Liquidity shocks, dollar funding costs, and the bank lending channel during the European sovereign crisis

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Abstract

This paper documents a new type of cross-border bank lending channel. The deepening of the European sovereign debt crisis in 2011 restrained the financial intermediation of European banks in the United States. In this period, some of the U.S. branches of European banks faced a dollar liquidity shock—due to their perceived risk reflecting the sovereign risk of their countries of origin—which in turn affected the branches' lending to U.S. entities. We use a novel dataset to analyze the operations of branches of foreign banks in the United States. Our results show that: (1) The U.S. branches of European banks experienced a run on their deposits, mainly from U.S. money market funds. (2) The branches with curtailed access to large time deposits relied more on funding from their own parent institutions, thus shifting from being net suppliers to being net receivers of dollar funding from their related offices. (3) Since the additional funding received from parent institutions was not enough to offset the decreased access to U.S. funding, such branches reduced their lending to U.S. entities.

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1. Introduction

The interaction between global banks and the shadow banking system, as a relevant factor in the international transmission of financial shocks, has garnered the attention of policymakers and academics 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, and in particular their funding operations through large time deposits received mostly from U.S. money market funds. 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.[1] This dollar liquidity shortage was partially compensated with transfers from parent banks to their U.S. branches. However, European parent banks' liquid resources 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 could transfer to their U.S. branches. In turn, this liquidity shock led to a decrease in branch lending to U.S. borrowers. Focusing on the experience of foreign banks in the United States and the liquidity shock induced by the money market funds' pullback in financing to these entities, we use detailed branch balance sheet data to document this new type of bank lending channel.

[1] 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.

Overall, our paper improves the understanding of interactions between the shadow banking system and global banks, and of how these linkages aided the transmission of the European sovereign debt crisis into the U.S. credit markets. Our main results show that, first, U.S. branches of European banks experienced a run on their deposits, mainly from U.S. money market funds. Second, in response to the liquidity shock, the U.S. branches of European banks relied more on funding from their own parent institutions, thus shifting from being net suppliers to being net receivers of dollar funding from their related offices. Third, since the additional funding received from parent institutions was not enough to offset the decreased access to U.S. funding, such branches reduced their lending to U.S. entities.

Our results suggest that the transmission of shocks from the European sovereign crisis into U.S. credit markets was facilitated by the disclosure requirements for U.S. money market funds implemented in early 2011, which made it easier for investors to monitor the portfolio holdings of money market funds. The European events led to a shift in the degree of information sensitivity of the securities issued by U.S. money market funds. Gorton and Pennacchi (1990, 1993) argue that banks create liquidity by producing informationally-insensitive securities. Bank debt is designed to be informationally-insensitive, that is, not subject to adverse selection when traded because it is not profitable to produce private information to speculate in this debt. In the extreme, the securities are riskless, like insured demand deposits. However, 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 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, 2012; McCabe, 2010).

The sharp deterioration in sovereign credit risk experienced in Europe in mid-2011—along with the U.S. money market funds' exposure to European banks—caused securities issued by the money market funds to become informationally-sensitive, that is, subject to adverse selection. Fear of the resulting "lemons market" led to the stoppage of flows to the money market funds with exposure to European sovereign debt, which in turn led the money market funds to withdraw dollar funding from the U.S. branches of European banks, thus inflicting an adverse liquidity shock on such bank branches. As documented by Chernenko and Sunderam (2012), U.S. money market funds with exposures to European banks endured a "quiet run," that is, investor withdrawals increased as sovereign distress heightened in Europe. In turn, as shown in Figure 1, these problems 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 the U.S. branches of euro-area banks in mid-2011, of which more than half are received from U.S. money market funds.[2] 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 slightly slower pace than in 2011. In addition, the 2011 deposit run was focused on 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. In fact, 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. Money market funds and other investors assessed that, in the event of a European sovereign default in a given country, several European banks from that country were likely to have solvency problems, but without knowing exactly which banks were more prone to this potential outcome. 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 the parent banks in Europe initiated internal liquidity transfers in 2011 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 years. However, this change in the direction of funding coincided with an increase in the cost of

[2] U.S. money market funds held about 60 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.

exchanging euros into dollars, 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 the European sovereign credit markets can translate into adverse real effects to the U.S. economy.

