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Abstract

This paper documents a new type of cross-border bank lending channel using a novel dataset on the balance sheets of U.S. branches of foreign banks and their syndicated loans. We show that: (1) The U.S. branches of euro-area banks suffered a liquidity shock in the form of reduced access to large time deposits during the European sovereign debt crisis in 2011. The shock was related to their euro-area affiliation rather than to country- or bank-specific characteristics. (2) The affected branches received additional funding from their parent banks, but not enough to offset the lost deposits. (3) The liquidity shock prompted branches to cut lending to U.S. firms, which occurred mostly along the extensive margin. In turn, the affected U.S. firms suffered reduced access to syndicated loans, which prompted them to cut investment and built up their cash reserves.

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1. Introduction

The interaction between global banks and the shadow banking system, as a relevant factor in the international transmission of financial shocks, has garnered the attention of policymakers and academics since the Global Financial Crisis. On one hand, global banks' lending activity across countries is a well-known channel for the international propagation of shocks (Cetorelli and Goldberg, 2012 a,b; Peek and Rosengren, 1997; Schnabl, 2012). On the other hand, U.S. money market mutual funds represent a key component of the shadow banking system and a major source of short-term dollar financing for foreign banks operating in the United States (Chernenko and Sunderam, 2014). The role of money market funds in the global propagation of shocks has been less documented, but gained prominence during the escalation of the European sovereign debt crisis in 2011.

We analyze the activity of foreign banks in the United States through the operations of their local branches, which receive sizeable funding in the form of large time deposits from U.S. money market funds.[1] In 2011, the rising prospects of European sovereign defaults, together with the regulatory reform requiring money market funds to disclose their asset portfolios, translated into a severe funding shock to some of the U.S. branches of euro-area banks.[2] To a large extent, the shock occurred as the money market funds cut their holdings of large time deposits issued by these branches. The dollar liquidity shortage was partially compensated with transfers from the euro-area parent banks to their U.S. branches. However, the liquid assets of

[1] The Foreign Bank Supervision Enhancement Act (FBSEA) of 1991prohibited U.S. branches of foreign banks from receiving insured deposits. A few branches that had insurance prior to the enactment of this law were grandfathered, but most of the deposits at U.S. branches of foreign banks are from large institutional investors or corporations.
[2] The Securities and Exchange Commission (SEC) amended rule 2a-7 to require money market funds to disclose information about their portfolio holdings each month. Funds began reporting this information in form N-MFP in November 2010. However, as noted in rule 30b1-7(b), the information collected in this form is released to the public "60 days after the end of the month to which the information pertains". Thus, the first batch of information was released on January 31, 2011.

euro-area parent banks were denominated largely in euros. As parent banks attempted to exchange these funds into dollars in large quantities, the cost of dollar funding increased substantially, reducing the amount of funds they could transfer to their U.S. branches. In turn, the liquidity shock led to a decrease in branch lending to U.S. borrowers, which negatively affected U.S. firms' investment and prompted them to increase cash holdings.

Focusing on the experience of foreign banks in the United States and the liquidity shock induced by the U.S. money market funds' pullback in financing to these entities in 2011, we use detailed branch balance sheet data and loan-level information to document a new type of bank lending channel. Namely, a shock in the form of increased sovereign stress in a bank's country of origin triggered a run on the branches' liabilities abroad; since the run was offset only partially by internal capital markets, branches reduced lending in the host country. Our empirical setup is ideal for analyzing the effect of a liquidity shock on bank lending for three reasons. First, the liquidity shock related to the European sovereign crisis mostly affected the U.S. branches of euro-area banks. This feature allows us to compare the lending activities of the U.S. branches of euro-area banks with those of the U.S. branches of foreign banks headquartered in other regions. Second, market commentary at the time suggested that the U.S. money market funds and other corporate investors pulled their dollar funding from euro-area banks regardless of the idiosyncratic credit risks they posed during the crisis, guided merely by the sovereign risk of their countries of origin.[3] Hence, after testing this assertion, we treat the funding shock as a Diamond and Dybvig (1983) bank run, where the run is driven by a shift in expectations rather than anything "fundamental about the bank's condition."[4] Third, we use a novel confidential

[3] For example, see http://www.reuters.com/article/2011/10/11/markets-money-idUSN1E79A0QC20111011

[4] In this scenario, there is a staggered run mechanism. Money market funds run from the U.S. branches of foreign banks to prevent a run on their own liabilities. The triggering mechanism for the behavior of money market funds is

supervisory dataset (i.e., the Shared National Credit, henceforth SNC) that provides loan-level data on syndicated lending, and that allows to control for factors affecting loan demand during the crisis, the omission of which might have biased our results toward falsely identifying an effect of funding shocks on bank lending. In addition, the syndicated loan market is particularly relevant for the U.S. branches of foreign banks, as roughly ¾ of their commercial and industrial (C&I) lending is done through these lending arrangements.

Besides adding to the literature on the global transmission of liquidity shocks, this study also makes an important contribution to the analysis of internal liquidity management within banking organizations. Previous studies focusing on internal liquidity management have documented that internal funds are good substitutes for external financing in periods of stress or when external financing constraints are binding (Cetorelli and Goldberg, 2012c; De Haas and Van Lelyveld, 2014). In these papers, liquidity management is frictionless, as the focus is either on movements of funds within a country (Campello, 2002), or on funding across countries with transferred funds denominated in the parent bank's home currency (Cetorelli and Goldberg, 2012a). However, the European sovereign crisis in 2011 was different, as a large deviation from covered interest rate parity in the euro-dollar foreign exchange market led to significant disruptions in bank liquidity management (Hrung and Sarkar, 2013; Ivashina, Scharfstein, and Stein, 2015). The data used in this paper allow for a direct measurement of the amounts transferred between the U.S. branches of foreign banks, their head-offices, and all other affiliates inside and outside the United States, as a result of the liquidity shock described above.

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labeled "headline risk". As noted in Copeland, Martin, and Walker (2014), "headline risk" is the "risk that a money fund may find itself in the headline of a news story". During the European sovereign debt crisis, money market funds had no incentives to appear in news reports naming them as holders of European bank debt, as it would trigger a run on their liabilities. As a result, these funds withdrew their deposits from the branches of euro area banks.

Our main results show that, first, the run on wholesale deposits in 2011 was not triggered by bank-specific characteristics, but rather by a broad sentiment against the liabilities of U.S. branches of euro-area banks. Second, in response to the liquidity shock, the U.S. branches of foreign banks with larger liquidity shocks—i.e., mostly the euro-area bank branches—relied more on funding from their own parent institutions, shifting from being net suppliers to being net receivers of dollar funding from their related offices. Third, internal funding was not enough to compensate for the drop in external financing. Therefore, the U.S. branches of foreign banks with larger liquidity shocks cut their C&I lending to U.S. firms. This result is robust to controlling for loan demand, which we do by using data on syndicated loans and estimating fixed effects at the sector- and firm-level. The reduction in lending took place mostly along the extensive margin rather than the intensive margin (i.e., branches reduced the number of U.S. firms to which they kept lending, rather than the amount of lending per firm). Fourth, the affected U.S. firms were not able to fully offset the reduced access to loans from euro-area banks by turning to other lenders; instead, they experienced reductions in loan volume and access to the syndicated loan market. Fifth, the publicly-traded U.S. firms that had lending relationships with the U.S. branches of foreign banks affected by liquidity shocks reduced their investment and increased their cash reserves relative to other publicly-traded firms. Overall, our results suggest that the liquidity shock suffered by the U.S. branches of euro-area banks during the 2011 European sovereign crisis had real economic effects in the United States.

Our findings provide evidence that the liquidity shock was not related to individual bank characteristics, but was facilitated by the structural vulnerabilities of U.S. money market funds and the change in regulation that allowed investors to scrutinize in more detail the holdings of these funds. Short-term debt issued by money market funds, although similar to bank debt, can

become information-sensitive, since it is not covered by deposit insurance and concerns may arise that losses from specific investments, like euro-area bank debt, may lead to a decrease in the funds' net asset value below their target of $1.00, an event commonly referred to as "breaking the buck" (Kacperczyk and Schnabl, 2013; McCabe, 2010). As documented by Chernenko and Sunderam (2014), U.S. money market funds with exposures to euro-area banks endured a "quiet run," that is, investor withdrawals increased as sovereign distress heightened in the euro area. In turn, as shown in Figure 1, these concerns at U.S. money market funds led to a considerable drop in the funding they provided to the U.S. branches of euro-area banks starting in June 2011.

The same pattern is visible in Figure 2, which shows a sharp decline in the amount outstanding of large time deposits concentrated at the U.S. branches of euro-area banks in mid-2011, of which more than half were initially received from U.S. money market funds.[5] In contrast, when Lehman Brothers collapsed in September 2008, the decline in large time deposits was milder and more uniformly distributed across the U.S. branches of foreign banks. As mentioned before, our results suggest that the U.S. money market funds and their investors focused largely on the aggregate sovereign distress of the foreign banks' countries of origin to make their divestment decisions, rather than discriminating among banks' relative holdings of risky sovereign debt. This type of inefficient liquidation is labeled by Huang and Ratnovski (2011) as the "dark side" of wholesale funding.

Our results on the working of internal capital markets show that, unlike during the 2008 Global Financial Crisis, euro-area parent banks initiated internal liquidity transfers to their U.S.

[5] U.S. money market funds held about 65 percent of all large time deposits issued by the U.S. branches of euro-area banks in the second quarter of 2011, but only 40 percent at the end of 2011.

branches in 2011 to offset the decrease in short-term financing from money market funds. However, these transfers coincided with an increase in the parents' dollar funding costs, which prevented the liquidity shortage from being offset completely. Figure 3 shows that the U.S. branches of euro-area banks became net borrowers vis-à-vis their head offices in the second half of 2011—unlike other foreign bank branches—which happened abruptly and for the first time in several years. However, this change in the direction of funding coincided with a large deviation of covered interest parity in the euro-dollar foreign exchange market, as measured by the 3-month implied basis spreads from euro-dollar swaps, shown in Figure 4. Thus, internal capital movements were not enough to prevent the contraction in net lending by U.S. branches of euro-area banks to non-financial firms in the United States, making clear how and to what extent an external financial shock in European sovereign credit markets can translate into adverse real effects to the U.S. economy (Figure 5).

Our findings also add to the literature that analyzes the impact of liquidity shocks on the real economy (Bernanke and Blinder, 1988; Kashyap and Stein, 2000). In this context, one branch of the empirical literature focuses on the international transmission of shocks through the activities of global banks. This literature has identified at least three types of channels that explain the propagation of a shock to banks' balance sheets to their lending abroad. The first type of channel, which was studied in Peek and Rosengren (1997), centers on the effects of a shock to a bank's capital on the lending of its affiliates abroad, such as the capital losses suffered by Japanese parent banks during the stock market downturn in the early 1990s that resulted in decreased lending by the U.S. branches. A similar effect is documented in Cetorelli and Goldberg (2012), who show that the funding shock suffered by euro-area banks due to their exposure to ABCP in 2008-09 resulted in reduced internal lending to their U.S. branches, which

in turn resulted in decreased lending by these branches in the United States. The second type of channel, documented in Giannetti and Laeven (2012) and De Haas and Van Horen (2013), emphasizes the transmission of shocks through cross-border (syndicated) lending. As in the first channel, constraints to capital are the main catalyst for the contraction in foreign credit. The third type of channel focuses on the effect of a liquidity shock to a bank on its lending to non-related banks operating in a third country (Schnabl, 2012). In this case, domestic banks in the third country reduce their lending activity as they are unable to access foreign sources of financing.

Our paper adds to this literature by documenting a new type of liquidity shock, as opposed to a shock to capital, which was caused by the foreign banks' reduced access to funding from *host* market sources (i.e., U.S. money market funds) rather than from sources in their country of origin or in third countries. Another important factor sets this liquidity shock apart from others: the shock was linked to developments in foreign financial markets (i.e., the European sovereign debt crisis) but *without* being triggered by adverse cross-border banking flows (for instance, like in Cetorelli and Goldberg 2012 a,b). In addition, our paper highlights the frictions associated with internal financing operations that involved multiple currencies (i.e., the costs encountered by euro-area banks when exchanging *euro liquidity* into dollars due to large deviations from covered interest parity), which can impair the effectiveness of internal capital markets in offsetting liquidity shocks.

Lastly, the paper also contributes to the literature that highlights the role of banks as providers of liquidity insurance (Acharya, Almeida, and Campello, 2013). As banks' access to wholesale financing diminishes, firms may become unable to get liquidity insurance in the form

of lines of credit from these financial institutions. In turn, firms may decide to increase cash holdings and reduce the resources devoted to investment during stress episodes.

In a closely related paper, Ivashina, Scharfstein, and Stein (2015) examine the same European sovereign crisis episode to test the change in euro-area banks' syndicated lending in dollars relative to their lending in euros. Our paper complements their study and makes additional contributions along three dimensions. First, as noted before, we use branch-level information to assess the magnitude of the liquidity shock suffered by the foreign branches and the amount of funding received from their parents to mitigate the liquidity shock. Second, the SNC database on syndicated loans that we use has several advantages over the Thomson Reuters' Dealscan database used in the afore-mentioned study. The SNC database reports the exact amount that participants in a syndicate contribute to each loan, the borrower's identity, and the legal entity within the banking organization that holds the loan (e.g, branch, commercial bank subsidiary, etc.). This information is only sparsely available in Dealscan.[6] In addition, the SNC database reports annual snapshots of all syndicated loans held by financial institutions that satisfy a set of minimum requirements, including the loans originated in previous years that are still outstanding. However, Dealscan only reports information on syndicated loans at issuance, thus lacking the time series dimension offered by the SNC. Third, we are able to assess the effect of the liquidity shock on firms' investment decisions by using a matched sample between

[6] Traditionally, studies that rely on Dealscan to analyze syndicated lending assign the full value of the loan amount to the "lead" bank(s) within the syndicate. For a matched sample (between Dealscan and our supervisory database) of more than 8,000 loans to U.S. borrowers, we find that this assumption would overestimate the loan amounts assigned to U.S. banks, relative to non-U.S. banks, by 15 to 20 percent.

the SNC syndicated loan database and the borrowing firms' balance sheet information from Compustat.[7]

Our results have important policy implications. As domestic regulators are implementing the new set of liquidity requirements passed under Basel III, a relevant question concerns the currency in which global banks should keep their liquidity buffers (Tarullo, 2012). This is particularly important for multinational banks with global funding models. The main implication from our findings is that banks that rely on unstable sources of foreign currency funding should keep part of their liquidity buffer in that foreign currency. This measure would help banks absorb potential liquidity shocks and mitigate their negative impact on lending.

