - p^*)L^* + r_M M^* - r_D^*(D^*)D^* - aC(D^*, L^*) - IP(D^*, L^*, M^*) - F_S \end{aligned} \quad (7)$$

$$s.t. \quad (1 - s_E)E(a) + D \geq L + M$$

$$s_E E(a) + D^* \geq L^* + M^*$$

$$\frac{(1 - s_E)E(a)}{\omega_L L + \omega_M M^+} \geq k$$

$$\frac{s_E E(a)}{\omega_L L^* + \omega_M M^{*+}} \geq k$$

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 . 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 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:

$$\begin{aligned}
& \max_{\substack{L, D, M, T \\ L^*, D^*}} pr_L(L) \cdot L - (1 - p)L + r_M M - r_D(D) \cdot D - aC(D, L) - IP(D, L, M) + \\
& \dots p^* r_{L^*}^*(L^*) \cdot L^* - (1 - p^*)L^* - r_D^{*w} \left(D_w^*; \left(\frac{E(a)}{k \cdot RWA} \right) \right) \cdot D_w^* - aC(D_w^*, L^*) - F_B \quad (8) \\
& s.t. \quad E(a) + D \geq L + M + T \\
& \quad \quad D_w^* + T \geq L^* \\
& \quad \quad \frac{E(a)}{\omega_L(L + L^*) + \omega_M M^+} \geq k
\end{aligned}$$

where $F_B > 0$ is the fixed cost of operating a foreign branch, and T is the intra-firm transfer between the two entities ($T > 0$ 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 market²¹, 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 $r_D^{*w} \left(D_w^*; \left(\frac{E(a)}{k \cdot RWA} \right) \right)$ is the supply of wholesale deposits, where RWA denotes risk-weighted assets: $RWA = \omega_L(L + L^*) + \omega_M M^+$.

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 $\frac{E(a)}{k \cdot RWA} = 1$, the capital requirement is binding and the bank experiences maximum distress, resulting in a flight of wholesale deposits. Distress decreases as $\frac{E(a)}{k \cdot RWA}$ grows bigger than one.

²¹All interbank activity M is managed by the parent.

3.5 Industry Equilibrium and Equity Accumulation

Each country is populated by a 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:

$$\int M(a; r_M)G(a)da + \int M^*(a; r_M)G^*(a)da = 0. \quad (9)$$

Each bank starts the first period with a given level of equity $E(a)$, and accumulates equity over time through reinvested profits:

$$E'(a) = E(a) + \pi(a) \quad (10)$$

where $E'(a)$ denotes second period equity. Finally, banks exit the market if they reach negative equity: if $E'(a) < 0$ for a national bank or for the parent of a conglomerate, the entire bank shuts down, while if $E'(a)$ 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 types: national banks, parent + subsidiary pairs, and parent + branch pairs. Notice that in the model branching and subsidiarization are alternative choices, hence no bank chooses both options to operate in a foreign market. This result is consistent with most of the observations in our sample. Among the 47 European banks in our sample, 37 operate in the US market either exclusively with branches or exclusively with subsidiaries. 6 of the remaining banks adopt both options, but have more than 70 percent of their assets in one organizational form.

The fixed costs associated with foreign operations imply that the largest, most efficient 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 global banks into subsidiarization (branching) if subsidiarization is associated with lower variable costs but higher fixed costs than branching, as illustrated in Figure 4.

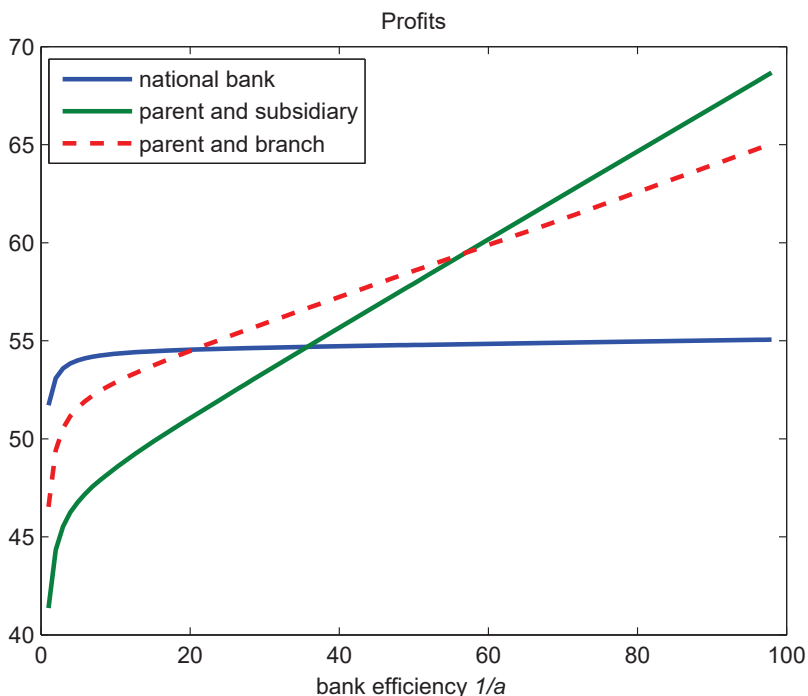


Figure 4: **Selection.** Selection by efficiency/size into international and organizational status.