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. 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.

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 focus on the international transmission of shocks through the internal and inter-bank funding activities of global banks. For example, such studies have documented the effect of a bank capital shock arising from the downturn in the Japanese stock market in the early 1990s on the lending of U.S. branches of Japanese banks (Peek and Rosengren, 1997); the effect of the 1998 Russian sovereign default on the lending of international and domestic banks to Peruvian firms (Schnabl, 2012); or the effect of the sudden shortage in dollar funding suffered by European banks during the 2008-09 global financial crisis on the lending of their U.S. branches (Cetorelli and Goldberg, 2012b). Another set of empirical studies address the role of internal capital markets within banking organizations in ameliorating the effect of external financing shocks (Campello 2002; Cetorelli and Goldberg 2012c). For example, recent studies document the role of dollar liquidity transfers from U.S.-based bank branches to their dollar-strapped European parents (Cetorelli and Goldberg 2012b), or the transfers between U.S. parent banks and their foreign branches during the 2008-09 crisis (Cetorelli and Goldberg 2012a).

Our paper adds to this literature by documenting a new type of liquidity 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 other 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 (Cetorelli and Goldberg 2012a,b), as it had happened before (i.e., without the European parent banks pulling funding from their U.S. branches). In addition, our paper highlights the frictions associated with the European banks' internal financing operations that involved multiple currencies (i.e. the costs encountered by European banks when exchanging *euro liquidity* into dollars), which impaired the effectiveness of internal capital markets in offsetting the liquidity shock suffered by the U.S. branches.

2. Methodology

We study the effect of the sovereign debt problems in Europe on the operations of branches of foreign banks in the United States. First, we relate the decline in foreign branches' lending to a liquidity shock triggered by the European sovereign debt crisis in 2011. Second, we examine the internal liquidity operations undertaken by the foreign parent banks in an attempt to offset the liquidity shock faced by their branches. Third, we assess the determinants of the liquidity shock by relating the branches' reduced access to deposits from U.S. money market funds to the increase in the sovereign risk of their country of origin.

2.1 The effect of the liquidity shock on U.S. lending

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).

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.[3] 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 $\Delta Loans_{ij} = \{\Delta TotLoans_{ij}, \Delta C\&ILoans_{ij}, \Delta C\&ILoansUS_{ij}\}$. This specification uses a comprehensive sample consisting of the U.S. branches of 129 foreign banks—both European and non-European—as will be described in the data section.

The key explanatory variable is the change in outstanding large time deposits between 2010 and 2011 received by the branches of bank *i* from the country of origin *j* ($\Delta Large\ Time\ Deposits_{ij}$), as a proxy for the funding shock.[4] 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

[3] 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.

[4] As for loans, the outstanding large time deposits at the end of every quarter are averaged separately for 2010 and 2011. In Section 2.3 below, in order to examine more specifically the origin of the liquidity shock, we use the increase in sovereign risk for each bank *i*'s country of origin *j* from 2010 to 2011, as well as bank-specific measures of exposure to sovereign risk in the pre-crisis period as explanatory variables for the change in deposits.

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

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.[5] 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.[6] We use two different methods with fixed effects as in Khwaja and Mian (2008) to avoid this kind of bias, and our baseline results are preserved in each case.

First, we use fixed effects for the country of origin of the foreign bank branches, in an alternative estimation to equation (1), to control for demand shocks that are specific to borrowers working with foreign banks from the same country. For instance, the 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, 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.

[5] 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.

[6] 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).