The paper is organized as follows. Section 2 presents the data used in our analysis. Section 3 attempts to trace the origin of the liquidity shock to bank-, country-, and region-specific characteristics. Section 4 documents the internal liquidity management undertaken by the foreign bank organizations in response to the liquidity shock. Section 5 presents the results documenting the effect of the liquidity shock on the lending operations of the U.S. branches of foreign banks, on the U.S. firms' access to syndicated loans, and in turn on the U.S. firms' investment and cash reserves. Finally, Section 6 presents a set of robustness checks, and Section 7 concludes.

2. Data

We construct a comprehensive picture of the foreign bank organizations that operate in the United States, using a number of datasets that include the characteristics of the U.S. branches

[7] Previous papers have documented the real effects of bank capital shocks on the commercial real estate market (Peek and Rosengren, 2000) and on U.S. publicly-traded firms (Chava and Purnanandam, 2011). To our knowledge, this is the first paper showing the impact of a bank liquidity shock on U.S. publicly-traded firms.

of foreign banks, those of their parent banks, the flows between foreign parents and the U.S. bank branches, as well as the syndicated lending of the latter.

2.1 Branch and loan-level data

The Federal Financial Institutions Examination Council (FFIEC) requires all U.S. branches and agencies of foreign banks to report balance sheet and off-balance sheet information every quarter in the "Report of Assets and Liabilities of U.S. Branches and Agencies of Foreign Banks" (FFIEC 002).[8] Table 1 reports the number of banks per country that had branches in the United States as of 2011.[9] Taiwanese banks had the widest presence, with 13 U.S. bank branches, followed by the German banks. However, the branches of Japanese banks were the largest, with assets totaling $356 billion, thus edging the branches of Canadian banks, which held $320 billion in assets. The branches of European banks had a total of $1.2 trillion in assets, which represented more than half of the $2.1 trillion in assets held by all the foreign bank branches in the United States as of 2011.[10]

Table 2 shows the aggregate balance sheet of U.S. branches of foreign banks averaged across all quarters of 2011. The assets of European bank branches hovered at around $1.2 trillion during 2011, which was little changed from before the 2008 Global Financial Crisis. However, the balance sheet composition of European bank branches changed significantly during this period. For example, the claims on non-related parties increased from about 70 percent of total assets prior and during the 2008-2009 financial crisis (not shown) to about 86

[8] See Goulding and Nolle (2012) for a detailed analysis of these statistics and how they compare to those reported by U.S. commercial banks.
[9] We drop branches where the sovereign of the parent bank's country of origin does not have liquid Credit Default Swap (CDS) premiums.
[10] After matching the data on bank branches with that on parent banks, our results are based on the U.S. branch organizations of 131 foreign banks from 42 countries.

percent during 2011. Of these claims, as the European fiscal strains deepened, the branches of European banks increased cash holdings, which averaged about 40 percent of total assets in 2011. Loans were the second largest claim, at 23 percent of total assets in 2011, with C&I loans accounting for about half.

On the liabilities side, the largest funding component for the U.S. branches of foreign banks was deposits, representing about 50 percent of total liabilities on average during 2011. Most deposits were in the form of large time deposits—i.e., uninsured time deposits of $100,000 or more—representing 43 percent of the total branch liabilities. As noted above, a sizeable portion of these large time deposits were held by U.S. money market funds. For the U.S. branches of all foreign banks, the share of large time deposits contributed by money market funds fell from 61 percent at the end of 2010 to 57 percent at the end of 2011. To a large extent, this drop was explained by the decrease in the share of money market funds in the large time deposits of euro-area bank branches, which fell from 65 to 40 percent over the same period (not shown).

To analyze the liquidity management within banking organizations, we focus on the size and evolution of cross-border transactions between U.S. bank branches and their foreign parents. Financial flows between branches and parent banks can take the form of loans or the repatriation of profits. In Table 2, the *Net due from* position of the U.S. branches of foreign banks is listed on the assets side, while the *Net due to* position is part of liabilities. (The net due from and net due to positions represent the net funding provided and received, respectively, from related depository institutions.) The table shows that the U.S. branches of European banks had a positive *Net due to* position with related institutions in 2011, meaning that these branches owed to related institutions more than what the related institutions owed to the branches (i.e., 23

percent of their liabilities vs. 14 percent of assets). For the branches of all foreign banks in the sample, the aggregate *Net due to* positions roughly matched the *Net due from* positions with related offices.

In Table 3, Panel A reports summary statistics for the sample of branches of foreign banks. The mean U.S. branch network of foreign banks held about $16 billion in assets in 2011, but the median only reached about $1.4 billion.[11] With the exception of the *Net due to* positions with related entities and the head office, the mean of the branch indicators shown in the table did not change significantly between 2010 and 2011.

The last two rows in panel A of Table 3 show data for the parent banks of the branches. These data originate from the FR Y-7Q report collected by the Federal Reserve Board.[12] The variable *Relative size of branch network* is equal to the ratio of the assets of a branch network relative to the assets of the parent bank. In 2011, the average size of the branch networks in the sample was about 4.4 percent of the parents' assets, and represented a non-negligible amount of the total assets of these international banks. Lastly, *Parent Tier 1 capital ratio* is the ratio of Tier 1 capital over risk-weighted assets for the parent banks. In 2011, the average ratio stood at 12 percent, about 1 percent lower than in 2010.

In addition to the FFIEC 002 data on outstanding loans, we also use the SNC dataset on syndicated lending by the U.S. branches of foreign banks to U.S. addressees across sectors. This is a database on syndicated credits compiled by U.S. bank supervisors, which captures all syndicated credits larger than $20 million that have at least three unaffiliated U.S.-supervised bank participants. In all, the database contains about 8,700 credits with aggregate commitments

[11] We aggregate all branches of the same parent as a single entity.
[12] We match the data on bank branches from form FFIEC 002 to the data on their parent banks from form FR Y-7Q using the branches' RSSD identification and the National Information Center (NIC) database.

of $2.8 trillion in 2011. For some of our estimations, we aggregate the SNC data into outstanding C&I loan commitments and actual loans (or drawdowns) provided by the branches of foreign banks to U.S. borrowers from 78 sectors defined at the 3-digit NAICS level.[13] After merging the data on syndicated loans with the information on branch and parent balance sheets, our sample consists of 102 U.S. branch networks of foreign banks from 34 countries.

Panel B in Table 3 shows summary statistics for the sample of loans included in our dataset in 2010 and 2011. *Commitments* represent the total value of lines of credit as well as the total value of term loans. The median commitment for our sample of branches increased from $25 million to $30 million between 2010 and 2011. In that same period, the median of *utilization* (i.e., the value of commitment that is actually drawn down) remained unchanged at $5.1 million.

2.2 Other controls

We use additional country and bank-specific controls in our main specifications. Sovereign credit risk is measured by the 5 year CDS composite quotes compiled by Markit. To measure bank credit risk, we use the 5 year bank-specific CDS premiums from the same source. In addition, in the 2010 and 2011 versions of the European bank stress test conducted by the European Banking Authority (EBA), banks disclosed their detailed sovereign exposures, both by maturity and by country. We use this information to construct measures of banks' exposures to their own sovereign, as well as to Greece, Ireland, and Portugal.

[13] The sample of syndicated loans from the SNC includes both term loans and lines of credits. For term loans, the portion utilized from the loan should equal the amount committed by the lenders. In contrast, the utilized portion of lines of credit is typically lower than the total commitment (Barakova and Parthasarthy, 2012).

In one of our specifications, we test whether the government support for parent banks affected their U.S. branches' access to money market funding. We measure bank support using two types of bank-specific ratings from Moody's Investors Service. First, since 1995, Moody's has assigned *bank-specific financial strength ratings (BFSR)* to banks from about 90 countries, which "are intended to provide investors with a measure of a bank's intrinsic safety and soundness on an entity-specific basis" (Moody's Investors Service, 2007). More importantly, this measure does not include any external support that a bank may receive from its parent, from other institutions under a cooperative or mutual arrangement, or from the government. Second, Moody's also assigns a *bank-specific deposit rating (BDR)* to the banks it rates. This is the rating agency's opinion on a bank's ability to repay its deposit obligations punctually. As such, they incorporate both the bank's BFSR rating as well as Moody's opinion of any external support. Using these two ratings, we define the bank-specific government support measure as the difference (in rating notches) between a bank's BFSR and its BDR for long-term foreign currency deposits (see Correa et al., 2014).

3. Tracing the liquidity shock to foreign sovereign risk

We follow a difference-in-difference approach to explore the link between the change in the U.S. branches' financing received in the form of large time deposits ($\Delta Large\ Time\ Deposits_{ij}$) between 2010 and 2011 and the European sovereign debt crisis. The three sets of tests below use different explanatory variables as proxies for the parent banks' exposure to the sovereign debt crisis.

First, we focus on the relation between the liquidity shock and region-, country-, and bank-specific characteristics. Thus, we assess whether the liquidity shock was related to broad

characteristics such as the geographic location of the parent bank or, more narrowly, to the change in sovereign risk of the country of origin or, even more specifically, to branch- and parent bank-specific characteristics. A broad pullback in funding from euro-area bank branches would provide evidence that investors did not discriminate according to bank-specific characteristics, but rather acted like in a traditional "bank run" on banks from the same country or region (Diamond and Dybvig, 1983). On the contrary, a link between the liquidity shock and bank-specific characteristics would indicate a more differentiated pullback.

In the following specification, the dependent variable is the change in large time deposits from 2010 to 2011 held by the branches of foreign bank *i* from country of origin *j*. The quarter-end deposits are aggregated across all branches of a given foreign bank *i*, and are averaged separately for 2010 and 2011. The change in large time deposits from 2010 to 2011 constitutes the dependent variable. Among the explanatory variables, D_j is a dummy variable equal to 1 if the parent bank originates in the euro area and ΔCDS_j is the change in the average sovereign CDS premium of country of origin *j* from 2010 to 2011:[14]

$$\Delta Large\ Time\ Deposits_{ij} = \beta_0 + \beta_1 D_j + \beta_2 \Delta CDS_j + \beta_3 X_{ij} + \varepsilon_{ij} \qquad (1)$$

In addition, X_{ij} includes the following branch and parent bank-specific controls. *Log Branch* $Assets_{ij}$ controls for the initial branch size in 2010. $Loans/Assets_{ij}$ is the share of loans in the branches' assets in 2010, with a higher ratio suggesting that the United States represented a larger investment market for bank *i*, as in Cetorelli and Goldberg (2012 a,b). Similarly, $Deposits/Branch\ Assets_{ij}$ is the share of large time deposits in the branches' liabilities in 2010, with a higher ratio suggesting that the United States represented a larger funding market for

[14] The euro-area banks in our sample originate from Austria, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain. Other European countries, not in the euro area, with branches in the United States were Norway, Sweden, Switzerland, Turkey, and the United Kingdom.

bank *i*. The *Relative size of branch*$_{ij}$ captures the relative importance of the branch, measured by its assets, relative to the overall size of the banking organization. *Parent Tier 1 ratio*$_{ij}$, defined relative to risk-weighted assets, is a measure of capital adequacy for the branch's parent.

Second, we explore the importance of additional bank-specific characteristics using the following specification, in which ΔCDS_{ij} is a proxy for the idiosyncratic risk of the parent bank, obtained by removing the effect of the change in sovereign CDS premium from the change in the actual CDS premium of parent bank *i* from country of origin *j*:[15]

$$\Delta \text{Large Time Deposits}_{ij} = \beta_0 + \beta_1 D_j + \beta_2 \Delta CDS_{ij} + \beta_3 X_{ij} + \varepsilon_{ij} \quad (2)$$

Alternatively, we replace ΔCDS_{ij} with other measures of bank-specific risk, such as the conditional capital shortfall measure of systemic risk ($SRISK_{ij}$) in Brownlees and Engle (2016).

Third, we interact bank- and country-specific characteristics to obtain more precise measures of bank-specific exposure to sovereign risk as explanatory variables. In the following specification, we test whether the liquidity shock suffered by foreign branches was related to the change in sovereign CDS premium of the country of origin *j* (ΔCDS_j) interacted with the bank-specific measure of government support ($GovSup_{ij}$) defined in Section 2.2. We expect that the greater a parent bank's reliance on government support before the crisis, the larger should be the impact of an increase in sovereign risk on the branches' access to funding:

$$\Delta \text{Large Time Deposits}_{ij} = \beta_0 + \beta_1 D_j + \beta_2 \Delta CDS_{ij} + \beta_3 GovSup_{ij} \times \Delta CDS_{ij} + \beta_4 GovSup_{ij} + \beta_5 X_{ij} + \varepsilon_{ij} \quad (3)$$

[15] To obtain the change in the idiosyncratic component of banks' CDS premiums, we regress the change in the bank-specific CDS premiums on the change in the country of origin's sovereign CDS premiums, each computed as annual averages, in a panel for the period from 2007 to 2011, and take the residuals.

