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Ricardo Correa

Horacio Sapriza

Andrei Zlate

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Ricardo Correa, Horacio Sapriza, Andrei Zlate

Federal Reserve Board[*†]

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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, which prompted them to cut lending to U.S. firms along the extensive margin, negatively affecting corporate investment. (2) The affected branches received additional funding from parent banks, but not enough to offset the lost deposits. (3) The liquidity shock was related to country rather than bank-specific characteristics.

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[†] Correspondence: Ricardo.Correa@frb.gov, Horacio.Sapriza@frb.gov and Andrei.Zlate@frb.gov, Division of International Finance, Board of Governors of the Federal Reserve System, Washington, D.C. 20551, U.S.A. The views in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System.

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 only recently. On the 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 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, 2012). Their role 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 are funded to a great extent with large time deposits received 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 European banks.[2] This dollar liquidity shortage was partially compensated with transfers from parent banks to their U.S. branches. However, European parent banks' liquid assets were denominated largely in euros; thus, 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

[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.

could transfer to their U.S. branches. In turn, this liquidity shock led to a decrease in branch lending to U.S. borrowers, as well as to changes in some firms' investment expenditures and 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 this new type of bank lending channel. This setting is ideal for analyzing the effect of a liquidity shock on bank lending for three reasons. First, the liquidity shock tied 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 to 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 this 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 supervisory dataset that provides loan-level data on syndicated lending, and that allows us to control for factors affecting loan demand during the crisis, the omission of which may have biased our results toward falsely identifying an effect of funding shocks on bank

[3]For example, see this article by Reuters quoting a JP Morgan analyst:
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 labeled "headline risk". As noted in Copeland, Martin, and Walker (2012), "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.

lending. 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, 2011). 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, 2012). 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 related affiliates based inside and outside the United States, as a result of the liquidity shock documented above.

Our main results show that, first, U.S. branches of foreign banks that endured a run on their deposits during the European sovereign debt crisis cut their aggregate lending, as well as their C&I lending to U.S. addressees. This result is robust to controlling for loan demand by using syndicated loan information and estimating fixed effects at the sector and firm levels. Second, following the methodology developed in Khwaja and Mian (2008), we show that

branches that suffered larger drops in deposits cut their lending especially along the extensive margin, rather than along the intensive margin (i.e. they cut the number of firms to which they kept lending, rather than cutting the amount of lending per firm). Third, in response to the liquidity shock, U.S. branches of foreign banks 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. However, internal funding was not enough to compensate for the drop in external financing. Fourth, we find that the publicly-traded U.S. firms that had lending relationships with the U.S. branches of foreign banks with liquidity shocks invested less and held more cash than other publicly-traded firms that also borrowed in the syndicated loan market. This result suggests that the liquidity shock had real economic effects in the United States. Lastly, we document that the wholesale deposit run was not triggered by bank specific characteristics, but rather by a broad sentiment against the liabilities issued by the U.S. branches of euro-area banks.

This last result provides evidence that the liquidity shock was not related to individual bank characteristics, but was triggered in part 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 informationally 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 (2012), 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 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 at U.S. branches of euro-area banks in mid-2011, of which more than half are received from U.S. money market funds.[5] For comparison, when Lehman Brothers collapsed in September 2008, the amount of large time deposits at U.S. branches of euro-area banks also declined significantly, but at a slower pace than in 2011. In addition, the 2011 deposit run was focused on the U.S. branches of euro-area banks, which contrasts with the more stable or even increased funding received by the U.S. branches of other 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 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.

Another difference relative to the financial crisis of 2008-2009 is that in 2011 European parent banks initiated internal liquidity transfers to their U.S. branches in order 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 for the first time in several

[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.

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, also shown in Figure 3. Thus, internal capital movements were not enough to prevent the contraction in net lending by U.S. branches of European 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.

Our paper is framed within 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 set of existing empirical studies focuses on the international transmission of shocks through the activities of global banks. This literature has identified three types of channels which document the propagation from a shock to a bank's balance sheet to its lending abroad. The first 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. The second channel, documented in Giannetti and Laeven (2012) and in 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 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 capital shock, 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 an adverse cross-border banking flow (as in Cetorelli and Goldberg 2012a,b). In addition, our paper highlights the frictions associated with internal financing operations that involved multiple currencies (i.e., the costs encountered by European 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.

In a closely related paper, Ivashina, Scharfstein, and Stein (2012) study 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 and makes additional contributions to their results along three dimensions. First, as noted before, we are able to use branch level information in our analysis to assess the extent of the liquidity shock suffered by these branches and the amounts of funding received by their parents to mitigate the liquidity shock. Second, the syndicated loan database used in our study, called the Shared National Credits (SNC) program, has several advantages over the Thomson Reuters' Dealscan database used in their analysis. The SNC database reports the exact amount that each participant in a syndicate contributes to each loan, and also the identities of the borrower as well as 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

[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.

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 this liquidity shock on firms' investment decisions by using a matched sample between the SNC syndicated loan database and firms' balance sheet information from Standard and Poor's Compustat.[7]

Our results have important policy implications. As the Basel Committee and domestic regulators discuss new bank liquidity requirements, 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 would help banks absorb potential liquidity shocks and reduce the impact on lending.

The paper is organized as follows. Section 2 presents the data used in our analysis. Section 3 presents the econometric results regarding the effect of the liquidity shock on lending by the U.S. branches of foreign banks, as well as the effect of decreased lending on corporate investment by the U.S. firms. Section 4 documents the internal liquidity management undertaken by the foreign bank organizations in response to the liquidity shock. Section 5 analyzes the link of the liquidity shock to bank, country, and region-specific characteristics. Finally, Section 6 presents a set of robustness checks, and Section 7 concludes.

[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.

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 U.S. branches of foreign banks, parent banks, flows within the two, and their syndicated lending.

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 have branches in the United States as of 2011.[9] Taiwanese banks have the widest presence, with 13 banks having U.S. branches, followed by German banks. However, branches of Japanese banks are the largest, with assets totaling $356 billion, thus edging the branches of Canadian banks which hold $320 billion in assets. Branches of European banks have a total of $1.2 trillion in assets, more than half of the $2.1 trillion in assets held by all the foreign bank branches in the United States in 2011.[10]

Table 2 shows the aggregate balance sheet of U.S. branches of foreign banks averaged across all quarters of 2011. Before the financial crisis, the U.S. branches of European banks had almost $1.2 trillion in assets (not shown). This number went up to $1.4 trillion as of December 2008 (also not shown), but then fell back to $1.2 trillion in 2011. The composition of the

[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 129 foreign banks from 42 countries.

balance sheet also changed significantly during this period. For example, claims on non-related parties by the European banks increased from about 70 percent of total assets prior and during the 2008-2009 financial crisis (not shown) to about 86 percent in 2011. Of these claims, as European fiscal strains deepened, branches of European banks increased their cash holdings, which now represent about 40 percent of their total assets. Loans are the second largest claim at 23 percent of total assets, with C&I loans accounting for about half.