Second, 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, U.S. branches of foreign banks 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 shock had a greater presence in the slower-growing U.S. sectors, and thus, faced weaker loan demand and reduced their demand for deposits. To control for this potential bias arising from the variation in loan demand across sectors, we use as our dependent variable 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. Thus, the sector-specific fixed effect (η_s) allows to assess whether borrowers from the same sector experience larger declines in lending from the banks facing relatively larger funding shocks:

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

The new dependent variable is constructed from data on syndicated loans to U.S. addressees compiled by U.S. banks supervisors, which will be discussed in the data section. We consider two measures of syndicated lending by U.S. branches of foreign banks: C&I commitments and C&I loans to U.S. residents, namely $\Delta Loans_{ijs} = \{\Delta C\&ICommitmentsUS_{ijs}, \Delta C\&ILoansUS_{ijs}\}$. The loans outstanding at the end of each year are aggregated across all branches of a given foreign bank *i* from country of origin *j*, and for each sector *s* at the 3-digit NAICS level.

2.2 Internal liquidity operations in response to the liquidity shock

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 by an increase in the branches' "net due to positions" with related depository institutions, particularly for the branches that suffered larger funding shocks.[7] The increased financing from parents could even offset the funding shock, in which case we would find no relation between the change in the branches' loans and large time deposits. We estimate the following equation:

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

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 (1). The coefficient of interest in this equation is β_1. The size and statistical significance of this coefficient provides information about the degree of substitution between the branches' large time deposits and the funds transferred to the branch from related depository institutions.

2.3 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. Our tests below use different sets of explanatory variables as proxies for the parent banks' exposure to the sovereign debt crisis.

In the first specification, the proxy for sovereign risk is the change in the average sovereign credit default swap (CDS) premium of each bank's country of origin *j* from 2010 to 2011 (ΔCDS_j). We run the following regression, in which we use the same controls as in (1):

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

Alternatively, we replace the change in sovereign CDS premiums with dummy variables for the euro area, the euro-area core, and the euro-area periphery countries.[8] In this test, we assess

[7] 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.

whether country-specific factors, like the change in CDS premiums, or broad signals, like just the geographical location of the branches' parent, triggered the funding shock. Evidence pointing to country-specific determinants would suggest that investors were selective in terms of the branches they would like to finance. However, a broader pullback from branches of parents located in the same region would provide evidence that investors did not discriminate across banks and acted like in a traditional "bank run" (Diamond and Dybvig, 1983).

We also estimate (4) using the sub-sample of European banks with branches in the United States with available data on sovereign debt holdings.[9] In addition, we interact the increase in sovereign CDS spread for country of origin *j* (ΔCDS_j) with each bank *i*'s initial holdings of its own sovereign debt ($OwnSovDebt_{ij}$):

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

$OwnSovDebt_{ij}$ 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 banks. However, the model uses a narrower sample of bank branches, consisting of the 31 European banks with U.S. branches that reported their sovereign debt exposure to the European Bank Authority for the stress test conducted in 2011.[10]

In our last set of tests, 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,

[8] The euro-area banks in our sample originate from Austria, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain. Of these, the euro-area core covers Austria, France, Germany and the Netherlands; the periphery covers the rest.
[9] 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.
[10] We exclude branches with parents from Ireland and Portugal in this specification.

Ireland and Portugal, $GIPSovDebt_{ij}$) expressed as a share of tier 1 capital for the same 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:

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

3. Data

We construct a comprehensive picture of the foreign bank organizations that operate in the United States, using a number of data sets for the characteristics of branches, parent banks, and the countries of origin.

3.1 Branch and parent-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). Table 1 reports the number of banks per country that have branches in the United States.[11] 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.[12]

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 balance

[11] We drop branches where the sovereign of the parent bank's country of origin does not have liquid Credit Default Swap (CDS) premiums.
[12] 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.

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 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.

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.

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 median network of branches only reached about $1.4 billion.[13] 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.

[13] We aggregate all branches of the same parent as a single entity.

The last two rows in 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.[14] 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 Credits (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 contained about 8,700 credits with aggregate commitments of $2.8 trillion in 2011. For each year in our sample, 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.[15] 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.

3.2 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

[14] 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.