In Table 4, columns 1-2 present our first set of results on whether the liquidity shock was related to region-, country-, or bank-specific characteristics, as in equation (1). The dependent variable is the change in the branches' access to large time deposits. In column 1, there is a negative and statistically significant coefficient for the U.S. branches of euro-area banks, showing they suffered a disproportional decline in their access to large time deposits relative to other foreign bank branches. In column 2, the coefficient on the euro area indicator is still negative and statistically significant, while the coefficient on the sovereign risk of the parent country is not statistically significant. In addition, none of the branch- and bank-specific characteristics in X_{ij} are statistically significant in either specification, suggesting that the liquidity shock was an indiscriminate run on euro-area bank branches, rather than a more differentiated pullback guided by bank-specific characteristics. Figure 6 presents the intuition for this result, showing that the money market mutual funds withdrew their funding without differentiating across the U.S. branches of foreign banks with high or low tier 1 capital ratios (panel A). Also, the decline in large time deposits (panel B) or, more specifically, the decline in large time deposits that foreign branches received from money market funds (panel C) was uncorrelated with the parent banks' tier 1 capital ratio. The results for equation (2) with additional bank-specific characteristics support this conclusion, as shown in columns 3 and 4 of Table 4, where none of the bank-specific risk indicators (i.e., the change in the idiosyncratic component of banks' CDS or SRISK) is statistically significant, while the euro area indicator remains negative and statistically significant.

The results for equation 3 are in column 5. We expected that, for a given increase in a country's sovereign CDS premium, the branches of foreign banks that initially relied more on government support might have experienced larger reductions in dollar funding in the U.S.

capital markets. However, the coefficient on the interacted term is not statistically significant, providing no support for this hypothesis.

In the internet appendix, we present additional results for a modified version of equation (3), in which we replace the reliance on government support with the parent banks' initial holdings of own sovereign debt ($SovDebt_{ij}$) as a share of tier 1 capital, which is interacted with the change in sovereign CDS premia. Alternatively, we replace the interacted term with the parent banks' holdings of sovereign debt from the euro-area periphery (i.e. Greece, Ireland, and Portugal, $GIPSovDebt_{ij}$).[17] These specifications have the advantage of a more precise measurement of the parent banks' exposure to sovereign risk, but narrow down the sample to the 31 European banks that participated in the 2011 EBA stress test and provided data on sovereign debt holdings. However, none of the coefficients on the new proxies of exposure to sovereign risk is statistically significant.

Overall, our results suggest that money market investors withdrew their funding to euro-area branches in a rapid and somewhat indiscriminate way, like in a traditional deposit run. We find no evidence supporting the idea that the funding shock was related to bank-specific characteristics such idiosyncratic risk or exposure to sovereign risk.

4. Liquidity shocks and internal liquidity management

This section examines the internal funding operations undertaken by foreign parent banks in response to the liquidity shock faced by their U.S. branches. In theory, the foreign parent banks could step in and provide more dollar funding to their U.S. branches to compensate for the

[17] The 31 European banks with branches in the United States and with data on sovereign debt holdings from the 2011 EBA stress test originate in eight countries: Austria, France, Germany, Italy, Norway, Spain, Sweden, and the United Kingdom. We exclude branches with parents in Ireland and Portugal, which benefited from IMF bailout packages, from this specification.

latter's reduced access to U.S. money market deposits. Such an action would be reflected by an increase of the branches' "net due to positions" with related depository institutions, particularly for the branches that suffered larger funding shocks.[18] The increased financing from parents could have even offset the funding shock, in which case t there would be no reason to expect a link between the change in the branches' loans and large time deposits, which we explore in the next section. To test whether branches with larger liquidity shocks received more funding from their parents, we estimate the following equation:

$$\Delta NDTP_{ij} = \beta_0 + \beta_1 \Delta Large\ Time\ Deposits_{ij} + \gamma X_{ij} + \varepsilon_{ij} \quad (4)$$

where the dependent variable ($NDTP_{ij}$) is the change in the net due to position of the U.S. branches of bank *i* from country *j* relative to their parent bank from country *j* between 2010 and 2011. The explanatory variables are the change in large time deposits as a proxy for the liquidity shock ($\Delta LargeTimeDeposits_{ij}$) and the control variables (X_{ij}) defined for equation (1). The coefficient of interest in this equation is β_1, whose size and statistical significance provides information about the degree of substitution between the branches' large time deposits and the funds transferred to the branch from related depository institutions.

In Table 5, we present results on the internal liquidity management of foreign banks with U.S. branches during the 2011 European sovereign crisis. As expected, branches that faced a larger funding shock—shown by a greater decline in deposits—received more dollar funding from their parent banks. The coefficient on $\Delta Large\ Time\ Deposits_{ij}$ is negative and statistically significant in almost all columns. In addition, the financial support was provided not only by the

[18] The "net due to position" of a branch relative to its related depository institutions represents the net funding received by the branch from related deposit-taking institutions, and is reported as a liability in the branch's balance sheet.

head office of the parent bank, but also by other offices of the parent organization. This is shown by the larger negative coefficients on deposits when the dependent variable (the change in the net due to position) is computed relative to all related offices (in column 1) than relative to the head office (in column 2). However, the coefficients are lower than 1, showing that the additional dollar funding from the parent institution offset only partially the branches' reduced access to large time deposits from the U.S. money market funds.

These results are consistent with findings in the existing literature on the role of bank liquidity management within banking organizations (Campello, 2002; Cetorelli and Goldberg, 2012 a,b). As external financing becomes costly, banks resort to shifting liquidity from offices with available funds to those facing constraints. However, our results also show that frictions can arise in intra-bank liquidity management when these flows are denominated in a currency different from that of the bank's country of origin. This is an important finding, as previous studies had only focused on frictionless liquidity management across countries, either when the funds were denominated in the home currency of the bank or when foreign currency was widely available.

5. The effect of the liquidity shock on U.S. lending by foreign banks

The banks' inability to mitigate the effect of liquidity shocks on their lending to creditworthy borrowers is commonly referred to as the bank lending channel. In this section, we examine the change in lending by the U.S. branches of foreign banks to U.S. borrowers that coincided with the sharp reduction in large time deposits received from U.S. money market funds, which can be characterized as a deposit run. In addition to the standard OLS estimation,

we follow an identification strategy with fixed effects to control for loan demand similar to that used to document the bank lending channel in Khwaja and Mian (2008).

5.1 Estimates using branch-level data

In our first set of tests, we assume that branches differ in the extent to which they face a funding shock, and that all U.S. borrowers are homogeneous and face shocks that are not correlated with this funding shock.[19] More precisely, we estimate the following equation:

$$\Delta Loans_{ij} = \beta_0 + \beta_1 \Delta Large\ Time\ Deposits_{ij} + \gamma X_{ij} + \varepsilon_{ij} \quad (5)$$

The dependent variable is the change in outstanding loans between 2010 and 2011 held by the branches of foreign bank *i* from country of origin *j*. We consider three measures of lending by the foreign bank branches: total lending, commercial and industrial (C&I) lending, and C&I lending to U.S. residents. For each measure, the outstanding loans every quarter are aggregated across all the branches of a given foreign bank *i* and averaged separately for 2010 and 2011. The change between the two periods constitutes the dependent variable, namely $\Delta Loans_{ij} = \{\Delta TotLoans_{ij}, \Delta C\&ILoans_{ij}, \Delta C\&ILoansUS_{ij}\}$. We average our main indicators across these two periods for two reasons. First, we aim to document the lending effect that the U.S. branches of European banks suffered in 2011, following the escalation of the European sovereign debt crisis.[20] Second, lending on the syndicated market has a strong seasonal component (Murfin and Petersen, 2014), and most C&I lending done by branches is through

[19] To partially mitigate this concern, we use fixed effects for the branches' country of origin in equation (5). The fixed effects address a situation in which the U.S. firms borrowing from the U.S. branches of French banks may export to the French market. In such a case, the demand faced by U.S. borrowers may be correlated with economic activity in the foreign banks' country of origin.

[20] As mentioned in the introduction, also note that the SEC changed its disclosure requirements for money market funds at the end of 2010, which facilitated the occurrence of the funding shock as a result of the sovereign crisis in Europe.

syndicates. Thus, we average total lending through the year to smooth out this seasonal component in our estimations.

The key explanatory variable in our estimations is the change in outstanding large time deposits between 2010 and 2011 received by the branches of bank *i* from country of origin *j* ($\Delta Large\ Time\ Deposits_{ij}$), as a proxy for the funding shock. Our hypothesis is that those U.S. branches that suffered a greater liquidity shock, as reflected by a larger decrease in large time deposits, had to reduce the supply of loans by more. We expect the coefficient estimate on the change in deposits to be positive and statistically significant. The regression also includes fixed effects for the branches' country of origin. The other controls are like in equation (1).

The results from estimating equation (5) are presented in Table 6. The liquidity shock triggered by the escalation of sovereign risk problems in Europe was associated with a decline in lending by the U.S. branches of foreign banks, including C&I lending to U.S. entities. This pattern is indicated by the positive and statistically significant sign on $\Delta Large\ Time\ Deposits_{ij}$ (columns 1-3). In terms of economic significance, these results show that a one billion dollar decrease in large time deposits implies reduction of $146 million in total loans, $61 million in C&I loans, and $43 million in C&I loans to borrowers domiciled in the United States. In assessing the magnitude of these effects, one should consider the full size of the funding shock: In the aggregate, the large time deposits of the U.S. branches of euro-area banks declined by almost $250 billion from the second to the fourth quarter of 2011 (see Figure 2). Moreover, the median foreign bank organization had total outstanding loans of less than $500 million, outstanding C&I loans of less than $300 million, and outstanding C&I loans to U.S. residents of just $190 million in 2010 (see Table 3). Thus, relative to the median branch's lending, the economic significance of our results is large.

One concern in this type of estimation is the potential positive correlation between the liquidity shock and the error term that may result from omitted variable bias, in which case the change in deposits would be positively correlated with factors affecting loan demand.[21] In addition, reverse causation—whereby reduced demand for loans may have prompted bank branches to reduce their own demand for large time deposits—may generate a similar problem. In both cases, the coefficient estimate on the liquidity shock would be biased upward, falsely indicating a positive relation between the change in deposits and banks' reduced ability to make loans.[22] In what follows, we deploy several methods to avoid this kind of bias, including instrumental variables and fixed effects to control for demand as in Khwaja and Mian (2008). For this purpose, we use both branch-level data from the FFIEC 002 report, as discussed immediately below, and loan level-data from the SNC dataset, as discussed in Section 5.2. Our baseline results are preserved in each case.

First, we instrument the change in large time deposits with variables that are unlikely to reflect changes in loan demand by U.S. firms. In light of the "quiet run" on the U.S. money market funds with exposures to euro-area banks documented in Chernenko and Sunderam (2014)—which supports the idea of a run by the money market funds on euro-area branches, rather than a voluntary reduction in deposits by the branches themselves—we use the share of large time deposits provided by money market funds at the end of 2010 and the euro area dummy as instrumental variables. As shown in columns 4-6 of Table 6, the coefficients on $\Delta Large\ Time\ Deposits_{ij}$ remain positive, and their statistical and economic significance increases relative to

[21] Our estimation reduces the possibility of having this bias, as the liquidity shock results from a mixture of regulatory changes in the U.S. money market fund industry and a sovereign shock affecting mostly European countries.

[22] However, a potential *negative* correlation between the liquidity shock and loan demand would bias the OLS estimate downward, and the OLS results would represent conservative estimates of the effect of the liquidity shock on loan supply, like in Khwaja and Mian (2008).

columns 1-3. For example, a one billion dollar decrease in large time deposits implies reductions in the amount of $368 million dollars for total loans, $150 million in C&I loans, and $75 million in C&I loans to U.S. firms. The Hansen test fails to reject the null hypothesis that the instruments are valid (i.e., they are correlated with the change in large time deposits but not with the error term). In light of the Kleiberger-Paap test, to ensure that weak identification does not affect our results, the AR, CLR, and KJ tests suggest that the coefficient estimate for the change in large time deposits is statistically significant at least for the C&I loans to U.S. firms (column 6).[23]

Second, as an alternative proxy for the liquidity shock, we use the change in large time deposits that is not explained by the internal liquidity management operations of global banks. When foreign parents provide more funding, the branches may reduce their demand for large time deposits voluntarily. To ensure than such endogenous responses do not drive our results, we use the change in large time deposits that is not explained by changes in funding from the parent as a proxy for the liquidity shock.[24] The results in columns 8-9 of Table 6 show positive and statistically significant coefficients on the residual funding as a proxy for the liquidity shock. Bank branches with unusually sharp declines in large time deposits—i.e., unusual in light of the historical relationship between their large time deposits and net funding from the parent—cut lending to U.S. firms by more.

[23] We use the WEAKIV Stata command to perform these tests, as in Finlay, Magnusson, and Schaffer (2013).
[24] We regress the change in large time deposits on the change in net due to positions (using annual averages) and on the vector of controls X_{ij} in a panel setting over the period from 2000 to 2007. We then apply the historical relationship to predict the change in large time deposits associated with the change in net due positions from 2010 to 2011, and use the difference between the actual and the predicted changes in large time deposits as a proxy for the liquidity shock in equation (5).

5.2 Estimates using loan-level data

Even with instrumental variables, the branch-level data may miss some demand factors that cannot be fully addressed at this level of aggregation. To provide an even better identification of demand shocks, we use loan-level data from the SNC database, which includes detailed information about all participants in syndicated loans that satisfy the conditions outlined in Section 2.1. Since most C&I lending by foreign bank branches is done through syndicated loans, the SNC dataset is ideal for analyzing the effect of the liquidity shock on lending.