On the liabilities side, the largest funding component for U.S. branches of foreign banks is deposits, representing about 50 percent of total liabilities. Most of these deposits are in the form of large time deposits, that is, uninsured time deposits of $100,000 or more. About 43 percent of branch liabilities are large time deposits. As noted above, a sizeable proportion of these large time deposits are held by U.S. money market funds. The share of deposits at U.S. branches of foreign banks from money market funds was 61 percent at the end of 2010. That number went down by 4 percentage points over the course of 2011. This drop was mostly explained by the decrease in the share of money market funds' deposits at U.S. branches of euro-area banks. The money market funds' share at these branches decreased to 40 percent at the end of 2011 from 65 percent at the end of 2010.

To analyze the liquidity management within banking organizations, we focus on the size and evolution of intra-bank transactions. 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 U.S. branches of foreign banks is listed on the assets side, while the *Net due to* position is part of the liabilities. The table shows that, on aggregate, the U.S. branches of European banks had a positive *Net due to* position with related institutions in 2011. This means 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.

Panel A in Table 3 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 only reached about $1.4 billion.[11] With the exception of the *Net due to* positions with related entities and the head office, the means 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 of a branch. 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 data on syndicated lending by the U.S. branches of foreign banks to U.S. addressees across sectors, from the Shared National Credit (SNC) dataset. 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

[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.

with aggregate commitments 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* is the total value of committed 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 the 2010 and 2011 version 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 information 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 (also see Correa et al., 2013).

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

The banks' inability to mitigate the effect of bank 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 U.S. branches of foreign banks to U.S. borrowers that coincided with a sharp reduction in the deposits that some of these banks 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).

3.1 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.[14] More precisely, we estimate the following equation:

$$\Delta Loans_{ij} = \beta_0 + \beta_1 \Delta Large\ Time\ Deposits_{ij} + \gamma X_{ij} + \varepsilon_{ij} \quad (1)$$

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 & 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 are 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.[15] Second, lending on the syndicated market has a strong seasonal component (Murfin and Petersen, 2012) and most C&I lending done by branches is through syndicates. Thus, we average total lending through the year to avoid capturing this seasonal component in our estimations.

[14] For example, U.S. firms borrowing from U.S. branches of French banks only produce goods that are destined to the U.S. domestic market. Thus, we assume that the demand faced by U.S. borrowers is not correlated with French economic activity.

[15] 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.

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.

In addition, X_{ij} includes the following 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 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.

The results from estimating equation (1) are presented in Table 4. 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 2-3). The result also holds after controlling for branch and parent bank characteristics (columns 4-6). In terms of economic significance, these results show that a one billion dollar decrease in large time deposits implies a reduction of $95 million dollars in total loans, or $39 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, 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.[16] Thus, the coefficient estimate on the liquidity shock would be biased upward, and would falsely indicate a positive relation between the change in deposits and the banks' reduced ability to make loans.[17] We use two different methods with fixed effects as in Khwaja and Mian (2008) to avoid this kind of bias. The first method uses aggregate branch-level data, presented below, while the second, described in the next section, uses loan level-information. Our baseline results are preserved in each case.

Using the branch-level data, we include fixed effects for the country of origin of the U.S. branches of foreign banks in equation (1), to control for demand shocks that are specific to borrowers working with the branches from one given country. For instance, U.S. firms with close commercial links to countries with rising sovereign risk may have developed long-standing relationships with the branches of parent banks originating in these same countries. Thus,

[16] 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.

[17] 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).

increased sovereign stress in country *j*, which triggers the banks' funding shock, may also be associated with macroeconomic problems that reduce country *j*'s demand for U.S. exports. In turn, the U.S. exporters would reduce their demand for loans from the branches of banks from country *j*, thus giving rise to a positive correlation between the funding shock and loan demand.

The results for this estimation using fixed-effects at the country level are shown in columns 7 through 9 in Table 4. The coefficients on $\Delta Large\ Time\ Deposits_{ij}$ remain positive and statistically significant, and their economic significance becomes even larger. For example, a one billion dollar decrease in large time deposits implies a reduction of $146 million dollars in total loans, or a decline of $43 million in C&I loans to borrowers domiciled in the United States.

3.2 Estimates using loan-level data

Even after controlling for country-level fixed effects using the branch-level data, there may be some demand factors that we are not able to take into account using this level of data aggregation. We address this problem by using loan-level data from the SNC database, which includes detailed information about all participants in syndicated loans that satisfy the conditions outlined in the data section. Most branch C&I lending is done through syndicated loans, making this dataset ideal for analyzing the effect of the liquidity shock on their lending.

In our first set of tests, we aggregate all syndicated loans outstanding by each branch at the 3-digit NAICS 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 aggregating the value of

the syndicated loans outstanding at the sectorial level is that both effects can be measured at the same time.[18]

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 the pace of economic activity—and therefore loan demand—also varies across sectors. 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. Thus, facing weaker loan demand, branches may have reduced their demand for deposits by more, which would bias the funding shock coefficient upwards. To control for this potential bias arising from the variation in loan demand across sectors, we estimate the following equation:

$$\Delta Loans_{ijs} = \beta_0 + \beta_1 \Delta Large\ Time\ Deposits_{ij} + \gamma X_{ij} + \eta_s + \varepsilon_{ijs} \quad (2)$$

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 consists of two measures of syndicated lending by 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

[18] 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 sectorial level.

sector *s* at the 3-digit NAICS level. The main explanatory variable is still 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. Importantly, the sector-specific fixed effect (η_s) controls for those cases when borrowers from the same sector experience declines in their demand for loans and are also clients of the banks facing relatively larger funding shocks. To estimate the fixed effects, we only include sectors with lending 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 5. As before, the coefficients on *ΔLarge Time Deposits* 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 $2.5 million in commitments and $0.75 in loans utilized, which represents about 4 percent in commitments of the median loans outstanding across branches and sectors.

Next we estimate equation (2), 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. First, we document the intensive margin adjustment of syndicated lending, since the regression includes firms that took loans in both 2010 and 2011. We include fixed effects at the level of the firm to control for firm-specific demand factors, and restrict our sample to those firms that received loans from at least two branches. Table 6 shows the results for this specification. The coefficient on the change in large time deposits is positive in all specifications, but it is not statistically significant in most cases. This provides some evidence

that most of the adjustment in lending by the U.S. branches of foreign banks did not happen in the intensive margin.

Second, we test whether the lending adjustment took place in the extensive margin, that is, whether U.S. branches of foreign banks with liquidity problems stopped lending to some firms. For this purpose, we estimate a logit model with firm fixed effects.[19] 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. 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).

Table 7 shows the results for this specification. All coefficients are reported as odd ratios. The estimations in columns 1 and 2 are computed using the complete sample of loans—revolving credit and term loans. The coefficient on *ΔLarge Time Deposits* is 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 deposit inflows between 2010 and 2011. A coefficient higher than one would have implied the opposite. In columns 3 through 6 we test whether this adjustment in the extensive margin was stronger for revolving credits or 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.

[19] 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.

In sum, we find that branches that faced liquidity problems restricted lending to firms and that most of this adjustment took place in the extensive margin. Next, we test whether this credit shock had any effect on firms' investment activity.

3.3 Branch liquidity shocks and corporate investment

In the previous sections, we showed that the liquidity shock faced by U.S. branches of foreign banks negatively affected their lending. However, to test whether this contraction on lending had an effect on firms, we have to analyze the performance of those firms that were affiliated with the liquidity-constrained branches (affected firms) to comparable firms that did not have lending relationships with those branches. In this section, we follow Duchin, Ozbas, and Sensoy (2010) and test whether the corporate investment of affected firms differed from that of a control group of firms after the European sovereign crisis escalated.