[15] 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 are typically lower than the total commitment (Barakova and Parthasarthy, 2012).

country. We use this information to construct measures of banks' exposures to their own sovereign, as well as to Greece, Ireland, and Portugal.

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., 2012).

4. Results

4.1 Liquidity shock and branch lending

The results from estimating equation (1) are presented in Table 4. The liquidity shock triggered by the escalation of sovereign risk problems in Europe—reflected by the U.S. money market funds' run from some branches' deposits—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 $\Delta \mathit{Large\ Time\ Deposits}_{ij}$ (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 $89 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. Moreover, the median foreign bank organization had total outstanding loans of less than $500 million, and outstanding C&I loans of just $190 million in 2010. Thus, relative to the median branch's lending, the economic significance of our results is large.

As noted in section 2.1, one concern is that the change in large time deposits may be correlated with factors affecting firms' demand for loans, which would bias upward the coefficient estimate on the change in deposits. We correct for this potential bias in two ways. First, we follow an estimation strategy similar to Khwaja and Mian (2008) and include fixed effects for the banks' country of origin, with the results reported in Table 4 (columns 7-9). The coefficients on Δ*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 imply a reduction of $141 million dollars in total loans, or $45 million in C&I loans to borrowers domiciled in the United States.

Second, we include fixed effects to control for the variation in demand across U.S. sectors, with the results reported in Table 5. Once again, the coefficients on Δ*Large Time Deposits*$_{ij}$ are positive and statistically significant, which is the case when either the change in loan commitments (columns 1-2) or the change in actual loans (columns 3-4) is used as the dependent variable.

4.2 Liquidity shock and financial support from parent banks

In Table 6, we present results on the internal liquidity management of foreign banks with U.S. branches during the 2011 European sovereign crisis. As expected, branches that faced a larger funding shock—shown by a greater decline in deposits—received more dollar funding from their parent banks. The coefficient on Δ*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.

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 6 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.

4.3 Sovereign risk and the liquidity shock

In Table 7, columns 1-4 present our first set of results on the determinants of the liquidity shock that affected some of the U.S. branches of foreign banks. The dependent variable is the change in the branches' access to large time deposits, mostly from U.S. money market funds. 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 the euro area and the euro-area periphery, respectively. (The variables take the value of one if a foreign bank is headquartered in the euro area or in a peripheral euro-area country, and zero otherwise). The results outlined in columns 1-3 are obtained for the full sample of 129 foreign banks. In contrast, 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 that case, the coefficient on the change in the own sovereign CDS spread is negative and 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 differentiated 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 confirm this finding, we test further whether U.S. money market funds and other investors differentiated across the bank-specific exposure to sovereign risk in their funding decision, rather than just across the aggregate sovereign risk of the country of origin. Column 5 in Table 7 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, the 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 provides more evidence for 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 3.2—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 expected 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 is 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.[16] The sample consists of the 28 banks with U.S. branches covered by the EBA stress test that have available CDS information. 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 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.

4.4. Robustness checks

Table 8 shows several robustness checks to confirm that our findings are not driven by spurious correlations. Columns 1-3 show the results for the estimation of equation (1), but with the

[16] 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.

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 8 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 8, 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. 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. 2010). 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 the U.S. branches of foreign banks in 2011.

6. 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, such branches reduced their lending to U.S. entities.

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 may have 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 Due from Related Depository Institutions	20%	14%	Net Due to 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 U.S. branches and agencies of foreign banks for 2010 and 2011. *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.