In our first set of tests, we aggregate all syndicated loans outstanding by each branch at the *3-digit NAICS sector level*. In this setting, we use sector-specific fixed effects to control for the change in loan demand that is common to all borrowers from the same sector. For instance, one concern is that the U.S. branches of foreign banks may lend more to some U.S. sectors than to others, while loan demand fared differently across sectors during the crisis. Therefore, it is possible that the branches of foreign banks that suffered the largest funding shocks had a greater presence in some of the slower-growing U.S. sectors. Facing weaker loan demand, those branches may have reduced their demand for deposits by more, which would bias the funding shock coefficient upwards. To control for this potential bias, we estimate the following equation:

$$\Delta Loans_{ijs} = \beta_0 + \beta_1 \Delta Large\ Time\ Deposits_{ij} + \gamma X_{ij} + \eta_s + \varepsilon_{ijs} \quad (6)$$

The dependent variable is the change in outstanding loans provided by the branches of foreign bank *i* from country of origin *j* to the U.S. borrowers from sector *s* ($\Delta Loans_{ijs}$), measured between 2010 and 2011. In alternative specifications, the dependent variable builds on two measures of syndicated lending by the U.S. branches of foreign banks: C&I commitments to U.S. addressees ($\Delta Commitments_{ijs}$), which include both term loans and the used and unused

portions of revolving credit, and C&I utilization ($\Delta Utilization_{ijs}$), which includes the total value of term loans and the used portion of revolving credit. The loans outstanding at the end of each year are aggregated across all branches of a given foreign bank *i* from country of origin *j* and for each sector *s* at the 3-digit NAICS level. The main explanatory variable is the change in outstanding large time deposits between 2010 and 2011 received by the branches of bank *i* from country *j* ($\Delta Large\ Time\ Deposits_{ij}$) as a proxy for the funding shock. Alternatively, we use the residual funding as a proxy for the funding shock, as in columns 7-9 of Table 6. Importantly, the sector-specific fixed effect (η_s) controls for those cases when firms from the same sector—experiencing similar demand for loans—borrow from banks facing relatively different funding shocks. To estimate the fixed effects, we only include sectors that borrow from at least two foreign bank branches. As in Khwaja and Mian (2008), standard errors are clustered at the branch level.

The results for this specification are reported in Table 7. As before, the coefficients on the funding shock variables (either the change in large time deposits or the residual funding) are positive and statistically significant, which is the case when either the change in commitments (columns 1-2) or the change in actual loans outstanding (columns 3-4) is used as the dependent variable. This effect is economically significant. A drop of $1 billion in branch funding leads to a decrease of $2.6 million in commitments and $0.7 million in loans utilized.

Next we estimate equation (6), but using data on the change in C&I loan commitments and utilization provided by the U.S. branches of foreign banks measured at the *firm level* instead of the sector level. As branches adjust their lending activity, they can either reduce the total value of loans outstanding to a firm without cutting the relationship, or they can stop lending to a firm altogether. The former is called an adjustment in the intensive margin, while the latter

represents a change in the extensive margin. The benefit of using loan-level data (without aggregating at the sector level) is that the analysis can distinguish between the extensive vs. intensive margin effects of the liquidity shock while using firm-level fixed effects to control for demand.[26]

First, to document the intensive margin adjustment of syndicated lending, we work with the sample of firms that took loans from the same branch in both 2010 and 2011. Also, to identify the firm-level fixed effects, we restrict the sample to those firms that received loans from at least two different branches. Table 8 shows the results for this specification. The coefficients on the funding shock variables (either the change in large time deposits or the residual funding) are positive in all specifications, but are not statistically significant in most cases. This result suggests that the U.S. branches of foreign banks did not adjust lending along the intensive margin in response to the funding shock in 2011.

Second, we test whether the lending adjustment took place along the extensive margin, that is, whether U.S. branches of foreign banks with liquidity problems stopped lending to some of the U.S. firms. For this purpose, we estimate a logit model with firm-level fixed effects.[27] The dependent variable is equal to one if a branch had a lending relationship with a firm in 2010 and no loans outstanding with the same firm in 2011; it is equal to zero if the lending relationship survived from 2010 to 2011. To identify the firm-level fixed effects, we restrict the sample to loans to U.S. firms that borrowed from at least two branches, and to cases in which at least one

[26] A branch can cut lending to a specific firm, but it is less likely to cut lending to all firms in a specific sector. Thus, the intensive and extensive margin at the firm level are analyzed simultaneously when the data is aggregated at the sector level.

[27] Some previous studies have used linear probability models to estimate this type of relationships between liquidity shocks and bank lending. However, as noted by Lewbel, Dong, and Yang (2012), linear probability models have important drawbacks, one of which is that they are not able to recover the appropriate sign in simple treatment exercises.

of these loans (but not all) survived in 2011.[28] Table 9 shows the results for this specification, with the coefficients reported as odd ratios. In columns 1 and 2, in which the dependent variables consider revolving credit and term loans taken together, the coefficients on the funding shock variables are statistically significant and less than one. A coefficient lower than one implies that a branch was less likely to end a relationship with a borrower if it had positive deposit inflows (and thus did not suffer a funding shock) between 2010 and 2011. A coefficient higher than one would have implied the opposite. In columns 3 through 6 we test whether the extensive margin adjustment was stronger for revolving credits or for term loans. We find that U.S. branches of foreign banks were more likely to stop providing revolving credit to firms if they suffered a liquidity shock in this period. Although the odds for term loans are also less than one, the coefficient is not statistically significant.

In sum, we find that branches facing liquidity problems restricted lending to U.S. firms, and that most of this adjustment took place along the extensive rather than the intensive margin. Next, we test whether this credit shock had any effect on the U.S. firms' access to syndicated loans and investment activity.

5.3 Branch liquidity shocks and U.S. firms' access to syndicated loans

In Sections 5.1 and 5.2, we showed that the U.S. branches of euro-area banks that suffered liquidity shocks in 2011 reduced their lending to U.S. firms. However, it remains an open question whether the affected firms were able or not to substitute the lost loans from euro-area bank branches with additional loans from elsewhere.

[28] Thus, the sample ensures that there was extensive margin adjustment for some of the firm's loans, but not for all.

To answer this question, we examine how firms' access to syndicated loans changed from 2010 to 2012, while distinguishing between the U.S. firms exposed to liquidity-constrained branches (i.e., affected firms) and comparable U.S. firms that historically did not borrow from constrained branches (the control group).[29] For this purpose, we use the SNC dataset and take firm-level aggregates of all outstanding loans from foreign bank branches and other lenders for each firm. We explore whether the affected firms suffered reduced access to syndicated loans between 2010 and 2012 along either the intensive margin (i.e., the amount of outstanding loans) or the extensive margin (i.e., firms lost access to syndicated loans altogether).

In Table 10, we regress the change in the outstanding amount of loans between 2010 and 2012 on explanatory variables reflecting the firms' exposure as of 2010 to foreign branches that later suffered a liquidity shock during the crisis. This test aims to determine whether a firm's lending relationship with constrained branches resulted in reduced access to syndicated loans along the intensive margin. In alternative specifications, we use the following explanatory variables: (1) the share of loans from euro-area branches as of 2010 (*Euro area loan share*); (2) an indicator variable that equals one if a firm borrowed from at least one euro-area bank branch as of 2010 (*Euro area dummy*); and (3) an indicator variable for the liquidity shock that equals one if a firm borrowed in 2010 from at least one foreign branch that later suffered deposit outflows between 2010 and 2011 (*Liquidity shock*). We also control for firm size and loan quality, using the log of 2010 commitments as a scale variable and an indicator variable that equals one if the firm had at least one loan with quality issues as of 2010). Importantly, we control for demand using fixed effects for 3-digit NAICS industries and states, like in Jimenez et

[29] Firms' access to term loans or revolving credit may be restricted when such loans mature and banks refuse to renew them. In addition, banks may curtail access to revolving credit if firms fail to comply with covenants. By observing the change in access to loans from 2010 to 2012 (rather than to 2011), we allow more time for loans to mature and firms to find substitute loans before observing the impact from the funding shock.

al. (2015): While two firms in the same industry or state are likely to encounter similar demand conditions, we expect differences in their exposure to constrained foreign branches to affect their access to syndicated loans. Indeed, the coefficients on the *Euro-area loan share* and *Liquidity shock* variables are negative and statistically significant in columns 3 and 9, suggesting that the privately-owned U.S. firms with links to constrained foreign bank branches suffered reduced access to revolving credit.

In Table 11, to examine the impact of the funding shock on firms' access to syndicated loans along the extensive margin, we use a panel logit model with similar explanatory variables. The dependent variable is a binary indicator that equals 1 if a firm had syndicated loans recorded in SNC as of 2010 but not as of 2012, and zero if the firm enjoyed continued access to SNC loans as of 2012. For each of the three explanatory variables reflecting U.S. firms' exposure to branches with liquidity shocks, the coefficients (reported as odd ratios) are larger than unit and statistically significant. Thus, U.S. firms that ex-ante borrowed from affected branches were more likely to lose access to syndicated loans (columns 1, 3, and 5) and, in particular, to lose access to revolving credit (columns 2, 4, and 6) once the European sovereign crisis escalated in mid-2011. The result holds for all firms, which include both publicly-traded and privately-owned firms.

5.4 Branch liquidity shocks and U.S. firms' corporate investment

Given our findings in Section 5.3—i.e., the U.S. firms linked to the foreign bank branches with funding shocks suffered reduced access to syndicated loans—we take our analysis further to examine whether the reduced access to syndicated loans left an imprint on the real activity of affected U.S. firms, for instance in the form of reduced investment. For this purpose,

we use data on publicly-traded U.S. firms from Compustat, which we merge with the SNC data on firms' syndicated loans and the FFIEC 002 data on the branches' liquidity shock.

Our sample selection process starts with all firms that had outstanding syndicated loans in SNC as of 2010 and also quarterly balance sheet information from the third quarter of 2010 to the second quarter of 2012 in Compustat. We then restrict the sample to firms with SIC codes inside the intervals 1500-4900, 5000-5999, and 7000-8999, thus excluding firms in agriculture, mining, utilities, and financial services. After undergoing these steps, our sample includes 1,366 firms.

To estimate the effect of branches' funding shock on corporate investment, we follow Duchin, Ozbas, and Sensoy (2010) and regress the ratio of investment to assets at the quarterly frequency on an indicator variable that equals one in the post-crisis period (*After*).[30] The post-crisis period is defined as the interval between the third quarter of 2011 and the second quarter of 2012. This period coincides with the sharp increase of sovereign stress in Europe, and also with the adjustments in foreign branches' lending to U.S. firms. The pre-crisis period is composed of the interval between the third quarter of 2010 and the second quarter of 2011, which allows for symmetry in the length of the estimation sample.

The main coefficient of interest is that on the interaction between *After* and each of the three explanatory variables used in Tables 10 and 11, which describe the firms' ex-ante relationship with the U.S. branches of foreign banks that later suffered a funding shock during

[30] We follow the Compustat variable definitions reported in the Appendix to Duchin, Ozbas, and Sensoy (2010). All variables derived from Compustat are windsorized at the 1 percent level, with the exception of Tobin's Q which is bounded at a maximum of 10.

2011 (*Euro-area loan share*, *Euro-area dummy*, and *Liquidity shock*).[31] In addition, all specifications include a measure of Tobin's Q and firm fixed effects; the reported standard errors are clustered at the firm level.

In Table 12 (columns 1-3), the results suggest that corporate investment increased, on average, between the pre- and post-European sovereign debt crisis, as shown by the positive and significant coefficient on the indicator *After*. However, the coefficients on the interacted terms between *After* and two of the variables measuring exposure to affected branches (*Euro-area dummy* and *Liquidity shock*) are negative and statistically significant. Thus, U.S. firms that had relationships with at least one euro-area bank branch (column 2) or with at least one foreign bank branch with deposit outflows (columns 3) had lower corporate investment than firms in the control group. These findings suggest that the funding shock faced by some branches of foreign banks negatively affected the real activity of U.S. firms.

Next we test whether affected firms maintained more cash holdings due to their relationship with constrained branches. Columns 4 through 6 estimate the same specification as above, but with the ratio of cash to assets as the dependent variable. We find that affected firms increased their cash holdings by about 50 percent, on average, relative to firms in the control group. This finding provides evidence that firms with relationships to constrained branches increased their cash holdings at the expense of investment. The finding is consistent with evidence on firms building cash at times when banks increased the price or reduced the supply of lines of credit, such as in Acharya, Almeida, and Campello (2013).

[31] The coefficient on *Liquidity shock* does not appear in the results, as it is time invariant and thus, absorbed by the firm fixed effects.

Overall, our findings are consistent with the existence of a new type of bank lending channel that relies on the effect of uninsured wholesale funding on the lending of U.S. branches of foreign banks. When these branches lost access to wholesale funding during the 2011 European sovereign crisis, the funding shock resulted in reduced lending to U.S. firms, which in turn forced firms to cut corporate investment.

6. Robustness checks

In this section, we provide additional evidence that the reduction in lending during the European sovereign crisis was linked to the funding shock suffered by foreign bank branches, rather than to a voluntary pull-back in borrowing by the U.S. firms. In short, we show that the U.S. subsidiaries of euro-area banks, which relied on relatively stable sources of funding—unlike their affected branches—did not suffer liquidity shocks and did not report decreased lending to U.S. firms in 2011.

Market commentary during the 2011 European sovereign crisis supports our hypothesis that the pullback was due to funding pressures suffered by U.S. branches of foreign bank. For example, Moody's announcement of the downgrade of BNP Paribas on December 9, 2011 states the following: *"The scale of the funding challenge facing BNPP is underscored by the bank's announcement of a deleveraging plan, aimed at reducing around EUR70 billion of risk-weighted assets (RWA) by the end of 2012. This reduction focuses on US dollar assets, reflecting the particular difficulty in sourcing term US dollar funding."* [34]

To further validate this hypothesis, we use data on the U.S. commercial bank subsidiaries of foreign banks to test whether the pullback in lending was broad-based or just restricted to the

[34] See http://www.moodys.com/research/Moodys-downgrades-BNP-Paribass-long-term-ratings-to-Aa3-concluding--PR_232989

branches. Since the subsidiaries rely on wholesale funding substantially less than branches, the finding that the subsidiaries of affected foreign banks did not cut lending to U.S. firms would support our hypothesis that the reduction in branch lending was linked to the funding shock, rather than to a voluntary pull-back in borrowing by U.S. firms.