Differences in efficiency then directly translate into differences in the size of deposits, loans, and overall assets, so that more efficient banks issue more loans, accept more deposits, and have overall more assets than less efficient banks. By including the relative sizes of different bank types as target moments of our calibration, we ensure that the model generates the same selection pattern 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 parameterizing and calibrating the model to be consistent with the cross-sectional stylized facts presented 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 distributions. 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 parameterize the model to preserve tractability and make possible the identification of key parameters. 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 retail deposit supply function: $D(r_D) = r_D^{\vartheta} B$, where $\vartheta > 0$ is the elasticity of retail deposit supply, and B is a parameter describing the aggregate size of the retail deposits market. For wholesale deposits, this specification is augmented to generate responses to a measure of distress of the banking conglomerate: $D_w(r_D^w) = (r_D^w)^{\vartheta_w} \log\left(\frac{E(a)}{k \cdot RWA}\right) B_w$ where $\vartheta_w < \vartheta$ is the elasticity of wholesale deposits and B_w is a parameter describing the aggregate size of the wholesale deposits market. 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. We assume that the management cost function is linear: $C(D, L) = c_L L + c_D D$ where $c_L, c_D > 0$, and postulate a parametric form for the deposit insurance assessment which broadly follows the FDIC Current Assessment Rate Calculator for Highly Complex Institutions:²²

$$IP(D, L, M) = \left[R_{min} + f_p \cdot \frac{M^-}{E(a)} \right] \cdot (L + M^+ - E(a)). \quad (11)$$

We calibrate directly the parameters p , R_{min} , 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

²²Appendix D contains more details about these parametric choices.

in turn is given by the probability of default times loss given default (one minus the recovery rate). The recovery rate is calibrated to a standard value of 40 percent, which in case of default implies $(1 - p) = 0.4$. In normal times, we calibrate the probability of default to a baseline value of 2.5 percent. This is an approximate middle-range measure based on estimated probabilities of default on debt with credit ratings varying from AAA to BB.²³ Based on these observations, we set the probability of loan repayment (in normal times) to 0.99 ($1 - 0.025 \times 0.6$).

Consistent with the assessment rates reported in Table D.1 in the Appendix, we set $R_{min} = 0.025\%$ to match the minimum possible assessment rate in the scenario in which the bank lends in the interbank market ($M > 0$) and $f_p = 0.0224\%$ is set such that the bank will be assessed the maximum possible rate if its capital constraint binds and it relies on the money markets for 95 percent or more of its funding.

We set the capital requirement to $k = 0.045$, which is 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 US 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 percent of the equity of the parent. As such, we set $s_E = 0.11$. Table 4 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 parameters of the banks' efficiency distribution, we start by observing that we cannot reject the hypothesis that the empirical distribution of interest revenues from loans is log-normal. In Appendix E we 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 $\sigma_L = (\varepsilon - 1)\sigma$. Maximum likelihood estimates of the parameters of the empirical distribution of interest revenues from loans deliver $\mu_L = 5.95$ and $\sigma_L = 1.93$. Hence we model banks' efficiency as a random draw

²³Source: http://www.newyorkfed.org/research/staff_reports/sr190.pdf.

Table 4: **Direct Calibration.**

Parameter	Definition	Value	Source
p	probability of loan repayment	0.99	World Bank
R_{min}, f_p	insurance premium parameters	0.00025, 0.000224	FDIC
k	capital requirement	0.045	Basel II/III
ω_L, ω_M	risk weights	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)

from a log-normal distribution whose parameters μ, σ , 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 ($k=0.045$) plus a 4 percent capital buffer.²⁴ 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.5 in the Appendix).

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 symmetry assumptions and use the model to choose values for these parameters such to match 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

²⁴We 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.

a link between the relative sizes of the loans markets and the subsidiary's equity share, so 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 subsidiary/ average branch, in terms of loans;
2. relative size of average subsidiary/ average branch, in terms of deposits;
3. relative presence of foreign branches versus foreign subsidiaries;
4. share of US 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 US- based FBOs, and in turn FBOs account for about 30 percent of total loans extended in the US. As a target for the average interest rate on retail deposits we use rates on checking accounts, at 0.12 percent. We use LIBOR to pin down the value of the interbank market interest rate, at 0.92 percent. Finally, loans in 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 percent.

Table 5 reports the model-generated moments alongside the corresponding moments in the data. The model does a good job at replicating the relative presence of foreign branches versus subsidiaries in the US, and the overall size of the foreign banking sector. We under-predict the relative size of loans and deposits, possibly due to a not perfect fit of the parametric efficiency and size distributions. The target interest rates all fit reasonably well. The corresponding calibrated parameters are reported in Table E.1 in the Appendix. The calibration reveals a sizeable elasticity of loans demand, $\varepsilon = 4.4$, corresponding to an average mark-up of 31 percent. The reported fixed costs imply that the cost of opening a subsidiary (branch) is equal to 52.3 percent (82.3 percent) of the average per-period profits of the subsidiary (branch) itself.

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

Table 5: **Moments, Model versus Data.** Parameters are matched to moments for the year 2010.

Moment	Data	Model
Nr. of subsidiaries/Nr. of branches	0.31	0.32
Share of U.S loans issued by FBOs	30%	35%
Average subsidiary loans/branch loans	3.87	2.09
Average subsidiary deposits/branch deposits	1.81	1.39
Avg. Interest Rate On Deposits	0.12%	0.23%
LIBOR One-Year Interbank Rate	0.92%	0.84%
Avg. Interest Rate on Loans	6.28%	7.2%

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 calibration of the fixed costs. Moments related to relative size are important to quantify the 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 numerical exercise with the goal of illustrating the consequences of the European sovereign debt crisis for the global banking sector. We show that model-generated changes in the activities of national banks, parent-branch pairs, and parent-subsidiary pairs are similar to what we observe in the data.