We select the sample of firms in our affected and control groups following three criteria. First, we start with all firms that had an outstanding syndicated loan between 2010 and 2012 in the SNC database and that had quarterly balance sheet information in Standard and Poor's Compustat. Second, we restrict the sample to firms with SIC codes inside the intervals 1500-4900, 5000-5999, and 7000-8999[20] Third, we further restrict our sample to those firms with available data between the third quarter of 2010 and the second quarter of 2012.

After determining the overall sample, we divide it between the group of affected firms and the control group. An affected firm is an institution that had a lending relationship with a U.S. branch of a foreign bank in 2010 that suffered outflows of large time deposit between 2010 and 2011. The control group is composed of firms with lending relationships with U.S. branches

[20] We exclude firms in the agriculture, mining, financial, and utilities sectors.

of foreign banks that enjoyed deposit inflows during this period, or firms with no lending relationships with the U.S. branches of foreign banks. After applying these sample selection criteria, we end up with a sample of 324 affected firms and of 1,047 firms in our control group.

To estimate the corporate investment equation, we follow Duchin, Ozbas, and Sensoy (2010) and regress the ratio of investment to assets at the quarterly frequency on an indicator variable equaling one in the post-crisis period (*After*).[21] We define the post-crisis period 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, as well as with the adjustment of foreign branches' lending decisions in the United States. The pre-crisis period is composed of the interval between the third quarter of 2010 and the second quarter of 2011, allowing for symmetry in the estimating sample.

The main coefficient of interest in this specification is that on the interaction between *After* and an indicator equaling one if the firm had a syndicated lending relationship with a U.S. branch of a foreign bank facing large time deposit outflows between 2010 and 2011 (*After x Liquidity shock*).[22] The results of this estimation are shown in columns 1 through 3 of Table 8. All specifications include a measure of Tobin's Q, firm fixed effects, and reported standard errors are clustered at the firm level. The first finding from these results is that corporate investment increased, on average, between the pre- and post-European sovereign debt crisis. This is shown by the positive and significant coefficient on the indicator *After*. This is consistent with positive U.S. aggregate growth in this period. However, the coefficient on *After x Liquidity*

[21] 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.

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

shock in column 1, shows that firms that had relationships with branches facing a liquidity shock invested at about half the pace as those without any relationship with these branches. This result is robust to using a slightly different definition of the liquidity shock proxy, as shown in column 2, and to including a control for the contemporaneous cash flow of the firm, as shown in column 3.[23] These findings are evidence that the liquidity shock faced by some branches of foreign banks had actual effects on firms' performance.

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 decreased their cash holdings by about 40 percent less, on average, than the firms in the control group. This finding provides some evidence that firms with relationships to constrained branches of foreign banks were more cautious at drawing down their cash holdings as the U.S. economy was picking up.

Overall, these findings are consistent with the existence of a new type of bank lending channel, which focuses on the effect of uninsured wholesale funding on the lending of U.S. branches of foreign banks. However, previous studies have argued that internal capital markets within banking organizations may mitigate the effect of external financing shocks on bank lending. This is the subject of the next section.

[23] The variable *Liquidity shock (fraction)* is defined as the fraction of affected branches to all branches providing credit to a firm as of 2010. This variable is equal to zero for firms that do not borrow from U.S. branches of foreign banks.

4. Liquidity shocks and internal liquidity management

Our second set of tests 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 latter's reduced access to U.S. money market deposits. Such an action would be reflected in an increase of the branches' "net due to positions" with related depository institutions, particularly for the branches that suffered larger funding shocks.[24] The increased financing from parents could have even offset the funding shock, in which case we would have found no relation between the change in the branches' loans and large time deposits. To test whether branches with larger liquidity shocks received more funding from their parents, we estimate the following equation:

$$\Delta NDTP_{ij} = \beta_0 + \beta_1 \Delta Large\ Time\ Deposits_{ij} + \gamma X_{ij} + \varepsilon_{ij} \quad (3)$$

where the dependent variable (*NDTP*) 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 same as in equation (2). 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 9, 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

[24] 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.

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 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 columns 1 and 4) than relative to the head office (in columns 2 and 5). However, the coefficients are lower than one, 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 intrabank liquidity management, when these flows are denominated in a currency different from that of the home-country of the bank. This is an important finding, as previous studies had only focused on frictionless liquidity management within a country, or liquidity management across countries, either when the funds were denominated in the home currency of the bank, or when foreign currency was widely available.

The control variables in X_{ij} show some interesting additional results. The coefficient estimates on $Log\ Branch\ Assets_{ij}$ in columns 4 and 5 of Table 9 are positive and statistically significant, suggesting that larger branches received more funding from their foreign parent institutions. Similarly, branches representing a large fraction of assets within the organization also received more funding from the rest of the group, as shown by the positive and significant

coefficient on *Relative size of branch* in column 4. Finally, in column 6, the dependent variable is the change in the branches' net due to position relative to related U.S. non-branch offices, such as subsidiaries, which have access to retail deposits as an alternative source of funding. The positive and statistically significant coefficient on *Loans to assets* shows that branches of foreign banks for which the United States represents a larger *investment* market received more support from their related U.S. non-branch offices. On the contrary, the negative and significant coefficient on *Deposits to assets* shows that branches of foreign banks for which the United States represents a larger *funding* market received less support from their related U.S. non-branch offices.

5. Tracing the liquidity shock to foreign sovereign risk

We follow a difference-in-difference approach to explore the link between the U.S. branches' change in financing through large time deposits ($\Delta Large\ Time\ Deposits_{ij}$) and the sovereign debt crisis in Europe. 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 country and region-specific characteristics. We assess whether the liquidity shock was related to broad signals like the change in sovereign credit default swap (CDS) premiums, or the geographical location of the branches' parent. Thus, a broad pullback from branches would provide evidence that investors did not discriminate by bank-specific characteristics, but rather acted like in a traditional "bank run" on banks from the same country or region (Diamond and Dybvig, 1983). In the following specification, the proxy for sovereign risk is the change in the average sovereign CDS premium of each bank's country of origin *j* from 2010 to 2011 (ΔCDS_j), and the other controls are like in specification (1):

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

In addition, we replace the change in sovereign CDS premiums with dummy variables for Europe, the euro-area, and western European countries not in the euro area.[25] We also estimate (4) using the sub-sample of European banks with branches in the United States and available data on sovereign debt holdings.[26]

Second, we further investigate the origin of the liquidity shock by adding bank-specific indicators to the country-specific characteristics discussed above. In this framework, evidence that the shock was related to country rather than bank-specific characteristics would provide further evidence in favor of a broad pullback in deposits. In the following specification, we interact the increase in the sovereign CDS premium for country of origin j (ΔCDS_j) with each bank i's initial holdings of its own sovereign debt ($OwnSovDebt_{ij}$):

$$\begin{aligned} \Delta Large\ Time\ Deposits_{ij} = {} & \beta_0 + \beta_1 \Delta CDS_j + \beta_2 OwnSovDebt_{ij} \\ & + \beta_3 \Delta CDS_j \times OwnSovDebt_{ij} + \gamma X_{ij} + \varepsilon_{ij} \end{aligned} \quad (5)$$

$OwnSovDebt_{ij}$ is parent bank i's holdings of sovereign debt issued by its country of origin j, expressed as a share of the parent bank's tier 1 capital. Compared to (4), this specification has the advantage that it uses a more precise proxy for the parent banks' exposure to the sovereign risk of their country of origin, since the initial holdings of their own sovereign debt varied across

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

[26] 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.

banks.[27] In addition, we test whether a change in the bank-specific expected government support, or in the bank-specific CDS premiums might have triggered the decrease in deposits.