	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

Table 4
Liquidity shocks and bank lending

The regressions examine 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. *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. Estimations in columns (7) through (9) include fixed effects for the banks' country of origin. Robust standard errors clustered at the country level in brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent variable	Δ Total loans	Δ Total C&I Loans	Δ U.S. C&I Loans	Δ Total loans	Δ Total C&I Loans	Δ U.S. C&I Loans	Δ Total loans	Δ Total C&I Loans	Δ U.S. C&I Loans
Δ Large time deposits	0.072	0.049***	0.039***	0.089*	0.053***	0.039***	0.141*	0.064*	0.045*
	[0.049]	[0.016]	[0.013]	[0.051]	[0.018]	[0.014]	[0.079]	[0.036]	[0.023]
Log branch assets (t-1)				0.229	0.028	-0.015	0.438	0.084	0.029
				[0.203]	[0.059]	[0.038]	[0.335]	[0.082]	[0.052]
Loans to assets (t-1)				0.081	0.014	0.030	0.129	-0.021	0.026
				[0.411]	[0.151]	[0.104]	[0.555]	[0.297]	[0.230]
Deposits to assets (t-1)				0.320	0.401	0.304	0.687	0.431	0.137
				[0.699]	[0.326]	[0.218]	[0.805]	[0.358]	[0.166]
Relative size of branch (t-1)				-5.203	-1.057	0.609	-8.525	-2.358	-1.722
				[5.230]	[1.824]	[1.039]	[10.595]	[2.560]	[1.219]
Parent Tier 1 capital ratio (t-1)				0.181	-0.085	-0.061	0.304	-0.732*	-0.003
				[0.404]	[0.271]	[0.170]	[0.908]	[0.367]	[0.238]
Observations	129	129	129	129	129	129	129	129	129
R-squared	0.06	0.14	0.18	0.13	0.17	0.21	0.48	0.47	0.43
Fixed effects	None	None	None	None	None	None	Country	Country	Country
Countries	42	42	42	42	42	42	42	42	42

Table 5

Liquidity shocks and bank lending by sector

The regressions 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. Thus, the dependent variable is constructed from data compiled by the Shared National Credit program. All regressions include fixed effects for the U.S. sectors. In columns (1) and (2), the dependent variable is the change in commercial and industrial loan commitments to U.S. addressees across sectors, in billions 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 country level in brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

	(1)	(2)	(3)	(4)
Dependent variable:	ΔCommitments	ΔCommitments	ΔUtilization	ΔUtilization
Δ Large time deposits	1.700**	2.601***	0.562**	0.730**
	[0.688]	[0.766]	[0.243]	[0.305]
Log branch assets (t-1)		27.825***		6.846**
		[6.263]		[3.004]
Loans to assets (t-1)		83.834***		37.374***
		[24.403]		[13.308]
Deposits to assets (t-1)		87.905***		32.260***
		[24.077]		[11.930]
Relative size of branch (t-1)		-24.399		20.104
		[126.580]		[56.013]
Parent Tier 1 capital ratio (t-1)		-112.494		-26.813
		[171.567]		[147.156]
Observations	1,662	1,637	1,662	1,637
R-squared	0.07	0.12	0.07	0.09
Sector fixed effects	NAICS 3 digit	NAICS 3 digit	NAICS 3 digit	NAICS 3 digit
Sectors	78	78	78	78
Countries	34	34	34	34

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 6

Liquidity shocks and bank liquidity management

The regressions examine 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 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 7

Bank liquidity shocks and sovereign risk

The regressions 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 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 core and peripheral Europe	Own-sovereign CDS premiums	Exposure to own-sovereign debt	Reliance on own-government support	Bank CDS premiums	Exposure to Greece, Ireland and Portugal
Dependent variable	Δ Large time deposits							
Δ Own-sovereign CDS premium	-0.008			-0.082*	-0.106*	-0.016*	-0.090**	
	[0.005]			[0.036]	[0.052]	[0.010]	[0.037]	
Dummy Europe		-3.800**						
		[1.516]						
Dummy peripheral Europe			-4.545***					
			[1.116]					
Dummy core Europe			-6.112					
			[3.926]					
Own sovereign debt/T1 capital (t-1)					-0.133			
					[0.665]			
Own sovereign debt/T1 capital (t-1) x					0.012			
Δ Own-sovereign CDS premium					[0.013]			
Government support (t-1)						-0.035		
						[0.134]		
Government support (t-1) x						0.002		
Δ Own-sovereign CDS premium						[0.002]		
Δ Idiosyncr. comp. of bank CDS premiums							-0.019	
							[0.026]	
GIP sovereign debt/T1 capital (t-1)								-24.847
								[33.486]
Observations	129	129	129	31	31	104	28	31
R-squared	0.08	0.15	0.21	0.55	0.57	0.11	0.57	0.42
Bank sample	All	All	All	European	European	All	European	European
Countries	42	42	42	8	8	37	8	8