Starting from the baseline model economy, we simulate the European sovereign debt crisis in two different ways. In the first specification, we introduce an unexpected drop in the probability of loan repayment (to $p' = 0.964$), after banks have decided their optimal amounts of loans and deposits based on the baseline value of p . This exercise, which we refer to as a “3.6 percent default”, generates an average reduction in equity accumulation of 10 percent, similar in size to what we see in the data (see Figure C.5 in the Appendix). In the second specification, we impose a homogeneous 10 percent drop in equity at the end of the period, with the same average effect, but balanced across banks. In both exercises, the decline in bank equity reduces banks’ buffers on capital requirements: $E(a)/RWA$ decreases. This decline differs across banks according to the importance of loans in their portfolio allocations.

Table 6 displays the results of this exercise as percentage changes from the baseline pre-crisis economy, reporting both partial equilibrium (keeping the interbank rate r_M constant) and industry

Table 6: **Response to a loan repayment shock in the model.** Percentage changes relative to baseline pre-crisis economy.

	3.6% default		$E'(a) = 0.9 \times E(a)$	
	PE	IE	PE	IE
Average P-B parent equity	0.92	0.92	0.90	0.90
Average branch wholesale deposits	0.91	0.88	0.88	0.87
Average P-B transfers	1.08	1.13	1.09	1.11
Average branch loans	0.98	0.99	0.97	0.98
Average P-S parent equity	0.81	0.81	0.90	0.90
Average subsidiary retail deposits	1	0.99	1	1.00
Average subsidiary loans	1	1.01	1	1.01
Aggregate loans	0.96	0.96	0.96	0.96
Interbank rate	0.84%	0.80%	0.84%	0.82%

equilibrium effects (letting r_M adjust). The two exercises have similar qualitative effects. The drop in parent equity implies that wholesale deposit supply in US-based branches decreases, due to depositors' fears about the health of the conglomerate. In our calibrated economy, the decline in wholesale deposit ranges from 9 percent to 13 percent across specifications. As branches experience a funding shock, their demand for borrowing increases, and intrafirm borrowing from their parents ($T > 0$) increases, from 8 percent to 13 percent across specifications. As we observe in the data, the need for extra funding is not entirely fulfilled by the transfer, and loans decline moderately (between 1 percent and 3 percent, less than what we observe in the data). At the same time, consistent with our empirical observations, the balance sheet of US-based subsidiaries is unaffected by the shock that happens in Europe, despite the large drop in parents' equity.²⁵ Finally, the shock has a sizeable negative effect on aggregate loans in the US, which decline of 4 percent.

This simple exercise is consistent with the changes in branches and subsidiaries' balance sheets that we documented in Section 2, and as such raises our confidence in using the model to evaluate changes in regulatory policies. To this end, Table 7 illustrates the effects of a loan repayment shock under several interesting counterfactual scenarios. All the results are reported as percentage changes relative to the pre-crisis scenario, in industry equilibrium.

The first column in the table is the same as in Table 6, where the shock hits the baseline calibrated economy. In the second column, we compute the response to the shock in the counterfactual scenario where only subsidiarization is allowed. As expected, since subsidiaries are isolated

²⁵The only changes in subsidiaries' loans and deposits are due to industry equilibrium responses to changes in the interbank rate.

Table 7: **Response to a loan repayment shock in the model under different policy scenarios.** Percentage changes relative to baseline pre-crisis economy.

	baseline (3.6% default)	only subs	only branch	k=6%	monetary policy intervention
Average P-B parent equity	0.92	-	0.89	-	0.92
Average branch wholesale deposits	0.88	-	0.88	-	0.79
Average P-B transfers	1.13	-	1.03	-	1.39
Average branch loans	0.99	-	0.96	-	1.04
Average P-S parent equity	0.81	0.84	-	0.84	0.81
Average subsidiary retail deposits	0.99	0.97	-	0.99	0.94
Average subsidiary loans	1.01	1.03	-	1.01	1.08
Aggregate loans	0.96	1.02	0.94	0.99	1.02
Interbank rate change	-0.04%	-0.08%	-0.02%	-0.02%	-0.18%

from the shock in Europe, lending in the US does not decline in this scenario, while the decline in deposits is due to industry equilibrium effects through interest rate changes. The “subsidiaries only” economy is associated with aggregate loans that are 6 percent higher than in the baseline case: since subsidiaries’ activities are independent from their parents, subsidiarization prevents the transmission of the European shock to the US economy. The third column shows the results of the opposite scenario, where only branching is allowed. This is the scenario that has the most dramatic implications for banking in the US: the shock generates a 12 percent decline in branch deposits, a 4 percent decline in branch loans, and a 6 percent decline in aggregate loans, larger than in the baseline case. Again, this is the result of allowing as the only mode of global banking the one that facilitates the most the transmission of shocks across countries. In the fourth column we report the effects of the shock under a counterfactual higher capital requirement: $k = 0.06$. In the calibrated economy, this has the effect of reducing the incentives to branching, so all global banks open subsidiaries and the results are very similar to the ones of the subsidiaries-only case. Finally, in the last column, we illustrate the effects of the shock under an ad-hoc monetary policy intervention: after the equity decline induced by the default, the Government makes a “helicopter drop” equal to 40 percent of the aggregate M^+ . As a result of this intervention, the interbank rate decreases substantially, the transfer from parents to branches increases, and US lending does not decline, opposite to the baseline scenario.