Third, we assess the potential spillovers from the parent banks' exposures to peripheral European countries. The main explanatory variable in this specification is the parent bank *i*'s initial exposure to sovereign debt from the European peripheral economies (i.e. Greece, Ireland and Portugal, $GIPSovDebt_{ij}$) expressed as a share of tier 1 capital for the sample of 31 European banks. The variable should capture the potential spillovers arising from the banks' holdings of sovereign debt from countries other than their own country of origin:

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

In Table 10, columns 1-4 present our first set of results on whether the liquidity shock was related to country or region-specific characteristics. The dependent variable is the change in the branches' access to large time deposits. In column 1, the coefficient on the change in the own sovereign CDS spread is negative but not statistically significant. In columns 2 and 3, when we replace the change in the own sovereign CDS spread with regional dummy variables, the results show negative and statistically significant coefficients for banks from Europe and specifically, the euro area. (The variables take the value of one if a foreign bank is headquartered in Western Europe, the euro area, other European countries, and zero otherwise). So far, the results outlined in columns 1-3 were obtained for the full sample of 129 foreign banks. The additional results in column 4 are obtained by estimating equation (4) for the sub-sample of 31 European banks with U.S. branches that participated in the 2011 EBA stress test. In this case, the coefficient on the change in the own sovereign CDS spread is negative and

[27] We exclude branches with parents from Ireland and Portugal in this specification.

statistically significant. This finding shows that investors did not differentiate across bank branches according to their related sovereign risk across all regions; however, as they focused on European banks, investors did differentiate among bank branches according to the sovereign risk of their country of origin. These results support the hypothesis that branch depositors withdrew their funding to euro-area branches in a rapid and somewhat indiscriminate way, like in a traditional deposit run.

To reinforce this finding, the second set of tests analyze whether the U.S. money market funds and other investors differentiated across financial institutions based on these banks' exposure to sovereign risk, rather than just across the aggregate sovereign risk of the banks' country of origin. Column 5 in Table 10 shows the results for equation (5), which includes the interacted term between the change in the sovereign CDS spread and the bank-specific initial holdings of its own sovereign debt. The estimation is done for the sample of 31 European banks with U.S. bank branches that participated in the 2011 EBA stress test, for which the data on sovereign debt holdings are available. The coefficient on the change in sovereign CDS spread is still negative and statistically significant, but the interacted term and the exposure to own sovereign debt are not significant. The result shows that, for a given increase in the sovereign risk of a bank's country of origin, U.S. money market funds reduced funding to all bank branches from that country, without differentiating according to each parent bank's relative holdings of own sovereign debt. This result lends further evidence to the hypothesis of a classical bank run scenario.

In addition, column 6 shows the results from a version of equation (5), in which the bank-specific measure of government support described in section 2.2—instead of the bank-specific holdings of sovereign debt—is interacted with the change in the sovereign CDS premium of the

bank's country of origin. We expect that, for a given increase in a country's sovereign CDS premium, banks that initially received more government support would have experienced a larger reduction in dollar funding from the U.S. capital markets. However, we find that bank branches whose governments experienced larger increases in sovereign CDS premiums, and that initially received more government support, did not experience larger reductions in funding than branches with less government support. In addition, the coefficient on the change in the own sovereign CDS premium is still negative and statistically significant, in a sample of 104 banks from Europe and the rest of the world for which the government support data are available.

To further explore whether bank-specific risk affected the U.S. investors' decision to withdraw dollar funding, we use the change in the idiosyncratic component of banks' CDS premium as an additional explanatory variable, along with the change in the sovereign CDS premium of the banks' country of origin and the other control variables.[28] The sample consists of the 28 banks with U.S. branches covered by the EBA stress test that have available CDS data. As shown in column 7, the coefficients on the change in both sovereign and bank-specific CDS premiums have negative signs; however, only the coefficient on the change in sovereign CDS spreads is statistically significant.

Finally, column 8 shows the results for our third test illustrated by equation (6). As the key explanatory variable, the specification includes the foreign banks' exposure to sovereign debt issued by the peripheral European countries—Greece, Ireland and Portugal—which encountered the steepest increases in the average sovereign CDS spreads in 2011. The coefficient estimate is negative, but not statistically significant, providing little evidence for a

[28] To obtain the change in the idiosyncratic component of banks' CDS premium, 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 compute the residuals.

link between the liquidity shock and bank-specific holdings of sovereign debt from peripheral Europe.

6. Robustness checks

We conduct further tests to assess whether our results are driven by funding shocks to the U.S. branches of foreign banks. In our first robustness test, we address the question of whether the pullback from the U.S. market was voluntary or pushed by funding pressures. Market commentary at the time supports our hypothesis that the pullback was due to funding pressures. For example, Moody's announcement of the downgrade of BNP Paribas on December 9, 2011 states the following:[29]

"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."

To formally verify this hypothesis, we use information from the U.S. commercial bank subsidiaries of foreign banks to test whether the liquidity shock and pullback in lending was broad or just restricted to the branches. If these subsidiaries did not suffer a liquidity shock and did not cut lending, this finding would support our hypothesis that the reduction in branch lending was linked to the liquidity shock. There were 38 foreign banks with U.S. commercial bank subsidiaries between 2010 and 2011, of which 28 had branches at the same time. In Table 11, columns 1 through 4, we assess whether the subsidiaries suffered a liquidity shock. The dependent variable is the change in deposits at these commercial bank subsidiaries in the period.

[29] The full announcement can be found here: http://www.moodys.com/research/Moodys-downgrades-BNP-Paribass-long-term-ratings-to-Aa3-concluding--PR_232989

Recall that the retail deposits of foreign-owned commercial banks are covered by U.S. federal deposit insurance (for accounts under $250,000). Thus, we show results for both the change in aggregate deposits as well as uninsured large time deposits insurance. The main explanatory variables are, alternatively, an indicator variable for commercial banks owned by euro area parents (columns 1 and 2), and an indicator variable equaling one if the branch affiliated with the commercial banks had a change in large time deposits in the bottom 25th percentile of the distribution for all U.S. branches of foreign banks (columns 3 and 4).[30] The aim of these estimations is to check whether the commercial bank subsidiaries of foreign banks affected by the European debt crisis suffered a deposit run as well. As the results show, the coefficient on the variables of interest are not statistically significant, which implies that the commercial bank subsidiaries did not endure a liquidity shock similar to that faced by the branches.

Next we check whether the U.S. commercial bank subsidiaries of foreign banks may have pulled back in lending even without having liquidity problems themselves. Consistent with our hypothesis, we find that this was not the case. Columns 5 through 8 show the results from regressing the change in the commercial bank subsidiaries' total loans and C&I loans on the liquidity shock indicators described above. We find that commercial banks owned by euro-area banks did not restrict their lending in this period. This is also true for commercial banks with affiliated branches that endured a liquidity shock. These results are evidence that foreign banks did not delever widely and indiscriminately across their legal entities. Instead, they cut lending in those entities that had unstable sources of financing like the branches.