There were 38 foreign banks with commercial bank subsidiaries in the United States during 2010 and 2011, of which 28 foreign banks also had U.S. branches at the same time. In Table 13 (columns 1-4), we assess whether the subsidiaries of affected foreign banks suffered a liquidity shock. The dependent variable is the change in deposits at subsidiaries between 2010 and 2011. Recall that the retail deposits of foreign-owned commercial banks are covered by U.S. federal deposit insurance (for accounts under $250,000). Therefore, we show results for both the change in total deposits (which include large time deposits and insured retail deposits) as well as the change in large time deposits taken separately (which are uninsured). The main explanatory variables are, alternatively, an indicator variable for subsidiaries owned by euro area parents (columns 1 and 2), and an indicator variable that equals one if the subsidiary was affiliated with branches that suffered changes in large time deposits in the bottom 25th percentile of the distribution for all U.S. branches of foreign banks (columns 3 and 4).[35] The aim of these estimations is to check whether the commercial bank subsidiaries of foreign banks affected by the European sovereign crisis suffered deposit runs as well. As the results show, the coefficients on the variables of interest are not statistically significant, which implies that the commercial bank subsidiaries did not endure liquidity shocks similar to those faced by the branches.

Next we check whether the U.S. commercial bank subsidiaries of foreign banks may have reduced lending even without having encountered liquidity problems themselves. Consistent

[35] Our results are robust to using the 50th percentile, as the threshold for the indicator variable.

with our hypothesis, we find that this was not the case. Columns 5 through 8 in Table 13 show the results from regressing the change in the commercial bank subsidiaries' total loans and C&I loans from 2010 to 2011 on the liquidity shock indicators described above. We find that commercial banks owned by euro-area banks did not reduce their lending during this period. This finding also holds for subsidiaries with affiliated branches that endured a liquidity shock. These results provide additional evidence that foreign banks did not delever widely and indiscriminately across their legal entities. Instead, they cut lending by those entities that had unstable sources of financing, i.e., the branches.

7. Conclusions

Our study shows how the interaction between money market funds and global banks in the United States is crucial to understanding the spillover effects from the European sovereign debt problems in 2011 to the U.S. credit markets. We show that the U.S. branches of euro-area banks faced a severe decline in their access to dollar funding from U.S. money market mutual funds in 2011. The liquidity shock was not correlated with country- or bank-specific characteristics, but was linked to the branches' affiliation with euro-area parent banks more generally. The branches with curtailed access to large time deposits relied more on funding from their own parent institutions, thus shifting from being net suppliers to being net receivers of dollar funding from their related offices. Since the additional funding received from parent institutions was not enough to offset the decreased access to U.S. funding, such branches reduced their lending to U.S. firms. In turn, the affected U.S. firms suffered reduced access to syndicated loans, which promoted them to reduce investment and increase cash reserves. The results are robust to controlling for demand at the sector- and firm-levels.

Our findings suggest that a new requirement for U.S. money market funds to disclose their detailed exposures, implemented at the beginning of 2011, may have exacerbated the funding shock suffered by euro-area banks. In addition, the frictions faced by European parent banks when converting euro liquidity into dollars impaired their ability to offset the dollar liquidity shock suffered by their U.S. branches through internal capital markets. Thus, one policy implication from our paper is that regulators and banks should be concerned not only about the aggregate liquidity requirements, but also about the liquidity needs in each relevant currency, especially for those banks relying on unstable sources of foreign currency funding. Further research should address these important issues.

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Table 1

Number of foreign banks with U.S. branches and the size of these branches

This table reports the total number of foreign banks with branches in the United States and the total assets of these branches as reported in the FFIEC 002 report. U.S. branches of the same parent bank are aggregated into a single entity.

Country	Number of banks with U.S. branches	Total branch assets ($ billions)
Austria	1	2.8
France	5	301.7
Germany	10	254.7
Ireland	2	3.2
Italy	3	26.9
Netherlands	1	75.0
Norway	1	23.2
Portugal	1	0.4
Spain	8	52.7
Sweden	4	93.5
Switzerland	3	158.5
Turkey	2	1.4
United Kingdom	5	239.1
Canada	7	320.0
Argentina	1	0.4
Brazil	4	24.0
Chile	2	6.0
Colombia	2	1.5
Costa Rica	1	0.4
Panama	1	0.8
Uruguay	1	2.3
Venezuela	2	0.5
Bahrain	2	1.0
China	6	23.7
Hong Kong	2	1.4
Indonesia	2	0.5
Israel	3	8.0
Japan	9	355.5
Jordan	1	0.4
South Korea	6	4.4
Malaysia	1	1.0
Pakistan	1	0.2
Philippines	2	0.1
Qatar	1	0.1
Saudi Arabia	1	0.1
Singapore	3	6.2
Taiwan	13	14.9
Thailand	3	0.5
United Arab Emirates	2	1.5
Nigeria	1	0.2
Egypt	1	1.0
Australia	4	71.4
Total	131	2,081.2

Table 2

Aggregate balance sheet of the U.S. branches and agencies of foreign banks in 2011

This table shows the aggregate balance sheets of: (1) the U.S. branches and agencies of all foreign banks and (2) the U.S. branches and agencies of European banks. The net funding to related depository institutions shows the aggregate value of branch claims minus liabilities on related entities for those branches that are in a positive *Net due from* position. Conversely, the net funding from related depository institutions shows the aggregate value of branch liabilities minus claims on related entities for those branches that are in a positive *Net due to* position. Information for U.S. branches and agencies of foreign banks is reported in the FFIEC 002 report.

Assets	***All***	***European***	**Liabilities**	***All***	***European***
Cash	35%	40%	Deposits	50%	48%
			of which: Large time deposits	43%	42%
Fed Funds Sold	0%	0%			
			Fed Funds Purchased	1%	1%
Resale Agreements	5%	6%			
			Repurchase Agreements	11%	7%
U.S. Gov. Securities	4%	4%			
			Trading Liabilities	5%	5%
Other Securities	10%	11%			
			Other Liabilities	14%	17%
Loans	24%	23%			
of which: C&I loans	12%	10%			
Other Assets	2%	2%			
Total Claims on Non-Related Parties	80%	86%	***Total Liabilities to Non-Related Parties***	81%	77%
Net Funding to Related Depository Institutions	20%	14%	Net Funding from Related Depository Institutions	19%	23%
Total Assets ($ billions)	2,081	1,233	***Total Liabilities ($ billions)***	2,081	1,233

Table 3

Summary statistics

This table shows the summary statistics for the balance sheet items of U.S. branches and agencies of foreign banks for 2010 and 2011 (Panel A), as well as information for their syndicated lending in the same period (Panel B). In Panel A, *Net due to* is equal to the liabilities minus claims of branches with respect to related offices. *Large time deposits* is the value of large time deposits ($100,000 or more). *Deposits to assets* and *Loans to assets* are the ratios of deposits and loans, for each branch, relative to its total assets. *Relative size of branch network* is equal to the ratio of assets for a network of branches controlled by a bank, relative to the assets of this parent bank. *Parent Tier 1 capital ratio* is the ratio of Tier 1 capital over risk-weighted assets for the parent of a branch. Information for parent banks is reported in the FR Y7Q report. Panel B shows summary statistics for the total value of commitments held by U.S. branches of foreign banks and the total portion of those commitments that has been drawn down (Utilization), which includes term loans and revolving credit. The value of commitments and utilization is the same in most cases. Information on syndicated loans is from the Shared National Credits (SNC) program.

Panel A: Branch-level information

	2010			2011		
	Mean	Median	Std. dev.	Mean	Median	Std. dev.
Total assets ($ billions)	13.9	1.2	25.5	15.9	1.4	30.2
Total loans ($ billions)	3.5	0.5	7.3	3.7	0.5	8.1
C&I loans ($ billions)	1.8	0.3	3.8	1.8	0.3	3.9
C&I loans to U.S. residents ($ billions)	1.3	0.2	3.0	1.3	0.2	3.0
Large time deposits ($ billions)	7.1	0.1	14.3	6.8	0.2	13.5
Net due to related offices ($ billions)	-3.1	0.1	11.2	-0.2	0.1	11.0
Net due to head-office ($ billions)	-2.4	0.0	10.5	-1.2	0.1	9.0
Net due to U.S. non-branch offices ($ billions)	-0.1	0.0	0.6	0.0	0.0	0.5
Deposits to assets (percent)	34.4	30.3	27.1	31.8	26.8	24.9
Loans to assets (percent)	33.1	24.7	28.2	33.2	27.6	27.9
Relative size of branch network (percent)	3.5	1.9	4.2	4.4	1.8	8.6
Parent Tier 1 capital ratio (percent)	13.1	10.9	15.8	12.0	11.2	3.8

Panel B: Loan-level information

	2010				2011			
	Obs.	Mean	Median	Std. dev.	Obs.	Mean	Median	Std. dev.
Commitments ($ millions)	7730	44.6	25.0	65.0	7838	51.8	30.0	71.2
Utilization ($ millions)	7730	13.5	5.1	26.8	7838	14.3	5.1	27.3

Table 4

Bank liquidity shocks and sovereign risk

The regressions in this table examine the determinants of the change in *Large time deposits* between 2010 and 2011. Columns (1) and (2) test whether the change in *Large time deposits* was related to the region- or country-specific characteristics, such as the parent banks' euro-area affiliation or the change in the sovereign risk of the parent's country of origin. Columns (3) and (4) tests whether bank-specific characteristics, such as the change in the idiosyncratic component of the parent's CDS premiums or SRISK, affected the funding received by branches. Column (5) tests for the impact of additional measures that combine bank- and country-specific characteristics, such as each parent bank's reliance on own government support interacted with the deterioration in sovereign risk. All regressions include the *Deposits to assets* and *Loans to assets* ratios, the *Relative size of branch* and the *Parent Tier 1 capital ratio*. Robust standard errors clustered at the country level are shown in brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Specification	(1) Dummy euro area	(2) Own-sovereign CDS premiums	(3) Bank CDS premiums	(4) SRISK	(5) Government support
Dependent variable			Δ Large time deposits		
Dummy euro area	-5.207**	-5.814**	-5.225*	-8.981**	-7.622**
	[2.218]	[2.646]	[2.964]	[3.383]	[3.166]
Δ Own-sovereign CDS premium		0.006			0.000
		[0.006]			[0.007]
Δ Bank CDS premium (idiosyncratic component)			0.005		
			[0.017]		
$SRISK_{(t-1)}$				0.568	
				[0.339]	
Government $support_{(t-1)}$					0.200
					[0.159]
Government $support_{(t-1)}$ x Δ Own-sovereign CDS premium					0.002
					[0.001]
Log branch $assets_{(t-1)}$	-0.159	-0.133	-1.166	-1.117	-0.087
	[0.570]	[0.568]	[0.924]	[1.014]	[0.566]
Loans to $assets_{(t-1)}$	1.327	1.678	-1.741	0.925	-0.003
	[1.401]	[1.444]	[2.415]	[4.760]	[1.306]
Deposits to $assets_{(t-1)}$	-0.227	-0.097	-0.660	2.795	-1.012
	[1.495]	[1.608]	[3.177]	[3.719]	[1.836]
Relative size of $branch_{(t-1)}$	24.544	25.494	59.533**	51.203*	27.016
	[19.728]	[19.528]	[24.979]	[26.603]	[20.888]
Parent Tier 1 capital $ratio_{(t-1)}$	6.193	8.539	6.253	37.826	7.356
	[9.566]	[9.903]	[27.612]	[49.292]	[16.857]
Observations	129	129	75	54	104
R-squared	0.21	0.21	0.27	0.35	0.29
Bank sample	All	All	All	All	All
Countries	42	42	28	19	37

Table 5
Liquidity shocks and bank liquidity management

The regressions in this table analyze the change in the average *Net due to position* (i.e., the net funding received) relative to related institutions for all U.S. branches and agencies of foreign banks between 2010 and 2011 (while excluding two branch networks without available information for the parent banks). The dependent variable in column (1) is the change in the *Net due to* position with all related offices, in billions of dollars. In column (2), the dependent variable is the change in *Net due to position* with the head office, while in column (3) the dependent variable is the change in the *Net due to position* with non-branch U.S.-based related offices. *ΔLarge time deposits* is the change in the average stock of time deposits of $100,000 or more between 2010 and 2011. *Deposits to assets* and *Loans to assets* are the ratios of deposits and loans, for each branch, relative to its total assets in 2010. *Relative size of branch* is equal to the ratio of assets for a network of branches controlled by a bank, relative to the assets of this parent bank in 2010. *Parent Tier 1 capital ratio* is the ratio of Tier 1 capital over risk-weighted assets for the parent of a branch in 2010. Robust standard errors clustered at the country level are shown in brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Dependent variable	(1) Δ Net due to related offices	(2) Δ Net due to head office	(3) Δ Net due to related U.S. non-branch offices
Δ Large time deposits	-0.868***	-0.624***	-0.006**
	[0.130]	[0.086]	[0.003]
Log branch assets$_{(t-1)}$	1.379***	0.406**	0.012
	[0.264]	[0.171]	[0.007]
Loans to assets$_{(t-1)}$	-1.641	-1.184*	0.025
	[1.284]	[0.640]	[0.016]
Deposits to assets$_{(t-1)}$	-1.159	-1.363	-0.060
	[1.196]	[0.841]	[0.039]
Relative size of branch$_{(t-1)}$	23.563*	25.822	0.544
	[11.842]	[15.835]	[0.354]
Parent Tier 1 capital ratio$_{(t-1)}$	-10.490	-11.482	-0.008
	[13.130]	[7.355]	[0.228]
Observations	129	129	129
R-squared	0.56	0.49	0.11
Countries	42	42	42