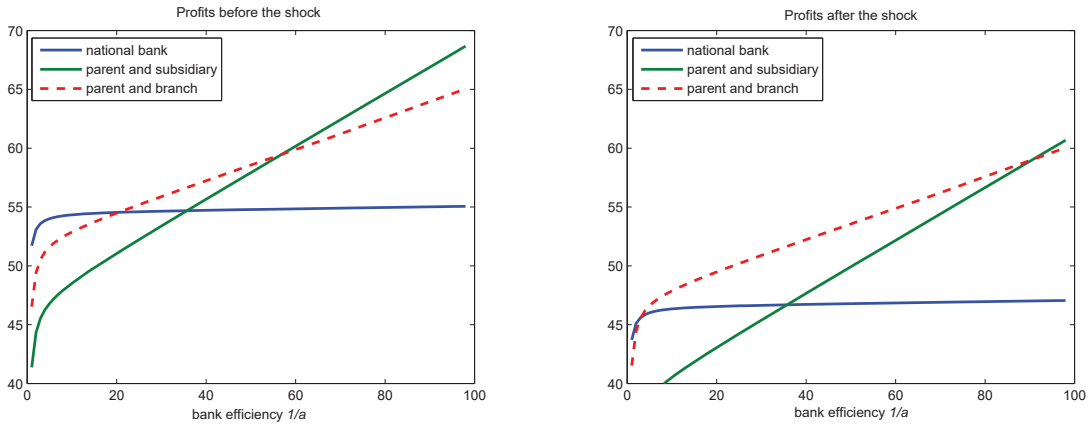


Figure 5: **Equilibrium Profits before and after a “large” shock to parent equity.**

4.3 The International Transmission of Shocks: Intensive versus Extensive Margin Adjustments

While the analysis so far focused on the European sovereign debt crisis, the structural model we developed in this paper allows us to think more broadly about banks’ responses to episodes of crisis and their aggregate consequences for the international transmission of shocks. Figure 5 illustrates graphically the implications of a generic, sizeable shock to parent banks’ equity or revenues for the equilibrium selection in the model. The left panel of the figure shows the equilibrium before the shock, with selection by efficiency into global status. The right panel illustrates selection in the post-shock economy. Following the shock, profits drop across the banks’ distribution, but banks with different global statuses show different responses. In particular, the fact that subsidiaries are separately capitalized does not allow parent-subsidiary conglomerates to reallocate resources internally, and the global profits of these banks are the most affected. On the other hand, the internal capital market that allows parents and branches to reallocate resources within the conglomerate across countries implies that their global profits fall less than the ones of the parent-subsidiary pairs.

Figure 5 implies that – for large enough shocks – it is more likely that parents decide to shut down subsidiaries compared to branches. If the parent of a branch is hit by a large shock, it can use the internal capital market (T) to reallocate resources across countries. Conversely, if the parent of a subsidiary is hit by a large shock, its only way to repatriate funds is to shut down its foreign subsidiary. Figure 6 shows suggestive evidence of this mechanism in the data. In the figure, we super-impose the time series of parent equity/assets growth on a histogram reporting

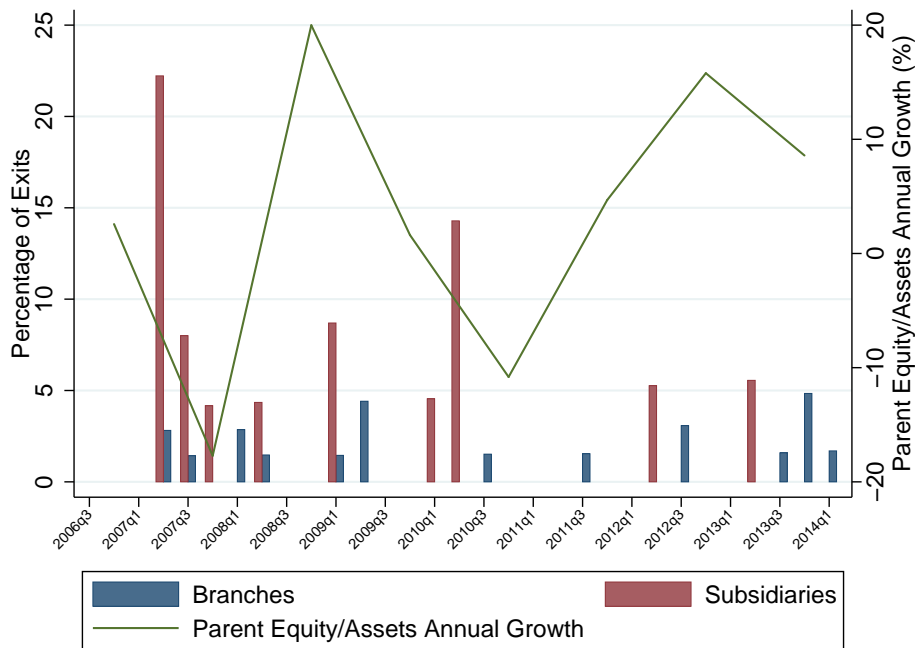


Figure 6: Exit and equity dynamics in the data.

the exit rates of US-based branches and subsidiaries of European banks. It is clear from the figure that a) subsidiaries are unconditionally more likely to exit than branches (consistently with the impossibility of their parents to repatriate assets otherwise), and b) periods of more pronounced exit tend to be periods where the equity position of parents decline.

Figure 6 provides external validity to the mechanism put forward in this paper. We can use these insights to evaluate the pros and cons of the two different organizational forms as vehicles of shock transmission across countries. On the one hand, the counterfactual analysis of our model economy, based on intensive margin changes, shows that branches act as vehicles of shock transmission across countries through their internal capital market. However, the same internal capital market allows for international intra-bank reallocations that have the effect to minimize the global consequences of a negative shock. On the other hand, subsidiaries are isolated from shocks to their parents in terms of their intensive margin balance sheet adjustments, but the absence of an internal capital market among the different units of the corporation makes banks that own subsidiaries less resilient to the shock.

These different responses on the different margins make the task of global banks' regulation extremely hard to accomplish. Our analysis so far reveals that the regulation has to balance a

trade-off between important policy priorities: limiting the transmission of shocks across countries versus maintaining the stability of large, systemically important banks.

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, management efficiency, and banking regulation. The features of the model allow us to highlight 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 European sovereign debt crisis through the lens of the theory, we calibrated the model and used 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 shocks across countries, so reducing their global impact.