In our second robustness test, we show that our main findings are not driven by spurious correlations. Columns 1-3 in Table 12 show the results for the estimation of equation (1), but

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

with the dependent variable (the changes in branches' loans) and the explanatory variables (including the change in deposits) measured over 2009-2010. With this specification, we want to verify that the positive link between the change in deposits and the change in loans for 2010-2011 (shown in Table 4) was not driven by an automatic relationship between the branches' liabilities and assets, and that the liquidity shock did indeed trigger the bank lending channel effect in 2011. Unlike for 2010-2011, the results for 2009-2010 show no relationship between the changes in branches' deposits and loans.

The rest of the specifications in Table 12 highlight the role of the investor disclosure requirement that became effective in January 2011, which required U.S. money market funds to disclose their detailed asset portfolios to the clients. Our hypothesis is that once clients gained more intimate knowledge of the mutual funds' asset portfolios, the mutual funds themselves become more cautions when lending to foreign banks facing different shocks. Thus, fluctuations in banks' risk should have a greater impact on the branches' access to large time deposits from U.S. money market funds after January 2011 than prior to the effective date of this requirement.

Columns 4-5 show the results of estimating the change in large time deposits as a function of bank CDS premiums and geographical dummies during the global financial crisis in 2007-2008. As shown in Figure 4, bank CDS premiums around the world rose markedly in late 2008, after the collapse of Lehman Brothers. In column 4, we test whether the U.S. branches of foreign banks facing larger financial stress back in 2008 experienced larger declines in time deposits, as it was the case of the U.S. branches of European banks in 2011. We find that changes in banks' CDS premiums were not significantly correlated with changes in branches' access to large time deposits in 2008. Figure 4 also shows that banks from emerging market economies (EMEs) faced the largest increase in CDS premiums in 2008. In column 5 of Table

12, we include an indicator variable for the branches of banks headquartered in EMEs. We find that this variable is not statistically significant.

Lastly, we test whether banks from core and peripheral euro area suffered any significant changes in large time deposits in 2008.[31] During the global financial crisis, the core euro-area banks faced large losses due to (1) their exposure to U.S. securities and (2) their support provided to the risky asset-backed commercial paper vehicles (Arteta, et al. 2013). As in the previous estimations, we do not find any significant relation between the core euro-area indicator variable and the change in large time deposits. In the case of peripheral euro area, the indicator variable estimate is significant, but has a positive sign. These results provide evidence for the role of investor disclosure requirement in establishing a channel between sovereign risk and the liquidity shocks suffered by the U.S. branches of foreign banks in 2011.

7. Conclusions

Our study shows how the interaction between money market funds and global banks in the United States is crucial to understand the spillover effects from the European sovereign debt problems in 2011 to the U.S. short-term credit markets. We document that the U.S. branches of European banks faced a severe decline in their access to dollar funding from U.S. money market funds in 2011, and that this liquidity shock was proportional with the increase in the sovereign risk of their country of origin. The branches with curtailed access to large time deposits relied more on funding from their own parent institutions, thus shifting from being a net supplier to being a net receiver 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,

[31] The core euro-area group is composed of: Austria, France, Germany, Italy, Luxembourg, and the Netherlands. The group of peripheral euro-area countries consists of: Greece, Ireland, Portugal, and Spain.

such branches reduced their lending to U.S. entities. The results are robust to using data on foreign bank lending that is aggregated at bank level, at the sector level or, alternatively, disaggregated at the loan level. Thus, our approach allows us to control for loan demand by using fixed effects for the banks' country of origin, for the borrower's sector, or for the borrowing firm itself. In turn, the liquidity shock impacted negatively the corporate investment of the U.S. firms borrowing from foreign bank branches affected by the liquidity shock.

Our findings suggest that a new requirement for U.S. money market funds to disclose their detailed exposures, implemented at the beginning of 2011, further impaired the European banks' access to U.S. dollar funding. 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 were 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. *Net due from* (*Net due to*) is the aggregate value of branch claims (liabilities) minus liabilities (claims) on related entities for those branches that are in a positive *Net due from* (*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). We include 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

Liquidity shocks and bank lending

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 dollar, originated by branches. In columns (2), (5) and (8), the dependent variable is the change in all commercial and industrial loans, while in columns (3), (6) and (9) the dependent variable is the change in commercial and industrial loans to U.S. addressees. Δ*Large 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. Estimations in columns (7) through (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	0.078	0.048***	0.038***	0.095*	0.053***	0.039***	0.146*	0.060*	0.043**
	[0.050]	[0.016]	[0.013]	[0.053]	[0.017]	[0.013]	[0.077]	[0.030]	[0.020]
Log branch assets$_{(t-1)}$				0.213	0.020	-0.019	0.430	0.117	0.032
				[0.201]	[0.058]	[0.037]	[0.300]	[0.068]	[0.042]
Loans to assets$_{(t-1)}$				0.006	-0.071	-0.030	-0.017	-0.026	-0.028
				[0.445]	[0.199]	[0.132]	[0.411]	[0.285]	[0.217]
Deposits to assets$_{(t-1)}$				0.236	0.291	0.234	0.528	0.331	0.077
				[0.590]	[0.228]	[0.165]	[0.799]	[0.350]	[0.124]
Relative size of branch $_{(t-1)}$				-4.570	-0.196	1.156	-8.944	-3.177	-1.821*
				[5.344]	[2.064]	[1.015]	[9.638]	[2.306]	[1.055]
Parent Tier 1 capital ratio$_{(t-1)}$				-2.584	-3.134	-2.079	-5.276*	5.846**	-2.563
				[4.123]	[2.909]	[1.560]	[2.825]	[2.274]	[1.774]
Observations	129	129	129	129	129	129	113	113	113
R-squared	0.07	0.14	0.18	0.15	0.20	0.23	0.48	0.50	0.45
Fixed effects	None	None	None	None	None	None	Country	Country	Country
Countries	42	42	42	42	42	42	26	26	26

Table 5

Liquidity shocks and bank lending by sector

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 Credits program. All regressions include sector-level fixed effects. In columns (1) and (2), the dependent variable is the change in commercial and industrial 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 commercial and industrial 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. *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 branch level are shown in brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Dependent variable	(1)	(2)		(3)	(4)
	ΔCommitments			ΔUtilization	
Δ Large time deposits	2.486*	2.601*		0.745***	0.730**
	[1.312]	[1.434]		[0.276]	[0.301]
Log branch assets$_{(t-1)}$	25.943***	27.825***		6.777***	6.846***
	[6.211]	[7.461]		[1.844]	[2.271]
Loans to assets$_{(t-1)}$	77.733**	83.834**		35.187***	37.374***
	[36.753]	[34.472]		[11.374]	[11.157]
Deposits to assets$_{(t-1)}$	100.963**	87.905*		35.209***	32.260**
	[49.582]	[51.033]		[12.427]	[13.186]
Relative size of branch $_{(t-1)}$		-24.399			20.104
		[145.720]			[44.080]
Parent Tier 1 capital ratio$_{(t-1)}$		-112.494			-26.813
		[294.073]			[162.896]
Observations	1,661	1,636		1,661	1,636
R-squared	0.12	0.12		0.09	0.09
Fixed effects	NAICS 3 digit	NAICS 3 digit		NAICS 3 digit	NAICS 3 digit
Banks	102	100		102	100