Table 8
Robustness checks

The regressions examine the robustness in the results shown in the previous estimations. 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 in brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Δ Total loans, 2009-2010	Δ Total C&I Loans, 2009-2010	Δ U.S. C&I Loans, 2009-2010	Δ Large time deposits 2007-2008	Δ Large time deposits 2007-2008	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.

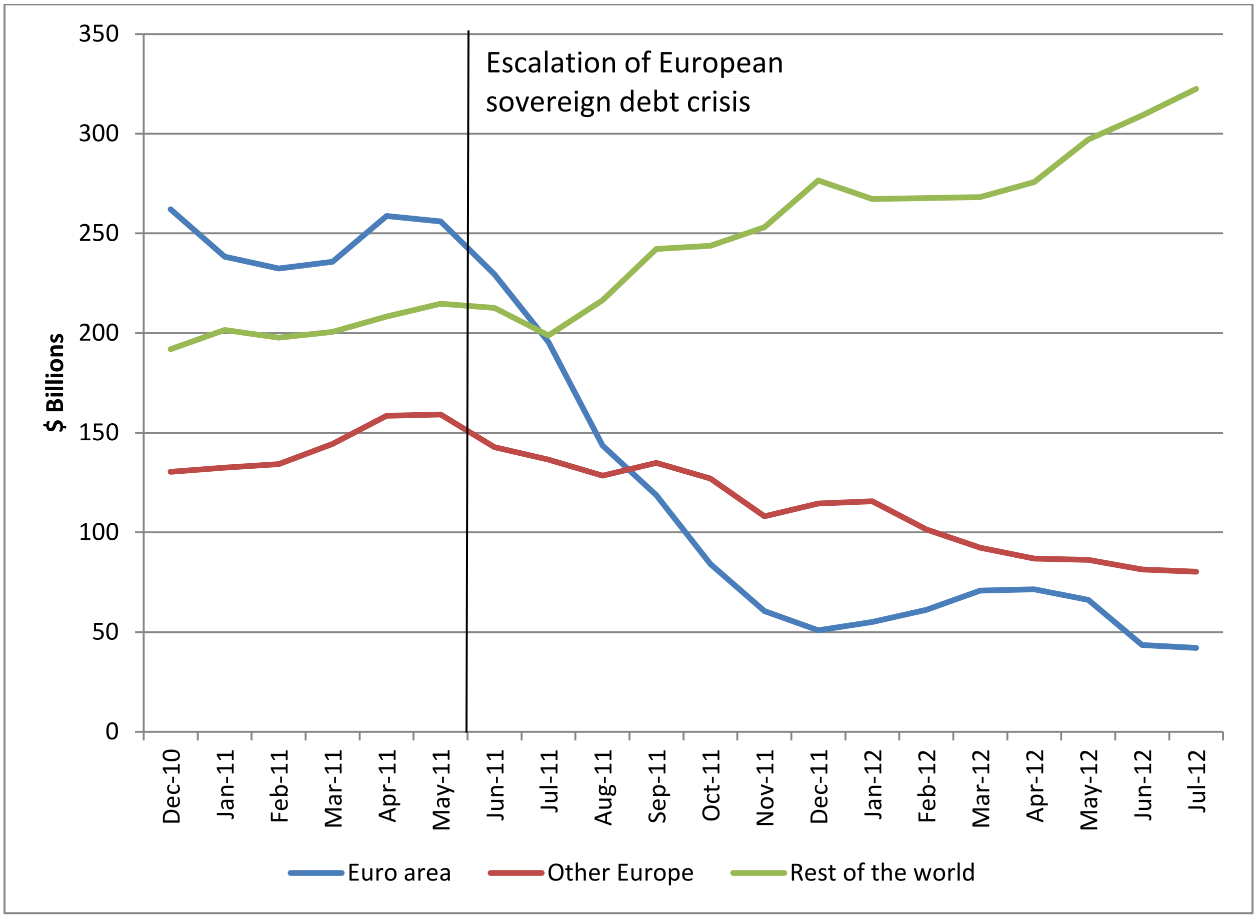

Figure 2. Large time deposits (greater than $100,000) outstanding at the U.S. branches of foreign banks.