We see this paper as the starting point of an agenda whose goal is to use careful quantitative analysis to inform the banking policy discussion. There are many important aspects of this problem which go beyond the scope of this paper, and we plan to tackle in future research.

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Appendix

A The Regulatory Framework: History and Current Status

The US Regulatory Framework has a long and complex history. We mention here those provisions that are relevant for the treatment of banks in our model.

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, 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.

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 US 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 Reserve's authority to supervise and regulate foreign banks. The Federal Reserve could now examine any foreign owned banking entity in the US, 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 US, 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 (1927) 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. 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

US 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 US 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 US Offices of Foreign Banks. The Structure Data is US 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 US 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.

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 US 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 Key field 132264), total deposits (132288), total net loans (132214), interest earned on loans (132532) and interest expense on deposits (133820.)

Exposure Data

Exposures for “top-tier” parent banks 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 above median 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 additional evidence in support of the broad patterns that we documented in the body of the paper.

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

In Section 2 we have shown large size differences between branches and 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.

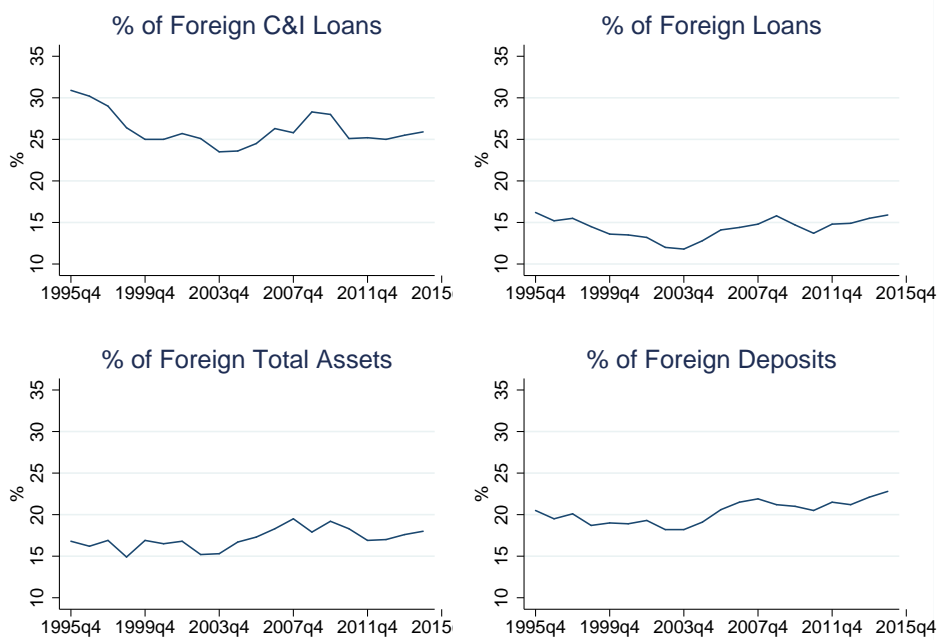


Figure C.1: **Percentage of assets, commercial and industrial loans, total loans, and deposits held in FBOs in the US.** Data source: Structure Data for US Offices of Foreign Banking Organizations - Selected Assets and Liabilities of Domestic and Foreign Owned US Commercial Banks plus US Branches and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

To support the assumption of the model whereby banks “transfer” their managerial efficiency when going abroad, Figure C.3 shows that the amount of assets foreign banks hold in the US is positively related to their domestic size.

Figure C.4 illustrates the evolution of intrafirm flows by bank exposure and also by main origin country, to illustrate that also banks from non-GIIPS countries were involved in the flow reversal we document in Section 2.

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.5 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.

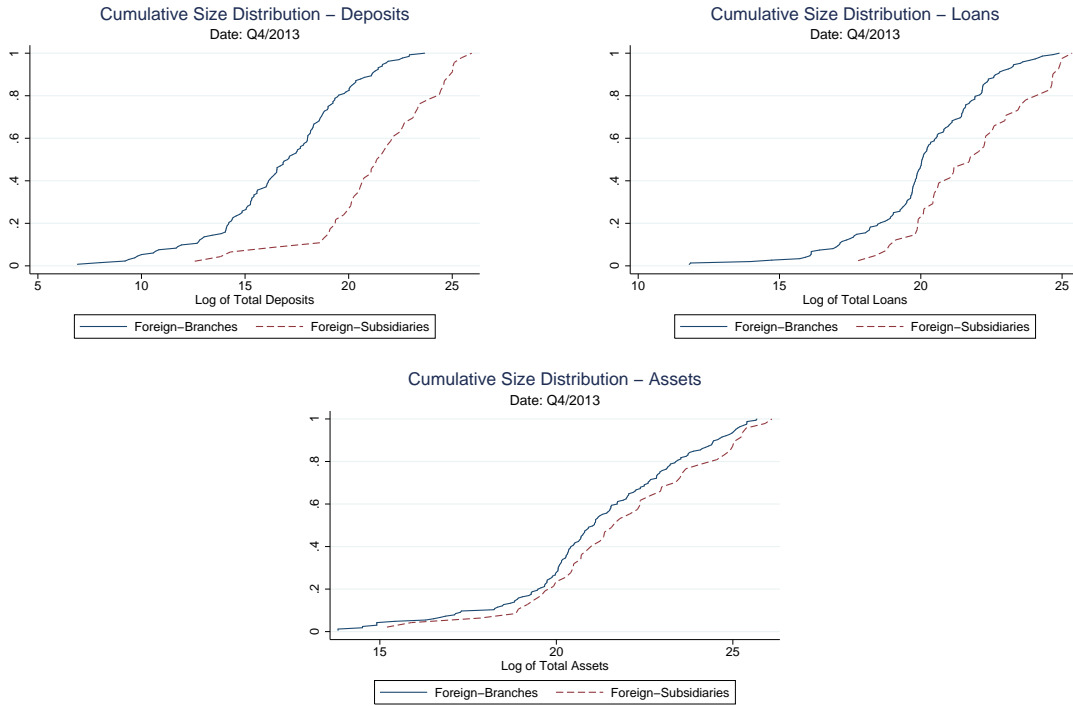


Figure C.2: **Size Distributions.** Cumulative distribution functions for deposits, loans, and assets, respectively, held in foreign owned subsidiaries and branches in the fourth quarter of 2013. Data source: US Structure Data for US Offices of Foreign Banking Organizations - Selected Assets and Liabilities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