Table 6

Liquidity shocks and bank lending by firm: 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. All regressions include firm-level fixed effects, as the sample includes loans to U.S. addressee firms that borrowed from at least two branches. In columns (1) and (2), the dependent variable is the change in commercial and industrial loan commitments to U.S. firms, in millions of dollars. In columns (3) and (4), the dependent variable is the change in the actual commercial and industrial 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. *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 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	0.113	0.128		0.062*	0.044
	[0.091]	[0.096]		[0.037]	[0.045]
Log branch assets$_{(t-1)}$	1.561***	1.670***		0.049	-0.071
	[0.351]	[0.472]		[0.288]	[0.325]
Loans to assets$_{(t-1)}$	-2.569	-2.815		1.309	1.994
	[3.733]	[3.829]		[1.741]	[1.731]
Deposits to assets$_{(t-1)}$	4.113	4.874		0.452	1.605
	[4.602]	[4.644]		[1.937]	[1.683]
Relative size of branch $_{(t-1)}$		-19.771*			-0.803
		[11.342]			[5.374]
Parent Tier 1 capital ratio$_{(t-1)}$		54.810			43.436*
		[37.691]			[24.045]
Observations	4,302	4,259		4,302	4,259
R-squared	0.31	0.31		0.51	0.51
Fixed effects	Firm	Firm		Firm	Firm
Banks	100	98		100	98

Table 7

Liquidity shocks and bank lending by firm: 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. 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). 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. *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. 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	0.985***	0.982***		0.982***	0.979***		0.987	0.985
	[0.004]	[0.004]		[0.004]	[0.005]		[0.009]	[0.010]
Log branch assets$_{(t-1)}$	0.758***	0.736***		0.734***	0.716***		0.929	0.887
	[0.026]	[0.028]		[0.029]	[0.032]		[0.062]	[0.074]
Loans to assets$_{(t-1)}$	0.493***	0.524**		0.591	0.620		0.295**	0.287**
	[0.135]	[0.150]		[0.191]	[0.209]		[0.146]	[0.146]
Deposits to assets$_{(t-1)}$	0.322***	0.383***		0.270***	0.283***		0.550	0.740
	[0.071]	[0.090]		[0.069]	[0.076]		[0.216]	[0.315]
Relative size of branch$_{(t-1)}$		3.363			6.545*			8.164
		[3.514]			[7.395]			[20.085]
Parent Tier 1 capital ratio$_{(t-1)}$		10.344			0.292			4.888
		[18.843]			[0.625]			[14.814]
Observations	3,306	3,236		2,488	2,465		928	881
Pseudo R-square	0.04	0.04		0.05	0.05		0.0159	0.0171
Fixed effects	Firm	Firm		Firm	Firm		Firm	Firm
Firms	475	469		370	369		135	130

Table 8

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 between 2010 and 2012, 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. *Liquidity shock* is an indicator variable equal to one if the firm had a syndicated lending relationship with a U.S. branch of a foreign bank facing large time deposit outflows between 2010 and 2011, as described in the text. 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	0.129***	0.124***	0.127***		-1.004***	-1.001***	-1.014***
	[0.022]	[0.021]	[0.022]		[0.148]	[0.143]	[0.147]
After x Liquidity shock	-0.073**		-0.068**		0.408*		0.422*
	[0.034]		[0.035]		[0.228]		[0.230]
After x Liquidity shock (fraction)		-0.104*				0.806*	
		[0.062]				[0.423]	
Tobin's Q	0.159***	0.158***	0.150***		1.694***	1.699***	1.598***
	[0.059]	[0.059]	[0.058]		[0.505]	[0.506]	[0.504]
Cash flow			0.011				0.118**
			[0.007]				[0.056]
Observations	10,250	10,250	10,036		10,250	10,250	10,036
R-squared	0.01	0.01	0.01		0.03	0.03	0.03
Firms	1,371	1,371	1,363		1,371	1,371	1,363
Firm fixed effects	Yes	Yes	Yes		Yes	Yes	Yes

Table 9
Liquidity shocks and bank liquidity management

The regressions in this table analyze the change in the average *Net due to position* with related institution 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) and (4) is the change in the *Net due to* position with all related offices, in billions of dollar. In columns (2) and (5), the dependent variable is the change in *Net due to position* with the head office, while in columns (3) and (6) 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	(4) Δ Net due to related offices	(5) Δ Net due to head office	(6) Δ Net due to related U.S. non-branch offices
Δ Large time deposits	-0.926***	-0.526***	-0.006	-0.881***	-0.531***	-0.006**
	[0.236]	[0.159]	[0.003]	[0.129]	[0.111]	[0.003]
Log branch assets$_{(t-1)}$				1.426***	0.341*	0.012
				[0.268]	[0.170]	[0.007]
Loans to assets$_{(t-1)}$				-1.223	-1.010	0.027*
				[1.083]	[0.625]	[0.014]
Deposits to assets$_{(t-1)}$				-0.720	-0.608	-0.058*
				[1.152]	[0.872]	[0.034]
Relative size of branch$_{(t-1)}$				21.060*	22.163	0.548
				[11.242]	[15.033]	[0.396]
Parent Tier 1 capital ratio$_{(t-1)}$				1.013	-0.430	0.015
				[1.009]	[0.846]	[0.016]
Observations	129	129	129	129	129	129
R-squared	0.34	0.29	0.04	0.56	0.39	0.11
Countries	42	42	42	42	42	42

Table 10

Bank liquidity shocks and sovereign risk

The regressions in this table examine determinants of the change in the average *Large time deposits* between 2010 and 2011. Columns (1) and (4) test whether the change in the sovereign CDS premium of the home country alone has an effect on the change of the average stock of the branches' *Large time deposits*, while columns (2) and (3) focus on the geographical location of the parent. Columns (5) and (6) test whether the effect of sovereign CDS premiums on funding depends on bank-specific characteristics, such as holdings of own sovereign debt, or reliance on own government support by the branches' parents. Column (7) tests whether the change in the idiosyncratic component of the parent banks' CDS premiums– in addition to the sovereign CDS– affected the funding received by branches. Column (8) examines whether holdings of sovereign debt from Greece, Ireland, and Portugal (GIP) by non-GIP banks had an effect on funding. 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.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Specification	Own-sovereign CDS premiums	Dummy Europe	Dummy euro area and "other" Europe	Own-sovereign CDS premiums	Exposure to own-sovereign	Government support	Bank CDS premiums	Exposure to Greece, Ireland and Portugal
Dependent variable				Δ Large time deposits				
Δ Own-sovereign CDS premium	-0.007			-0.081*	-0.105*	-0.016	-0.089**	
	[0.005]			[0.036]	[0.053]	[0.010]	[0.037]	
Dummy Europe		-3.825**						
		[1.526]						
Dummy euro area			-5.366***					
			[1.977]					
Dummy "other" Europe			-0.666					
			[3.387]					
Own sovereign debt/T1 capital$_{(t-1)}$					-0.111			
					[0.684]			
Own sovereign debt/T1 capital$_{(t-1)}$ x Δ Own-sovereign CDS premium					0.012			
					[0.013]			
Government support$_{(t-1)}$						-0.024		
						[0.132]		
Government support$_{(t-1)}$ x Δ Own-sovereign CDS premium						0.002		
						[0.002]		
Δ Idiosyncratic component of bank CDS premiums							-0.020	
							[0.027]	
GIP sovereign debt/T1 capital$_{(t-1)}$								-24.510
								[33.503]
Observations	129	129	129	31	31	104	28	31
R-squared	0.08	0.15	0.21	0.55	0.56	0.11	0.56	0.42
Bank sample	All	All	All	European	European	All	European	European
Countries	42	42	42	8	8	37	8	8