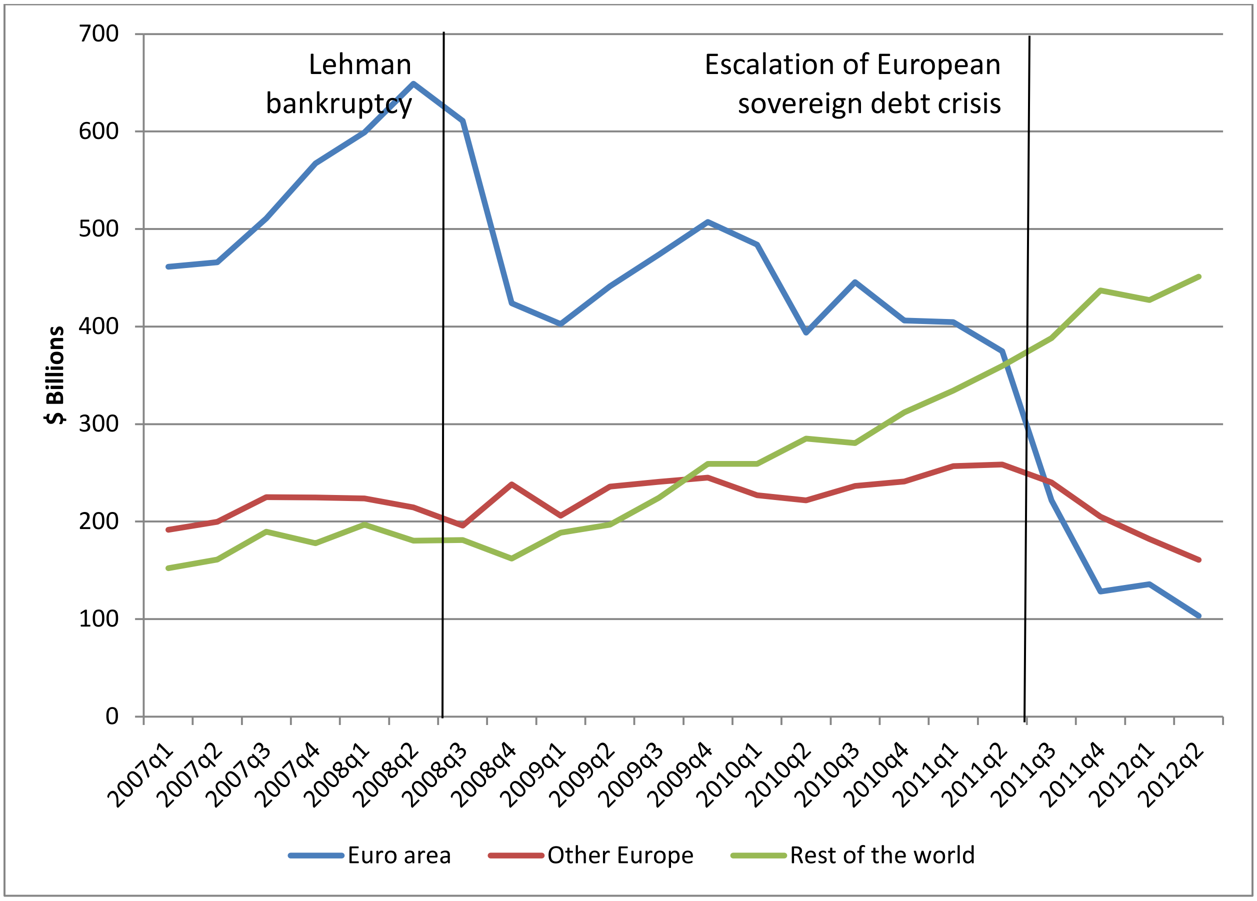

Figure 3. Net due to positions of the U.S. branches of euro-area banks with their head offices (the blue line), and the 3-month implied basis spreads from the euro-dollar swaps (averaged into quarters, the red line). The "net due to position" is equal to the balances owed by the branch to the head office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