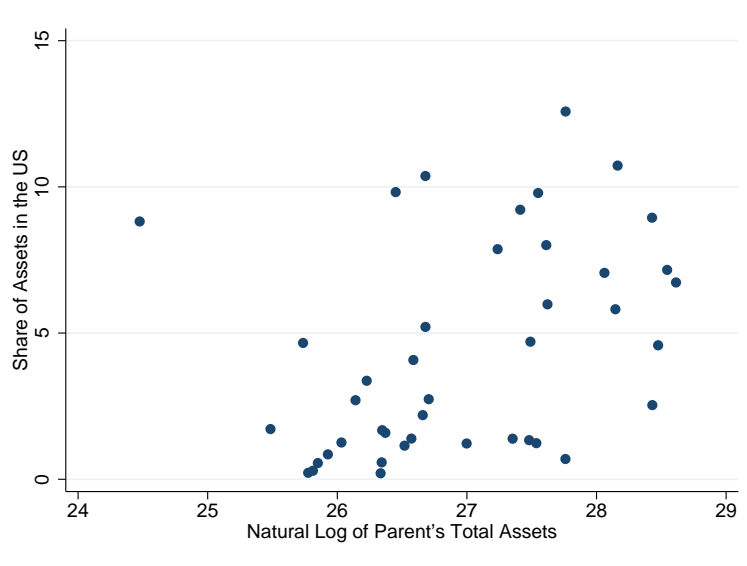


Figure C.3: **Size of Domestic versus Foreign Assets.** Share of US assets in a parent's total assets versus the parent's size. Source: SNL data for top tier parents of US branches and subsidiaries from Europe, 2013.

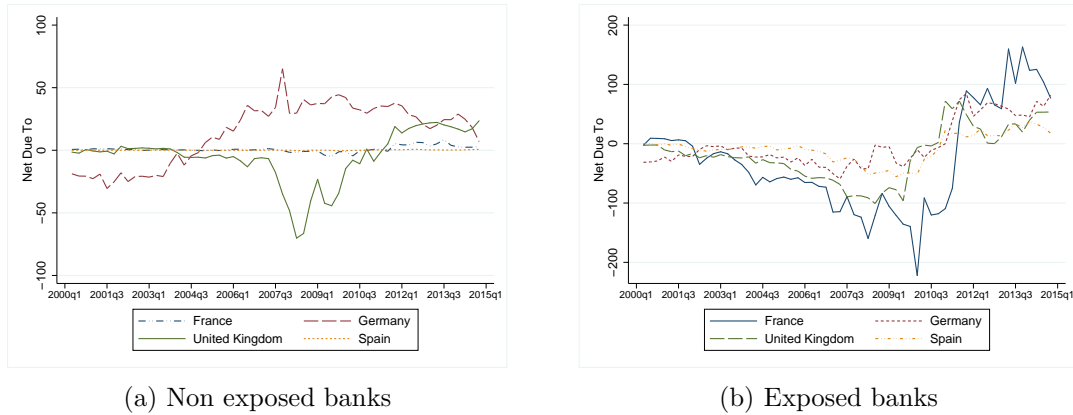


Figure C.4: **Net intrafirm flows by origin country.** The plot represents the difference between *Net due from related depository institutions* and *Net due to related depository institutions* (items 2 and 5, respectively, from the “Schedule RAL-Assets and Liabilities”), broken down by parent exposure and by origin country. Data source: Report of Assets and Liabilities of US Branches and Agencies of Foreign Banks (FFIEC 002). All values are expressed in billions.

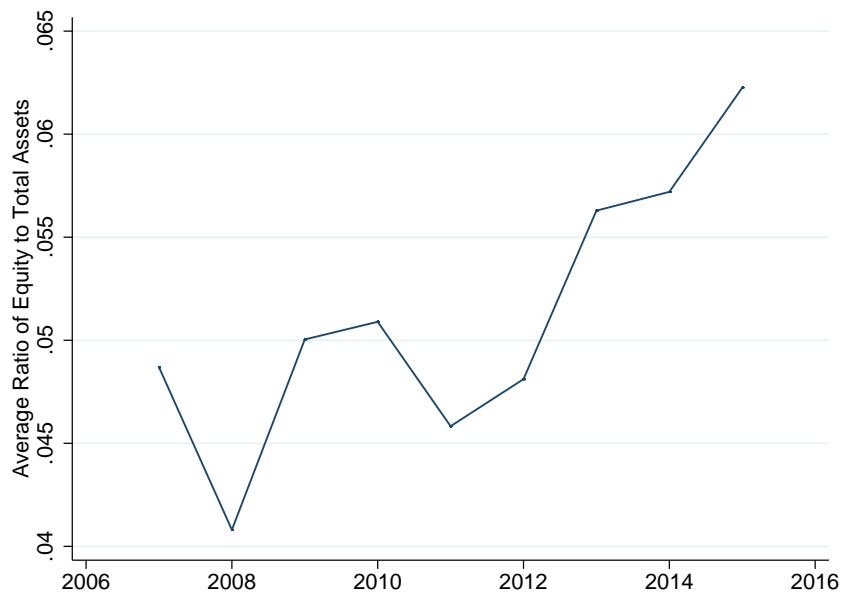


Figure C.5: **Parent Equity over Assets.** Average equity over assets held in European parents of foreign banking organizations in the US.