Table 11

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 (4) and (7), the dependent variable is the change in all loans, while in columns (6) and (8) the dependent variable is the change in commercial and industrial loans. *Dummy euro are*a 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

Table 12

Robustness checks: no spurious correlation

The regressions provide further robustness check for the results shown in Tables 4 and 10. Columns (1) through (3) explore whether there was a positive relation between the change in the average stock of large time deposits and the change in lending between 2009 and 2010. Columns (4) to (6) test whether the stock of large time deposits at branches changed significantly as a function of risk measure during the global financial crisis in 2007-2009. In columns (1) through (3), *ΔLarge time deposits* is the change in the average stock of time deposits of $100,000 or more between 2009 and 2010. *Deposits to assets* and *Loans to assets* are the ratios of deposits and loans, for each branch, relative to its total assets in 2009 for columns (1) to (3) and 2007 for columns (4) to (6). *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 2009 for columns (1) to (3) and 2007 for columns (4) to (6). *Parent Tier 1 capital ratio* is the ratio of Tier 1 capital over risk-weighted assets for the parent of a branch in 2009 for columns (1) to (3) and 2007 for columns (4) to (6). 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, 2009-2010	(2) Δ Total C&I Loans, 2009-2010	(3) Δ U.S. C&I Loans, 2009-2010	(4) Δ Large time deposits 2007-2008	(5) Δ Large time deposits 2007-2008	(6) Δ Large time deposits 2007-2008
Δ Large time deposits	0.125	0.025	0.035			
	[0.156]	[0.176]	[0.165]			
Δ Bank CDS premium				-0.006		
				[0.006]		
Dummy EME					-0.326	
					[0.409]	
Dummy core Europe						-1.211
						[2.088]
Dummy peripheral Europe						2.812**
						[1.235]
Log branch assets$_{(t-1)}$	-0.363*	-0.459***	-0.448***	0.629	0.395	0.490
	[0.181]	[0.169]	[0.163]	[0.776]	[0.330]	[0.374]
Loans to assets$_{(t-1)}$	-1.300**	-1.204*	-1.144*	1.770	1.129	1.056
	[0.525]	[0.613]	[0.610]	[2.683]	[1.231]	[1.278]
Deposits to assets$_{(t-1)}$	0.555	0.810**	0.703*	-0.368	-0.222	-0.746
	[0.345]	[0.370]	[0.375]	[2.512]	[1.266]	[1.184]
Relative size of branch$_{(t-1)}$	1.062	2.929	3.075	-38.273	-9.642	-6.909
	[4.898]	[4.075]	[3.851]	[39.226]	[9.133]	[9.651]
Parent Tier 1 capital ratio$_{(t-1)}$	-0.512*	-0.606*	-0.599*	-26.826	0.342	0.515
	[0.291]	[0.328]	[0.316]	[27.636]	[0.623]	[0.575]
Observations	116	116	116	82	140	140
R-squared	0.16	0.18	0.19	0.08	0.04	0.09
Countries	41	41	41	27	49	49

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

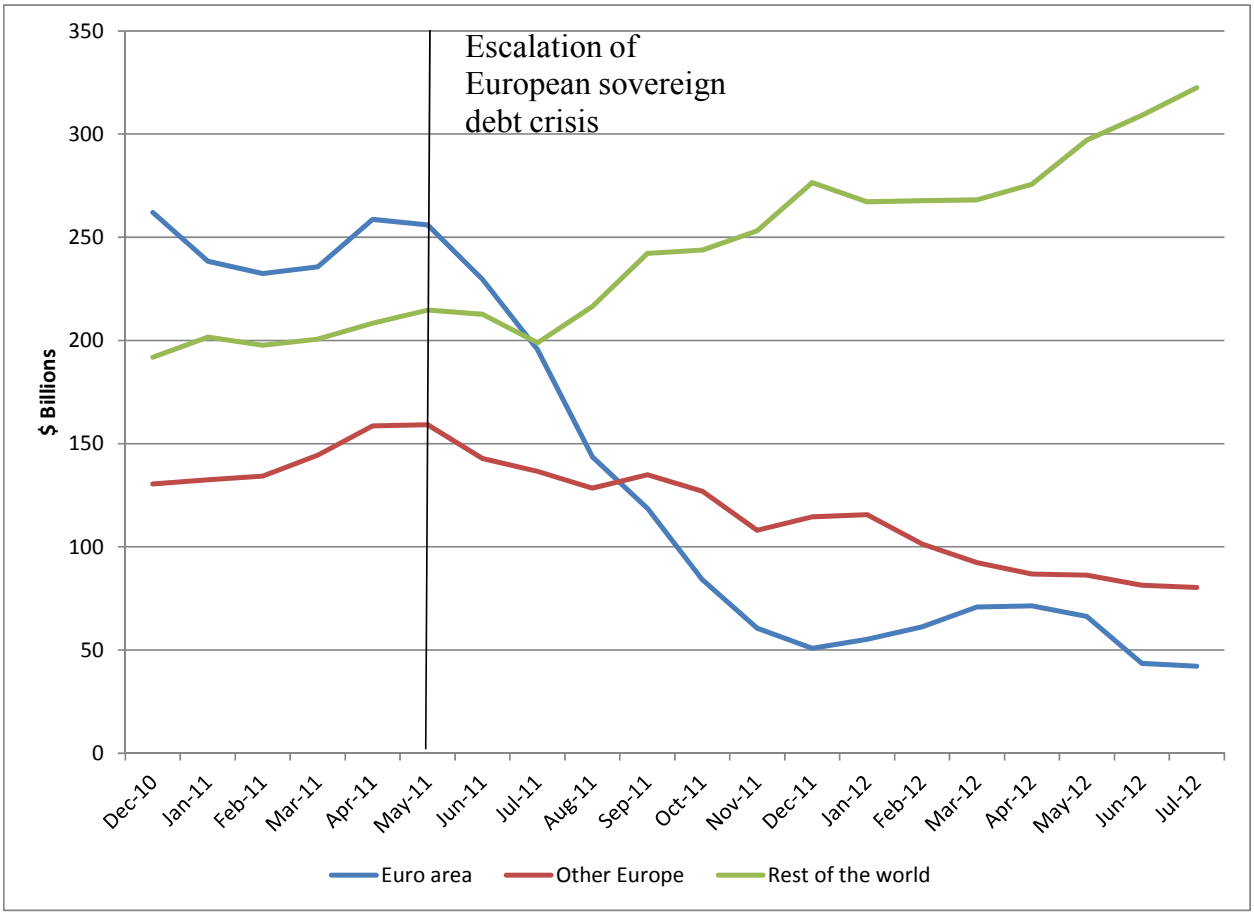

Figure 2. Large time deposits (greater than $100,000) outstanding at the U.S. branches of foreign banks.