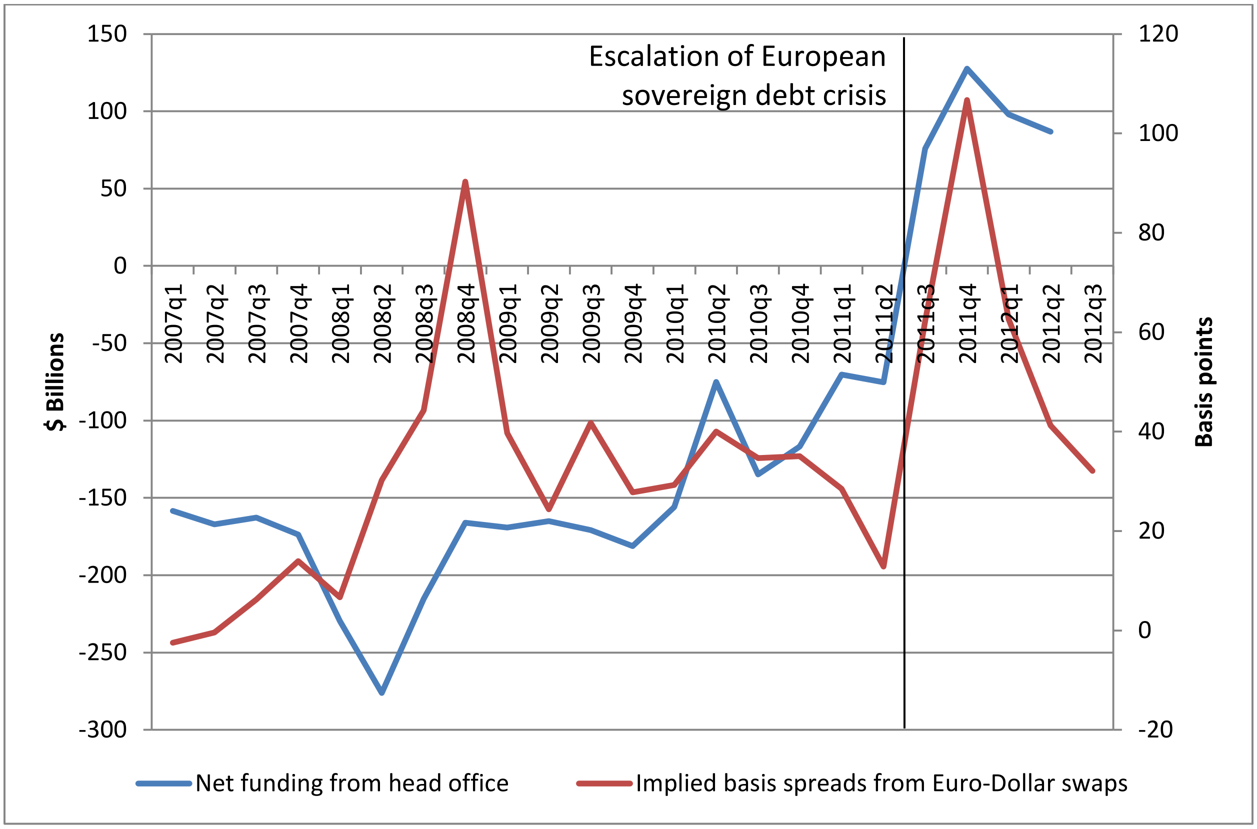

Figure 4. Median CDS premiums (5-year contracts) for banks headquartered in Europe (blue line), other advanced economies (red line), emerging economies (green line), and the rest of the world (purple line).