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

Bank Name	nr. of subs	nr. of branches	% of assets in subs.	% of assets in branches
Allianz Se	0	2	0	100

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Bank Name	nr. of subs	nr. of branches	% of assets in subs.	% of assets in branches
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
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

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Table C.1 – *Continued from previous page*

Bank Name	nr. of subs	nr. of branches	% of assets in subs.	% of assets in branches
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

D Details on the Construction and Solution of the Model

D.1 On the Modeling of Deposit Insurance

As described in Section 3, all banks accepting retail deposits have to pay deposit insurance to the Federal Deposit Insurance Corporation (FDIC). The FDIC is an independent agency created by the US Congress, in charge of insuring deposits. The main goal of deposit insurance is to prevent bank runs. At the same time, deposit insurance also generates moral hazard problems. Since bank deposits are insured, bankers have incentives to engage in riskier behavior. The classical way to address this moral hazard problem and ultimately reduce the risks of bankruptcies is to have the deposit insurance priced at the actuarially fair rate. Thus, in order to achieve a certain level of actuarial fairness, modern deposit insurance is not paid as a flat fee on insured deposits, rather it is assessed based on the risk profile of a bank’s assets and funding sources. Under the Dodd-Frank Act, the FDIC assessment is applied to all assets less tangible equity (the assessment base), so banks pay additional insurance even if their source of additional funding is not itself insured.

Small banks are classified based on their riskiness according to the CAMELS rating system of broad risk measures and assigned a risk category based on these measures.¹ Table D.1 reports the current rates by risk-category:

¹CAMELS rating is a supervisory rating system developed by US regulatory agencies in which capital adequacy, assets, management capability, earnings, liquidity, and sensitivity to market risk are assigned a rating from 1 (best) to 5 (worst). A rating of 5 indicates that the bank’s problems are beyond management’s ability to control or correct.

Table D.1: **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

Larger banks and complex institutions are subject to the same total range of rates, but assessed based on three factors. The CAMELS rating constitutes 30 percent of the bank’s assessment rate, and the rest of the rate is calculated according to a formula based on factors related to asset risk and funding risk (50 and 20 percent, respectively). The asset risk measures generally punish higher leverage, riskier classes of assets and asset concentration into a particular sector. The funding risk measures generally reward having a larger share of funding from insured deposits and holding highly liquid assets, on the theory that such funding is less likely to flee in crisis. These formulaic measures are similar in nature to the categories assessed subjectively in the CAMELS rating.

Our proposed reduced-form expression in equation (4) follows the principles of the FDIC Current Assessment Rate Calculator for Highly Complex Institutions, available at: <https://www.fdic.gov/deposit/insurance/calculator.html>.

The highly complex institutions pricing scorecard lists three criteria as building blocks of the CAMELS: 1) ability to withstand asset-related stress; 2) ability to withstand funding-related stress; and 3) potential loss severity. Our formulation follows the second criterium, the ability to withstand funding-related stress:

$$IP(D, L, M) = \underbrace{f_p(D, M^-, E(a))}_{\text{assessment rate}} \cdot \underbrace{(L + M^+ - E(a))}_{\text{assessment base}} \equiv \left[R_{min} + f_p \cdot \frac{M^-}{E(a)} \right] \cdot (L + M^+ - E(a)), \quad (\text{D.1})$$

where $R_{min} > 0$ and $f_p > 0$. We abstract from the exact formulas for calculating the FDIC assessment rate, and adopt a functional form that results in a higher insurance premium the higher the interbank borrowing the bank resorts to in order to fund its activities, as a share of bank equity. This formula applies to national banks, subsidiaries, and parents of subsidiaries. The analogous formula for parents of branches includes both parent and branch loans in its assessment base.

D.2 The Bank's Problem: A Parametric Example

In order to illustrate some properties of the bank's problem, in this section we resort to a parametric example (which exploits the same parameterization we use in the calibration).

Like in the calibration, 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 retail deposit supply function: $D(r_D) = r_D^{\vartheta}B$, where $\vartheta > 0$ is the elasticity of retail deposit supply, and B is a parameter describing the aggregate size of the retail deposits market. We also assume a linear separable management cost function: $C(D, L) = c_L L + c_D D$ where $c_L, c_D > 0$, and the special form of the deposit insurance assessment described above. Under these assumptions, if a national bank is a lender in the interbank market ($M > 0$), its optimal loans and deposits in the unconstrained equilibrium are given by:²

$$L_N^u(a) = \left\{ \frac{\varepsilon}{p(\varepsilon - 1)} [(1 - p) + r_M + ac_L] \right\}^{-\varepsilon} A \quad (\text{D.2})$$

$$D_N^u(a) = \left\{ \frac{\vartheta}{(\vartheta + 1)} [r_M - ac_D - R_{min}] \right\}^{\vartheta} B, \quad (\text{D.3})$$

and maximal profits are:

$$\pi_N(a) = r_M E(a) + H_1(\varepsilon, p) [(1 - p) + r_M + ac_L]^{1-\varepsilon} A + H_2(\vartheta) (r_M - ac_D - R_{min})^{1+\vartheta} B \quad (\text{D.4})$$

where $H_1(\cdot)$ and $H_2(\cdot)$ are functions of model parameters only. Equation (D.4) shows that optimal banks' profits are increasing in bank efficiency $1/a$ and in the bank's equity $E(a)$.