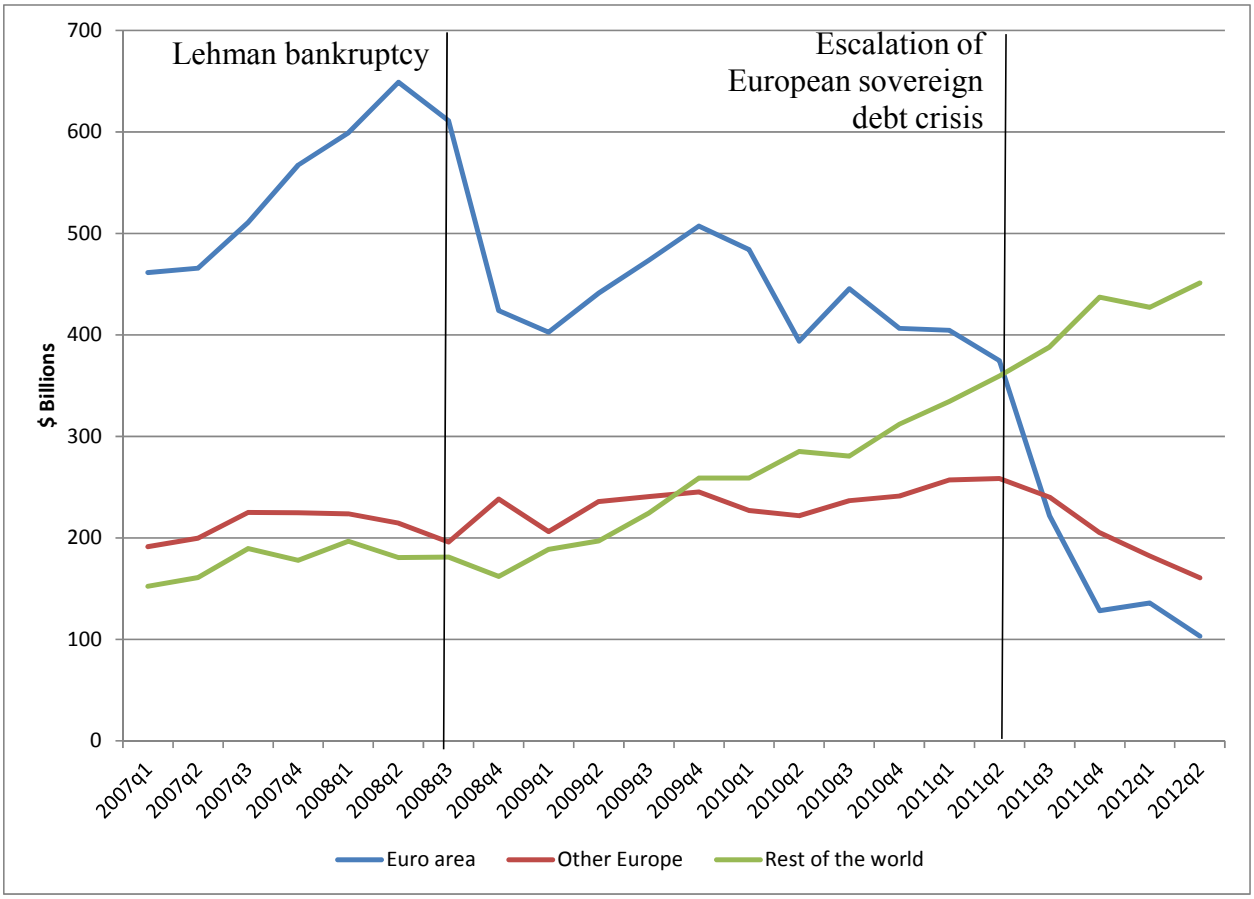

Figure 3. Net due to positions of the U.S. branches of euro-area banks with their head offices (the blue line), and the 3-month implied basis spreads from the euro-dollar swaps (averaged into quarters, the red line). The "net due to position" is equal to the balances owed by the branch to the head office minus the balance owed by the head office to the branch.

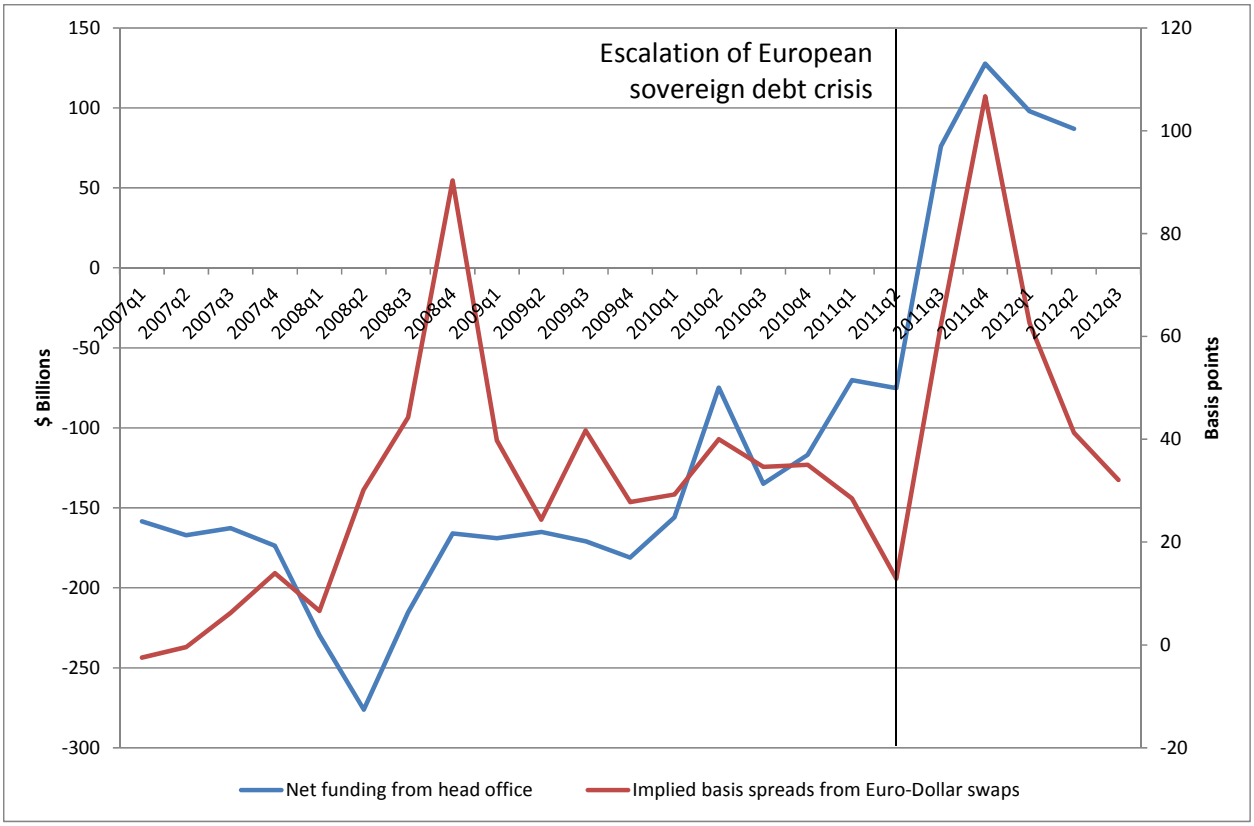

Figure 4. Median CDS premiums (5-year contracts) for banks headquartered in Europe (blue line), other advanced economies (red line), emerging economies (green line), and the rest of the world (purple line).