Table 6

Liquidity shocks and bank lending with bank-level data

The regressions in this table analyze the change in the average stock of loans for all U.S. branches and agencies of foreign banks (excluding two branch networks without available information for the parent banks) between 2010 and 2011. The dependent variable in columns (1), (4) and (7) is the change in total loans, in billions of dollars, originated by branches. In columns (2), (5) and (8), the dependent variable is the change in C&I loans, while in columns (3), (6) and (9) the dependent variable is the change in C&I loans to U.S. addressees. Among the explanatory variable, *ΔLarge time deposits* is the change in the average stock of time deposits of $100,000 or more between 2010 and 2011; in columns 4-6, it is instrumented using the share of large time deposits provided by money market funds as of end-2010 and the euro area dummy variable. *Residual funding* is a proxy for the funding shock defined as the change in large time deposits not explained by the historical relation between the branches' large time deposits and the net due to positions, as explained in the text. The other explanatory variables are like in Table 4. The estimations in columns 1-3 and 7-9 include fixed effects for the banks' country of origin. Robust standard errors clustered at the country level are shown in brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Dependent variable	(1) Δ Total loans	(2) Δ Total C&I Loans	(3) Δ U.S. C&I Loans	(4) Δ Total loans	(5) Δ Total C&I Loans	(6) Δ U.S. C&I Loans	(7) Δ Total loans	(8) Δ Total C&I Loans	(9) Δ U.S. C&I Loans
Δ Large time deposits	0.146*	0.061**	0.043**	0.368**	0.150**	0.075**			
	[0.078]	[0.028]	[0.019]	[0.187]	[0.066]	[0.033]			
Residual funding$_{(t)}$							0.113	0.044**	0.034***
							[0.088]	[0.016]	[0.012]
Log branch assets$_{(t-1)}$	0.420	0.113*	0.030	0.536**	0.132**	0.012	0.309	0.068	-0.003
	[0.293]	[0.058]	[0.033]	[0.233]	[0.066]	[0.029]	[0.290]	[0.071]	[0.035]
Loans to assets$_{(t-1)}$	-0.006	-0.020	-0.034	-1.274	-0.608	-0.180	0.378	0.142	0.080
	[0.406]	[0.279]	[0.221]	[0.891]	[0.378]	[0.221]	[0.454]	[0.277]	[0.190]
Deposits to assets$_{(t-1)}$	0.565	0.324	0.072	0.139	0.192	0.189	0.737	0.394	0.122
	[0.780]	[0.336]	[0.118]	[0.898]	[0.307]	[0.134]	[0.779]	[0.336]	[0.116]
Relative size of branch$_{(t-1)}$	-8.653	-3.074	-1.818**	-23.799*	-7.465*	-1.117	-8.291	-2.813	-1.706
	[9.446]	[2.041]	[0.866]	[12.352]	[3.915]	[1.870]	[10.496]	[2.972]	[1.522]
Parent Tier 1 capital ratio$_{(t-1)}$	-5.194*	-5.751**	-2.483	-12.272**	-7.299**	-3.451*	-4.153**	-5.352**	-2.176
	[2.752]	[2.343]	[1.842]	[6.110]	[3.359]	[2.032]	[1.706]	[1.932]	[1.523]
Observations	114	114	114	111	111	111	114	114	114
R-squared	0.48	0.51	0.46				0.44	0.47	0.41
Estimation	FE	FE	FE	IV	IV	IV	RES	RES	RES
Fixed effects	Country	Country	Country	None	None	None	Country	Country	Country
Countries	27	27	27	27	27	27	27	27	27
Hansen J statistic (p-value)				0.25	0.30	0.99			
Kleiberger-Paap Wald F stat.				4.78	4.78	4.78			
Weak id. test - AR (p-value)				0.21	0.11	0.10			
Weak id. test - CLR (p-value)				0.32	0.16	0.08			
Weak id. test - KJ (p-value)				0.27	0.15	0.09			

Table 7

Liquidity shocks and bank lending with sector-level data

The regressions in this table examine the change in the stock of loan commitments and actual loans provided by the U.S. branches of foreign banks to borrowers across U.S. sectors defined at the 3-digit NAICS level, measured between 2010 and 2011. The dependent variable is constructed from data compiled by the Shared National Credit program. In columns (1) and (2), the dependent variable is the change in C&I loan commitments to U.S. addressees across sectors, in millions of dollars. In columns (3) and (4), the dependent variable is the change in the actual C&I loans to U.S. addressees across sectors. Among the explanatory variables, *ΔLarge time deposits* is the change in the average stock of time deposits of $100,000 or more between 2010 and 2011. *Residual funding* is the proxy for the liquidity shock described in Table 6. *Deposits to assets* and *Loans to assets* are the ratios of deposits and loans, for each branch, relative to its total assets in 2010. *Relative size of branch* is equal to the ratio of assets for a network of branches controlled by a bank, relative to the assets of this parent bank in 2010. *Parent Tier 1 capital ratio* is the ratio of Tier 1 capital over risk-weighted assets for the parent of a branch in 2010. All regressions include sector-level fixed effects. Robust standard errors clustered at the branch level are shown in brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

	(1)	(2)		(3)	(4)
Dependent variable	ΔCommitments			ΔUtilization	
Δ Large time deposits	2.600*			0.730**	
	[1.433]			[0.301]	
Residual funding$_{(t)}$		4.066**			0.754
		[1.575]			[0.527]
Log branch assets$_{(t-1)}$	27.874***	20.138***		6.843***	4.936**
	[7.452]	[6.264]		[2.270]	[2.068]
Loans to assets$_{(t-1)}$	83.165**	66.864**		37.301***	35.372***
	[33.910]	[30.754]		[11.028]	[11.127]
Deposits to assets$_{(t-1)}$	87.117*	101.564**		32.255**	34.742**
	[49.566]	[50.738]		[12.848]	[13.583]
Relative size of branch$_{(t-1)}$	-25.243	-50.622		20.404	33.416
	[146.158]	[124.842]		[44.115]	[46.827]
Parent Tier 1 capital ratio$_{(t-1)}$	-110.003	6.369		-26.518	15.478
	[293.851]	[302.907]		[162.746]	[161.903]
Observations	1,652	1,652		1,652	1,652
R-squared	0.12	0.13		0.09	0.09
Estimation	FE	RES		FE	RES
Fixed effects	NAICS 3 digit	NAICS 3 digit		NAICS 3 digit	NAICS 3 digit
Banks	101	101		101	101

Table 8

Liquidity shocks and bank lending with loan-level data: the intensive margin

The regressions in this table analyze the change in the stock of loan commitments and actual loans provided by the U.S. branches of foreign banks to U.S. firms, measured between 2010 and 2011. The dependent variable is constructed from data compiled by the Shared National Credit program. In columns (1) and (2), the dependent variable is the change in C&I loan commitments to U.S. firms, in millions of dollars. In columns (3) and (4), the dependent variable is the change in the actual C&I loans to U.S. firms. Among the explanatory variables, *ΔLarge time deposits* is the change in the average stock of time deposits of $100,000 or more between 2010 and 2011, and *Residual funding* is constructed as described in Table 6. *Deposits to assets* and *Loans to assets* are the ratios of deposits and loans, for each branch, relative to its total assets in 2010. *Relative size of branch* is equal to the ratio of assets for a network of branches controlled by a bank, relative to the assets of this parent bank in 2010. *Parent Tier 1 capital ratio* is the ratio of Tier 1 capital over risk-weighted assets for the parent of a branch in 2010. All regressions include firm-level fixed effects, as the sample includes loans to U.S. addressee firms that borrowed from at least two branches. Robust standard errors clustered at the branch level are shown in brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

	(1)	(2)		(3)	(4)
Dependent variable	ΔCommitments			ΔUtilization	
Δ Large time deposits	0.066			0.012	
	[0.068]			[0.025]	
Residual funding$_{(t)}$		0.072			-0.024
		[0.075]			[0.025]
Log branch assets$_{(t-1)}$	1.178***	0.942***		-0.015	0.005
	[0.228]	[0.292]		[0.190]	[0.145]
Loans to assets$_{(t-1)}$	0.859	0.791		1.399	2.047**
	[2.149]	[1.819]		[0.913]	[0.958]
Deposits to assets$_{(t-1)}$	1.906	2.321		0.912	0.777
	[3.200]	[3.330]		[0.856]	[0.933]
Relative size of branch$_{(t-1)}$	-21.900***	-20.333***		-1.909	0.796
	[6.955]	[5.517]		[2.494]	[2.069]
Parent Tier 1 capital ratio$_{(t-1)}$	32.146	38.113*		23.329**	24.779**
	[21.957]	[22.716]		[10.920]	[9.757]
Observations	4,280	4,280		4,280	4,280
R-squared	0.45	0.45		0.68	0.68
Estimation	FE	RES		FE	RES
Fixed effects	Firm	Firm		Firm	Firm
Banks	99	99		99	99

Table 9

Liquidity shocks and bank lending with loan-level data: the extensive margin

The regressions in this table examine the extensive margin adjustment in the lending of foreign bank branches, namely whether the U.S. branches of foreign banks with liquidity problems stopped lending. The dependent variable is a dummy variable equal to one if a branch provided a loan to a U.S. firm in 2010 and the lending relationship was no longer in place in 2011; it is equal to zero if the lending relationship survived from 2010 to 2011. Among the explanatory variables, *ΔLarge time deposits* is the change in the average stock of time deposits of $100,000 or more between 2010 and 2011, and *Residual funding* is constructed as described in Table 6. *Deposits to assets* and *Loans to assets* are the ratios of deposits and loans, for each branch, relative to its total assets in 2010. *Relative size of branch* is equal to the ratio of assets for a network of branches controlled by a bank, relative to the assets of this parent bank in 2010. *Parent Tier 1 capital ratio* is the ratio of Tier 1 capital over risk-weighted assets for the parent of a branch in 2010. All regressions include firm-level fixed effects, as the sample includes loans to U.S. addressee firms that borrowed from at least two branches, and at least one loan (but not all) survived in 2011 (i.e. there was extensive margin adjustment for some of the firm's loans, but not for all). Standard errors are shown in brackets. All coefficients are reported as odd ratios. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

	(1)	(2)		(3)	(4)		(5)	(6)
	All loans			***Revolving credit***			***Term loans***	
Δ Large time deposits	0.982***			0.979***			0.985	
	[0.004]			[0.005]			[0.010]	
Residual funding$_{(t)}$		0.975***			0.966***			0.984*
		[0.005]			[0.006]			[0.009]
Log branch assets$_{(t-1)}$	0.737***	0.790***		0.716***	0.778***		0.885	0.948
	[0.028]	[0.029]		[0.032]	[0.033]		[0.073]	[0.075]
Loans to assets$_{(t-1)}$	0.510**	0.596*		0.616	0.799		0.285**	0.311**
	[0.146]	[0.173]		[0.208]	[0.274]		[0.145]	[0.160]
Deposits to assets$_{(t-1)}$	0.368***	0.330***		0.280***	0.248***		0.695	0.643
	[0.086]	[0.077]		[0.075]	[0.067]		[0.292]	[0.274]
Relative size of branch$_{(t-1)}$	3.211	3.278		6.473*	8.843**		8.140	5.123
	[3.357]	[3.293]		[7.314]	[9.643]		[19.998]	[11.982]
Parent Tier 1 capital ratio$_{(t-1)}$	10.688	2.724		0.292	0.080		4.847	1.202
	[19.479]	[4.834]		[0.627]	[0.168]		[14.658]	[3.640]
Observations	3,249	3,249		2471	2471		887	887
Pseudo R-squared	0.04	0.04		0.05	0.06		0.02	0.02
Estimation	FE	RES		FE	RES		FE	RES
Fixed effects	Firm	Firm		Firm	Firm		Firm	Firm
Firms	469	469		369	369		130	130
Loans	All	All		RC	RC		TL	TL

Table 10

Liquidity shocks and bank lending with firm-level data: the intensive margin

The regressions in this table analyze the change in the stock of loan commitments received by each firm captured in the Shared National Credit program between 2010 and 2012. The dependent variable is the change in C&I loan commitments to U.S. firms, in millions of dollars. Columns (1), (4), and (7) use information for term loans and revolving credit (All), while the dependent variables in the other columns only include revolving credits (RC) only. In columns (1) through (3), the explanatory variable of interest is *Euro-area loan share*$_{(2010)}$, the share of each firm's loan commitments funded by U.S. branches of euro-area banks as of 2010. In columns (4) to (6), *Euro-area dummy*$_{(2010)}$ is an indicator variable equaling one if the firm had an outstanding commitment with a U.S. branch of a euro-area bank in 2010 and in columns (7) to (9) *Liquidity shock*$_{(2010)}$ is an indicator variable equaling one if the firm had a relationship with a U.S. branch of a foreign bank facing large time deposit outflows between 2010 and 2011. Among the explanatory variables, *Log commitments*$_{(2010)}$ is the log of the total commitments of a firm as of 2010 and *Indicator for problem loan*$_{(2010)}$ is an indicator variable equaling one if the firm had a loan with credit quality issues as of 2010. All regressions include industry (NAICS 3 digit) and state level fixed effects. Robust standard errors clustered at the sector level are shown in brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Euro-area loan share$_{(2010)}$	26.018	-96.567	-119.231***						
	[71.054]	[75.187]	[45.024]						
Euro-area dummy				40.964*	5.258	-33.891			
				[24.217]	[18.838]	[24.519]			
Liquidity shock$_{(2010)}$							140.518	53.902	-99.485**
							[85.853]	[78.562]	[48.427]
Log commitments$_{(2010)}$	-5.046	37.904***	-4.729	-13.008	35.196***	-2.163	-6.742	34.837***	-4.609
	[19.810]	[12.162]	[15.552]	[20.611]	[11.324]	[13.705]	[19.511]	[12.146]	[15.705]
Indicator for problem loan$_{(2010)}$	-179.626***	-96.941***	-41.926*	-184.397***	-98.606***	-40.997*	-181.129***	-99.086***	-42.010*
	[40.981]	[26.141]	[22.507]	[41.055]	[26.037]	[23.878]	[41.335]	[26.025]	[22.246]
Observations	2,837	2,532	1,343	2,837	2,532	1,343	2,837	2,532	1,343
R-squared	0.05	0.07	0.07	0.05	0.07	0.07	0.05	0.07	0.07
Fixed effects	Industry, State	Industry, State	Industry, State	Industry, State	Industry, State	Industry, State	Industry, State	Industry, State	Industry, State
Sample	All firms	All firms	Private firms	All firms	All firms	Private firms	All firms	All firms	Private firms
Loans	All	RC	RC	All	RC	RC	All	RC	RC

Table 11
Liquidity shocks and bank lending with firm-level data: the extensive margin