D.3 Constrained Equilibrium in National Banks

In the model, the constrained equilibrium has two possible configurations, depending on whether the bank borrows or lends in the interbank market. We describe both below, under the parameterization introduced in the previous section.

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

²The intuition that this special example conveys is the same in the case in which a bank is a borrower in the interbank market, just less transparent algebraically.

in the constrained one. In this scenario, both customer loans and interbank loans enter the expression for risk-weighted assets, so that $M_N^c(a) = \frac{E(a)}{\omega_M k} - \frac{\omega_L}{\omega_M} L_N^c$. Deposits adjust to clear the resource constraint: $D_N^c(a) = \left(1 - \frac{\omega_L}{\omega_M}\right) L_N^c - \left(1 - \frac{1}{\omega_M k}\right) E(a)$ while constrained loans solve:

$$L_N^c(a) = \left\{ \frac{\varepsilon}{p(\varepsilon - 1)} \left[(1 - p) + \frac{\omega_L}{\omega_M} r_M + ac_L + (ac_D + R_{min}) \left(1 - \frac{\omega_L}{\omega_M}\right) + \dots \right. \right. \\ \left. \left. \frac{\vartheta}{\vartheta + 1} \left[\left(1 - \frac{\omega_L}{\omega_M}\right) L_N^c - \left(1 - \frac{1}{\omega_M k}\right) E(a) \right]^{1/\vartheta} B^{-1/\vartheta} \left(1 - \frac{\omega_L}{\omega_M}\right) \right] \right\}^{-\varepsilon} \quad A(D.5)$$

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:

$$L_N^c(a) = E(a)/(\omega_L k), \quad (D.6)$$

deposits adjust depending on the first order condition, and interbank borrowing clears the resource requirement:

$$M_N^c = D_N^c + \left(1 - \frac{1}{\omega_L k}\right) E. \quad (D.7)$$

D.4 Modeling the Wholesale Deposits Supply

Egan et al. (2017) show 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. We rely on their estimates and embed them in a parametric form of wholesale deposits supply that is consistent with their findings. Our model-based measure of bank distress is inversely related to the buffer on capital requirement that banks hold in normal times, given by equity over risk-weighted assets (RWA) divided by the capital requirement k . When $\frac{E(a)}{k \cdot RWA} = 1$, the capital requirement is binding and the bank experiences maximum distress, resulting in a flight of wholesale deposits. Distress decreases as $\frac{E(a)}{k \cdot RWA}$ grows bigger than one.

We choose the following functional form for the demand of wholesale deposits:

$$D_w^* = (r_D^{*w})^{\vartheta_w} \log\left(\frac{E(a)}{k \cdot RWA}\right) B \quad (\text{D.8})$$

where $\vartheta_w < \vartheta$ is the elasticity of wholesale deposits, and B_w is a parameter describing the aggregate size of the wholesale deposits market. 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.

For comparison purposes, Figure D.1 plots the retail deposit supply and the wholesale deposits supply for different values of the buffer on capital requirement.

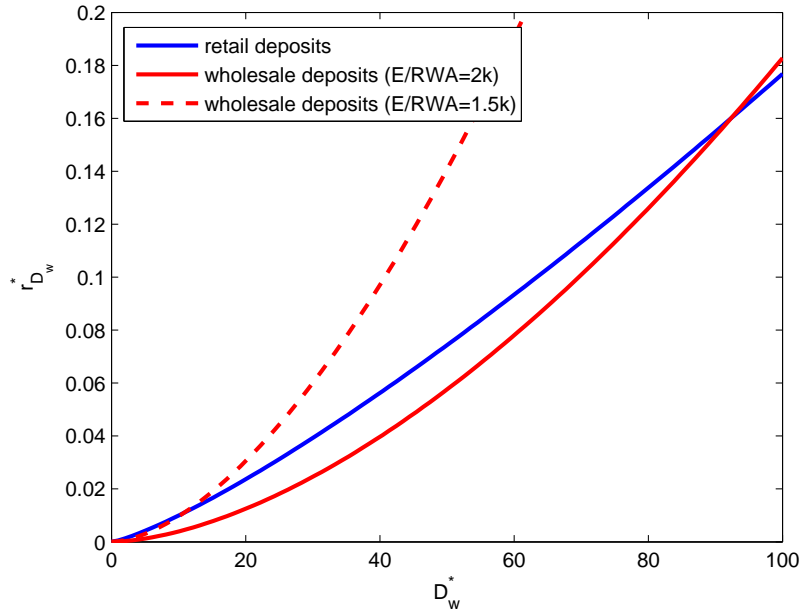


Figure D.1: **Retail and Wholesale Deposit Supply.**

E Details of the Calibration Procedure

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 result, 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, and under the assumption that a bank is lending in the interbank market, revenues from domestic loans are:

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

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:

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

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

The MLE estimates conditional on the distribution of the interest revenues from loans being log-normal deliver $\mu_L = 5.96$ 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.

E.2 Jointly Calibrated Parameters

Table E.1 reports the parameters that are calibrated to match the moments of interest. The implied parameters of the efficiency distribution, from equations (E.2)-(E.3), are $\mu = 5.4$, $\sigma = 0.57$.

Parameter	Definition	Value
c_L/c_D	Unit Management Cost	12.5
ε	Elasticity of Loan Demand	4.4
A^*	Loan Demand Shifter	5.52×10^{-2}
B^*	Retail Deposit Demand Shifter	1.28×10^5
B_w^*	Wholesale Deposit Demand Shifter	2.31×10^4
F_S	Fixed Cost of Subsidiarization	167
F_B	Fixed Cost of Branching	142

Table E.1: Calibrated Parameters.