The regressions in this table analyze the extensive margin of firms' access to syndicated lending for each firm captured in the Shared National Credit (SNC) program between 2010 and 2012. The dependent variable is a dummy variable equal to one if a firm had any lending relationship recorded in SNC in 2010 and was no longer in place in 2012; it is equal to zero if the firm still had positive outstanding commitments in 2012. Columns (1), (3), and (5) use information for term loans and revolving credit (All), while the dependent variables in the other columns only include revolving credits (RC) only. In columns (1) through (2), the explanatory variable of interest is *Euro-area loan share*$_{(2010)}$, the share of each firm's loan commitments funded by U.S. branches of euro-area banks as of 2010. In columns (3) and (4), *Euro-area dummy*$_{(2010)}$ is an indicator variable equaling one if the firm had an outstanding commitment with a U.S. branch of a euro-area bank in 2010 and in columns (5) to (6) *Liquidity shock*$_{(2010)}$ is an indicator variable equaling one if the firm had a relationship with a U.S. branch of a foreign bank facing large time deposit outflows between 2010 and 2011. Among the explanatory variables, *Log commitments*$_{(2010)}$ is the log of the total commitments of a firm as of 2010 and *Indicator for problem loan*$_{(2010)}$ is an indicator variable equaling one if the firm had a loan with credit quality issues as of 2010. All regressions include industry (NAICS 3 digit) level fixed effects. Standard errors are shown in brackets. All coefficients are reported as odd ratios. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Euro-area loan share$_{(2010)}$	2.085**	10.278***				
	[0.617]	[4.010]				
Euro-area dummy$_{(2010)}$			1.411***	1.466***		
			[0.139]	[0.160]		
Liquidity shock$_{(2010)}$					1.617*	6.302***
					[0.454]	[2.266]
Log commitments$_{(2010)}$	0.564***	0.546***	0.534***	0.533***	0.565***	0.544***
	[0.021]	[0.022]	[0.022]	[0.024]	[0.021]	[0.023]
Indicator for problem loan$_{(2010)}$	2.811***	3.785***	2.750***	3.781***	2.806***	3.787***
	[0.310]	[0.488]	[0.304]	[0.488]	[0.309]	[0.488]
Observations	3,997	3,373	3,997	3,373	3,997	3,373
Pseudo R-squared	0.09	0.11	0.09	0.10	0.09	0.11
Fixed effects	Industry	Industry	Industry	Industry	Industry	Industry
Loans	All	RC	All	RC	All	RC

Table 12

Liquidity shocks, bank lending, and corporate investment

The regressions in this table examine whether the liquidity shock faced by the U.S. branches of foreign banks, and in turn the decrease in their lending, had an effect on the investment of borrowing firms. The regression uses firm-level data for firms in the SNC database with outstanding syndicated loans in 2010, that had quarterly balance sheet information in Compustat, and that are not active in the agriculture, mining, financial or utilities sectors. The dependent variables are: (a) firms' quarterly investment-to-asset ratio (columns 1-3) and, alternatively, (b) the cash-to-assets ratio (columns 4-6). *After* is an indicator variable equal to one in the post-crisis period and zero before. *Euro-area loan share*$_{(2010)}$ is the share of each firm's loan commitments funded by U.S. branches of euro-area banks as of 2010; *Euro-area dummy*$_{(2010)}$ is an indicator variable equaling one if the firm had an outstanding commitment with a U.S. branch of a euro-area bank in 2010; *Liquidity shock*$_{(2010)}$ is an indicator variable equaling one if the firm had a relationship with a U.S. branch of a foreign bank facing large time deposit outflows between 2010 and 2011. All specifications include a measure of Tobin's Q, firm fixed effects, and reported standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

	(1)	(2)	(3)		(4)	(5)	(6)
Dependent variable	Investment/Assets				Cash/Assets		
After	0.121***	0.130***	0.129***		-0.924***	-1.013***	-0.989***
	[0.021]	[0.022]	[0.022]		[0.138]	[0.144]	[0.147]
After x Euro-area loan share	-0.368				1.393		
	[0.294]				[2.116]		
After x Euro-area dummy		-0.089**				0.583***	
		[0.035]				[0.225]	
After x Liquidity shock			-0.081**				0.438*
			[0.034]				[0.225]
Tobin's Q	0.158***	0.160***	0.159***		1.745***	1.724***	1.732***
	[0.058]	[0.059]	[0.059]		[0.507]	[0.505]	[0.505]
Observations	10,215	10,215	10,215		10,215	10,215	10,215
R-squared	0.01	0.01	0.01		0.03	0.03	0.03
Firms	1,366	1,366	1,366		1,366	1,366	1,366
Firm fixed effects	Yes	Yes	Yes		Yes	Yes	Yes

Table 13

Robustness checks: U.S. commercial bank subsidiaries of foreign banks

The regressions in this table examine the change in the average stock of deposits and loans at U.S. commercial bank subsidiaries of foreign banks between 2010 and 2011. The dependent variable in columns (1) and (3) is the change in total deposits at these subsidiaries, while columns (2) and (4) use the change in large time deposits (time deposits above $250,000). In columns (5) and (7), the dependent variable is the change in all loans, while in columns (6) and (8) the dependent variable is the change in C&I loans. *Dummy euro area* is an indicator variable equaling one if the parent of the commercial bank is headquartered in the euro area. *Branch liquidity shock indicator* is another indicator variable equaling one if a branch affiliated with the commercial bank had a change in their large time deposits ranked in the lower 25th percentile of the total distribution of changes in branches' large time deposits between 2010 and 2011. *Subsidiary deposits to assets* and *Subsidiary loans to assets* are the ratios of deposits and loans, for each subsidiary, relative to its total assets in 2010. *Relative size of subsidiary* is equal to the ratio of assets for the subsidiary compared to the assets of its parent bank in 2010. *Subsidiary total capital ratio* is the ratio of total regulatory capital over risk-weighted assets for the subsidiary as of 2010. Robust standard errors clustered at the country level are shown in brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Dependent variable	(1) Δ Total deposits	(2) Δ Large time deposits	(3) Δ Total deposits	(4) Δ Large time deposits	(5) Δ Total loans	(6) Δ Total C&I Loans	(7) Δ Total loans	(8) Δ Total C&I Loans
Dummy euro area	0.609	0.241			-0.572	0.134		
	[1.228]	[0.332]			[0.562]	[0.234]		
Branch liquidity shock indicator			1.026	0.104			-0.527	0.391*
			[1.470]	[0.294]			[0.647]	[0.220]
Log subsidiary assets$_{(t-1)}$	0.526*	0.022	0.604	0.045	0.348	0.117	0.432	0.110
	[0.298]	[0.058]	[0.427]	[0.079]	[0.204]	[0.078]	[0.278]	[0.097]
Subsidiary total capital ratio$_{(t-1)}$	0.589**	-0.009	1.080***	0.007	-0.172	0.087	0.635***	0.219***
	[0.226]	[0.013]	[0.197]	[0.020]	[0.320]	[0.068]	[0.099]	[0.032]
Subsidiary loans to assets$_{(t-1)}$	-0.786	0.474	-3.838	0.362	-2.006	0.733	-2.662	0.144
	[2.126]	[0.651]	[2.770]	[0.439]	[1.459]	[0.454]	[2.121]	[0.470]
Subsidiary deposits to assets$_{(t-1)}$	-1.216	0.218	-2.581	0.170	-1.010	0.449	-2.351	0.297
	[1.523]	[0.311]	[2.205]	[0.305]	[1.051]	[0.387]	[1.400]	[0.469]
Relative size of subsidiary$_{(t-1)}$	24.099	-0.819	27.524	-1.246	15.548	3.294	18.174	4.094
	[22.361]	[0.838]	[25.909]	[1.244]	[16.913]	[3.078]	[16.865]	[3.136]
Observations	38	38	28	28	38	38	28	28
R-squared	0.57	0.10	0.64	0.07	0.18	0.52	0.67	0.72
Related branch	No	No	Yes	Yes	No	No	Yes	Yes
Countries	22	22	16	16	22	22	16	16

Figure 1. U.S. money market funds' holdings of certificates of deposit (CDs) issued by the U.S. branches of foreign banks.

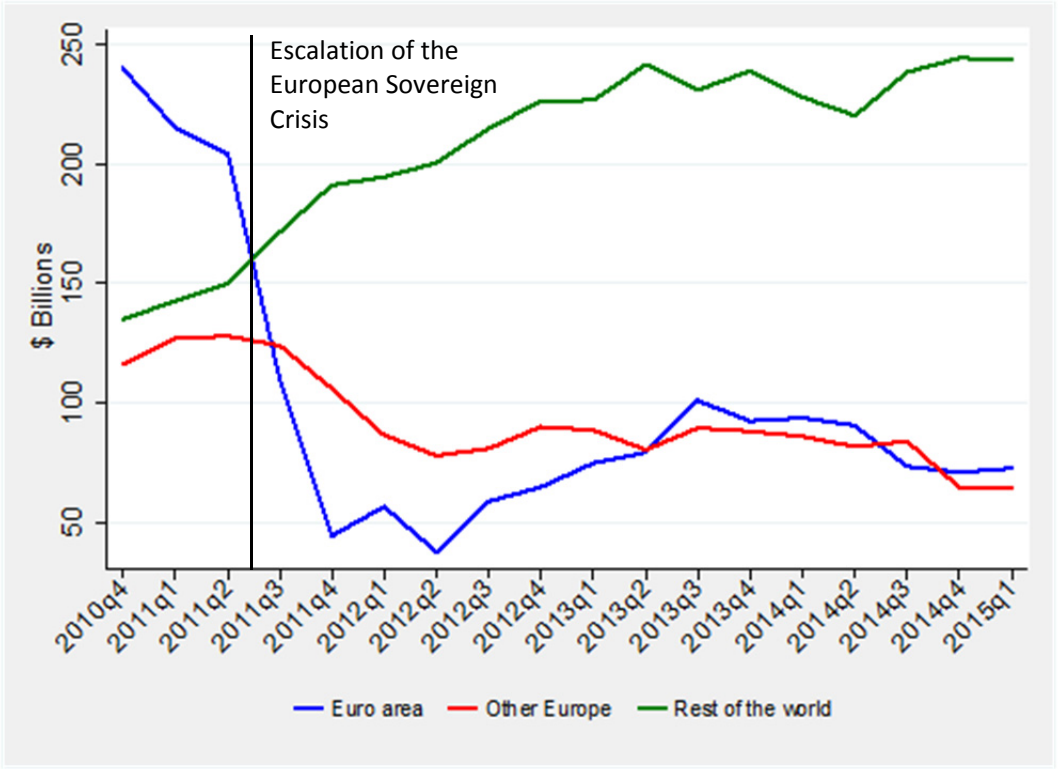


Figure 2. Large time deposits outstanding at the U.S. branches of foreign banks.

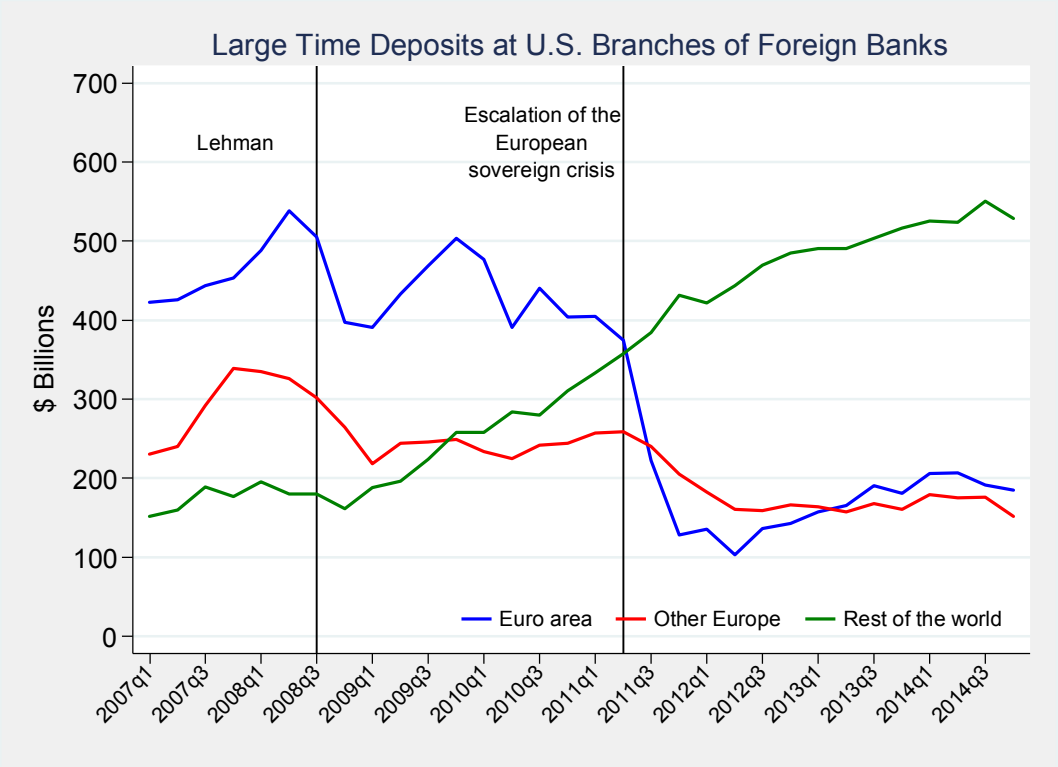


Figure 3. Net due to positions of the U.S. branches of foreign banks with their head offices.

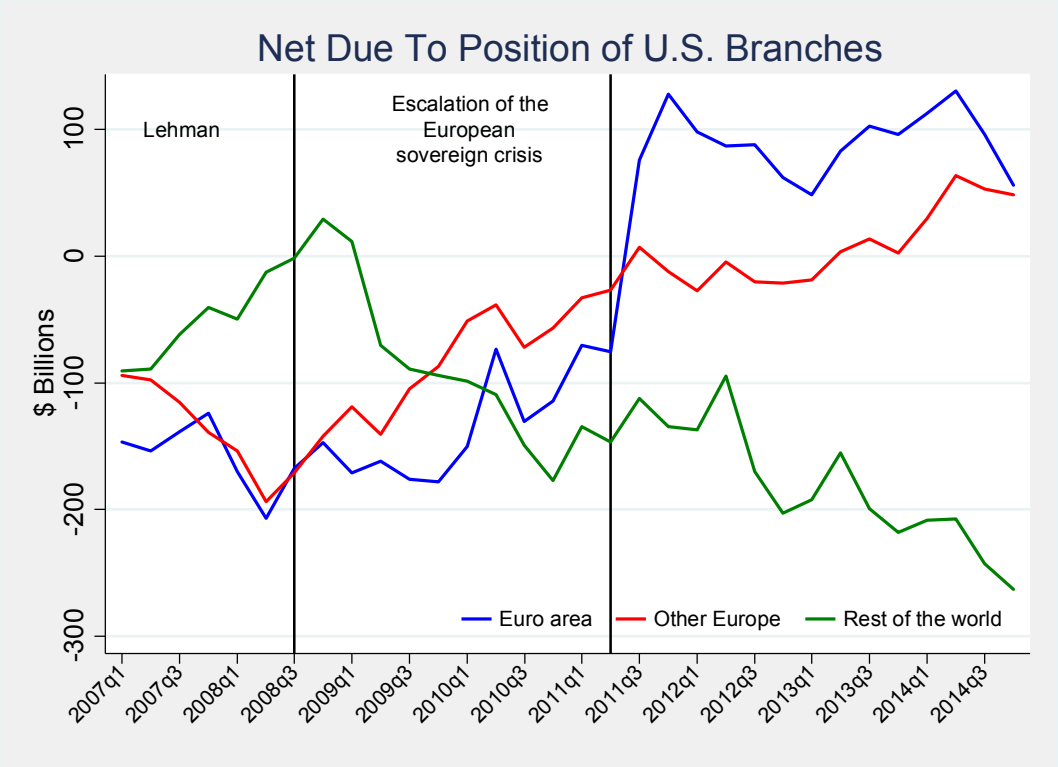
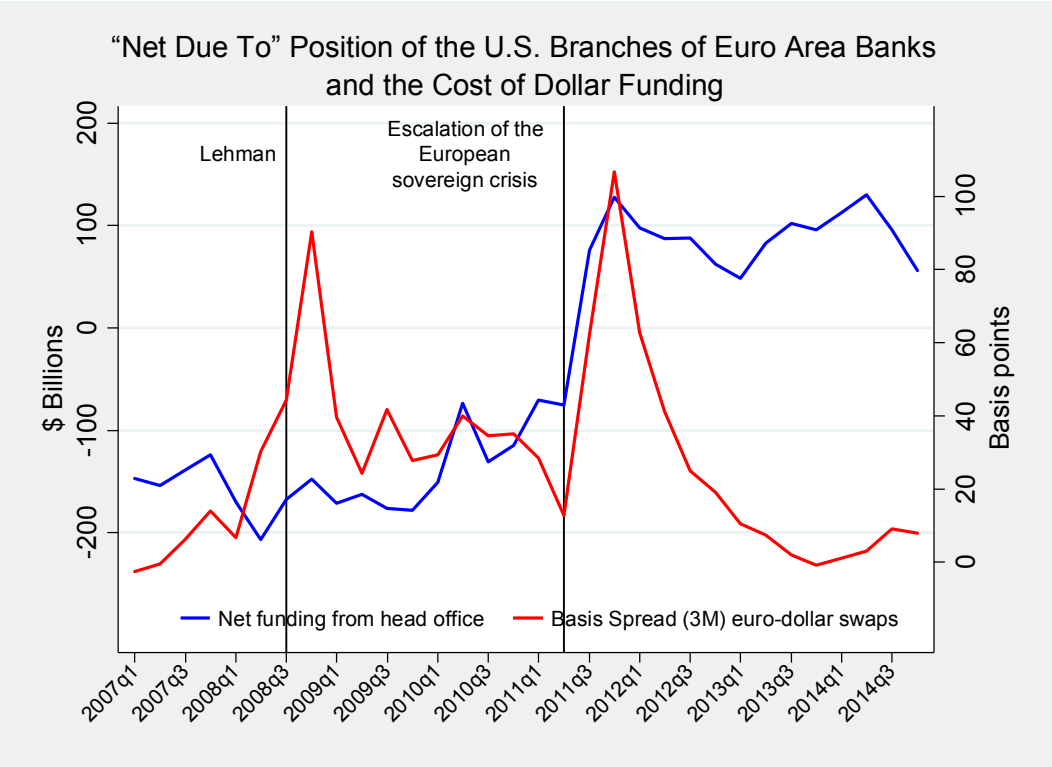


Figure 4. Net funding of the U.S. branches of euro-area banks from head offices and the cost of dollar funding.



Note: The net funding of the U.S. branches of euro-area banks from head offices is shown by the net due to position (the blue line), defined as the balances owed by the branch to the head office minus the balance owed by the head office to the branch. The cost of dollar funding is approximated as the 3-month implied basis spreads from the euro-dollar swaps averaged into quarters (the red line).

Figure 5. C&I loans to U.S. addresses outstanding at foreign bank branches

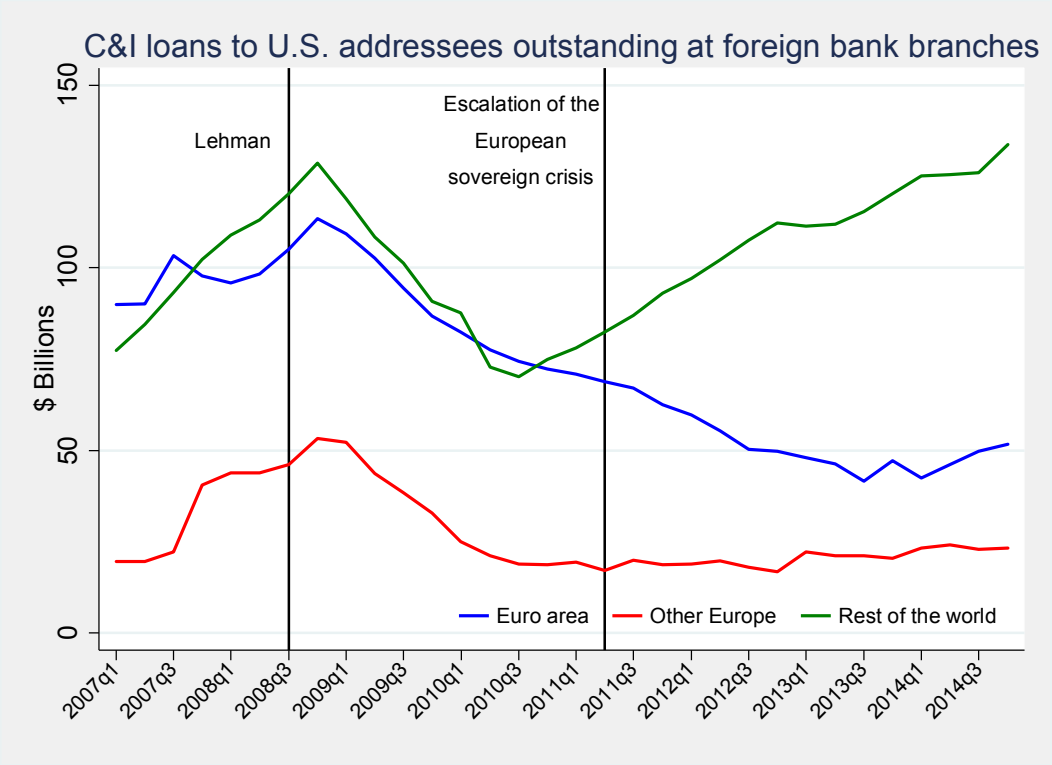
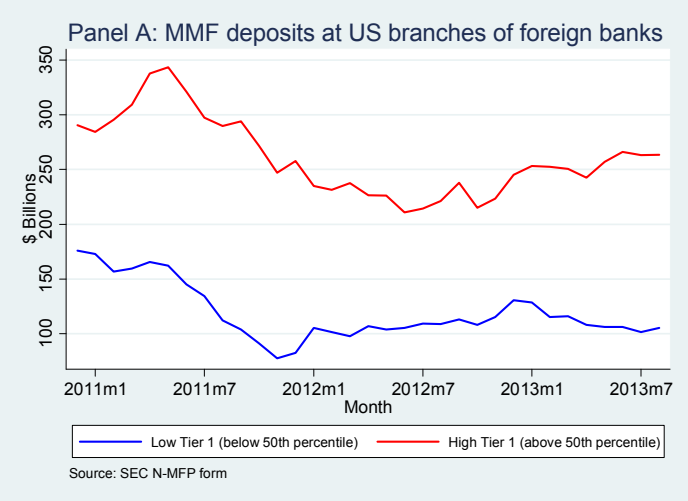
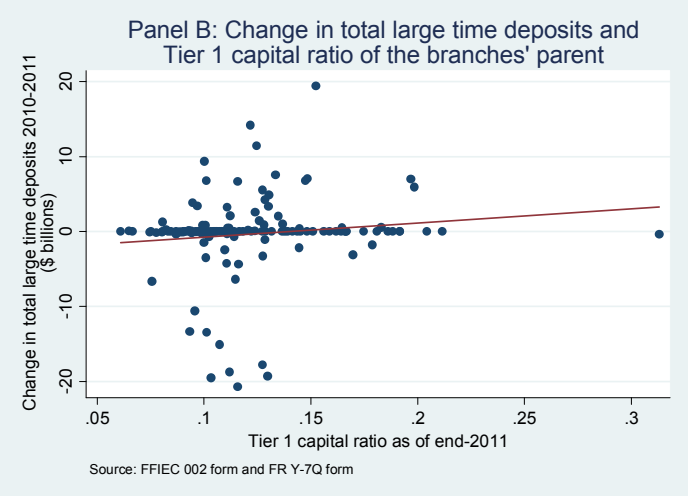


Figure 6. Liquidity shock vs. bank capital





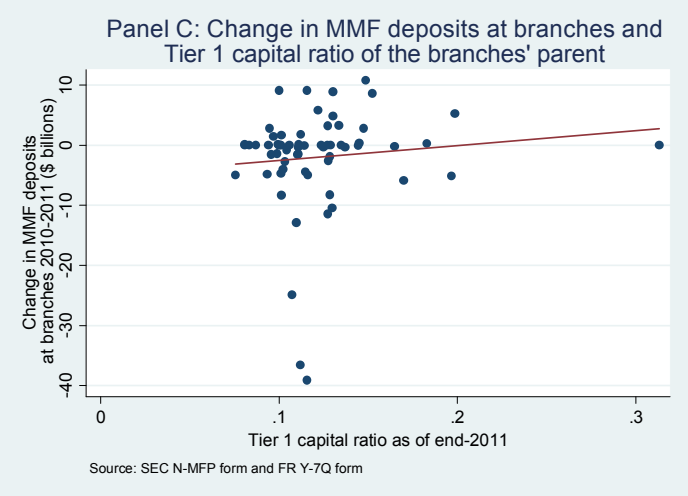
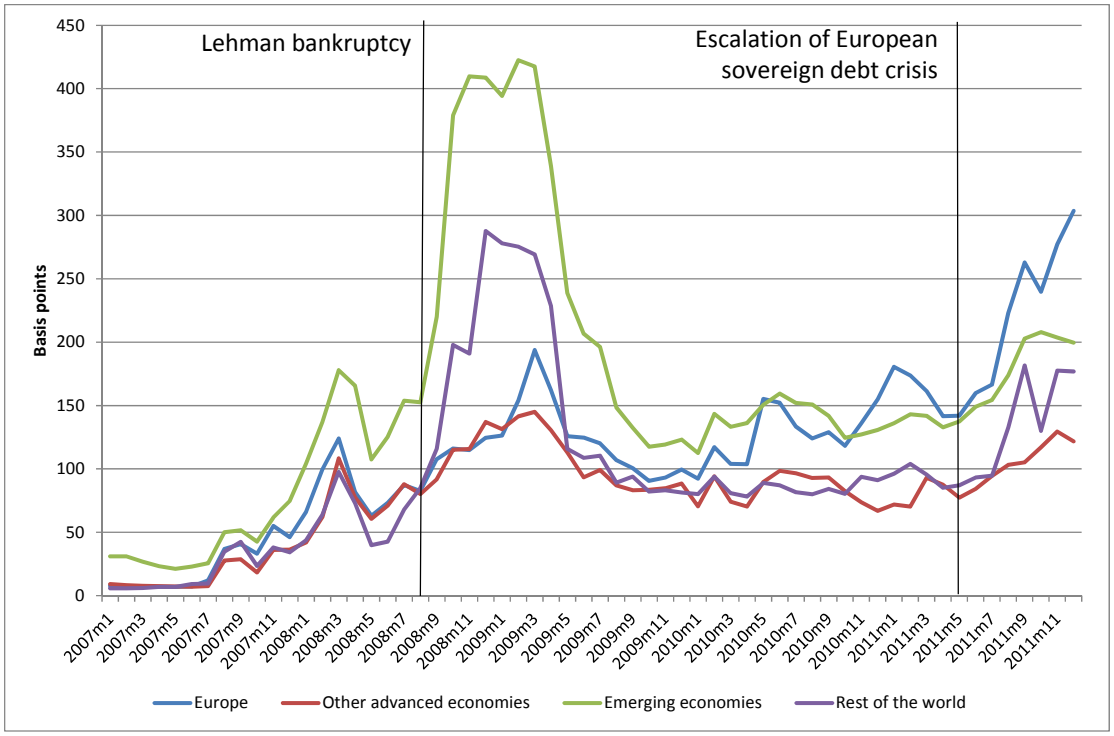


Figure 7. Median CDS premiums for banks by region.



Note: The median CDS premiums (5-year contracts) are averaged for banks headquartered in Europe (blue line), other advanced economies (red line), emerging economies (green line), and the rest of the world (purple line).