MONETARY POLICY AND GLOBAL BANKING

Falk Bräuning
Federal Reserve Bank of Boston

Victoria Ivashina
Harvard University and NBER

June 21, 2016

Abstract

Multinational banks use their global internal capital market to respond to local shocks. However, what distinguishes global banks is not only their geographical diversification, but also their funding model: the primary source of stable funding for banks is denominated in their domestic currency. When global banks use their global balance sheets to smooth out local shocks, they need to hedge their foreign exchange exposure. In times when there is limited capital to take the other side of the hedging transaction, this will attenuate the use of internal markets to smooth out local shocks. In this context, tightening monetary policy in the lender's home country can actually reduce pressure on the swap market, making lending abroad more attractive. Using the changes in interest paid on excess reserves by monetary authorities in six major currency areas between 2000 and 2015, we show that multinational banks reduce their reserve holdings and increase their lending abroad in response to a tightening of domestic monetary policy. This result is robust to the inclusion of a narrow set of fixed effects, and holds at the loan level. Consistent with the proposed mechanism, we show that global banks' cross-border movement of capital is associated with an increase in foreign exchange swapping activity and its rising cost, as manifested in violations of covered interest rate parity.

Key words: Global banks; monetary policy transmission; cross-border lending.
JEL Codes: E44, E52, F36, G15, G21, G28.

We thank seminar participants at the Federal Reserve Bank of Chicago, Federal Reserve Bank of Boston, Federal Reserve Board, Banque de France, UIUC, Nova School of Business and Economics, and University of Porto for helpful comments. We are particularly grateful to Stijn Claessens (discussant), François Gourio, Ali Ozdagli, and Christina Wang for detailed feedback. Botao Wu provided remarkable assistance with the data collection. The views expressed in this paper are those of the authors and do not necessarily represent the views of the Federal Reserve Bank of Boston or the Federal Reserve System.

I. Introduction

Foreign ("global") banks play an important role in most countries around the world, including developed economies. According to the Bank for International Settlements (BIS), as of June 2015, European and Japanese banks' claims on U.S. non-bank firms were 1.61 and 0.72 trillion dollars, respectively. DealScan data indicates that foreign banks help originate close to a quarter of all syndicated corporate loans in the United States. Similarly, U.S. banks are important lenders abroad: as of June 2015, U.S. banks held an equivalent of 0.74 and 0.11 trillion dollars in claims on European and Japanese non-bank companies. More generally, it is estimated that foreign banks account for about ten percent of assets of French and Italian banking (World Bank, 2008).

Given the economic significance of global banks, questions have been raised about their role in the propagation of economic shocks from one country to another. In this paper, we study the effect that monetary policy actions in one country might have on the lending decisions of global banks abroad. Cetorelli and Goldberg (2012) point out that global banks actively use fund transfers from their foreign offices (branches and subsidiaries) to respond to local monetary policy shocks. Specifically, when the Federal Reserve tightens monetary conditions, banks operating in the United States increase their borrowing from their offices in other countries. However, the previous literature does not explore the fact that the funding raised through this channel is likely to be denominated in a different currency than the assets they are trying to fund. In fact, much of the global banks' funding is denominated in domestic currency.[1] So, in responding to U.S. monetary policy, a global Eurozone bank could use funds available through its domestic offices, but these funds are likely to be denominated in euro, whereas its U.S. assets are denominated in U.S. dollars.

Such currency mismatch is typically fully hedged by banks; thus, their use of cross-border internal funding markets is tied to use of foreign exchange (FX) swaps. If these capital flows are large, the forward premium (the relative difference between the forward and spot exchange rate) is likely to rise, increasing the cost of the synthetic funding. This, in turn, will affect the relative attractiveness of lending in foreign currency. Thus, faced with a tightening monetary policy in the U.S., capital-constrained Eurozone banks would contract lending in U.S. dollars and expand credit in euro.

---

[1] Based on the currency break-down of bank funding reported in SNL, in 2015, the mean bank had 83% of all deposits denominated in domestic currency. These data are available for 56 banks from the major currency areas, which include Eurozone, United Kingdom, and Switzerland.

The effect of banks' internal capital reallocation on the cost of synthetic funding is magnified when banks take a global approach to the management of excess reserves and other short-term investments. The intuition is the same: tightening monetary policy triggers a cross-border—cross-currency—capital flow in the direction of the higher interest rate regime, thereby increasing the swapping activity as well as its marginal cost. For a capital-constrained bank, such an increase in carry trade activity would lead to a reduction in foreign lending and a redeployment of capital to an expansion in domestic lending. In the next section, we use this basic intuition in a simple model from which we derive testable predictions that guide our empirical analysis.

Our empirical results can be divided into two parts: (i) aggregate macro and (ii) firm- and loan-level micro evidence. We start by looking at the large-scale rise in the foreign banks' reserve holdings at U.S. Federal Reserve Banks following the introduction of the interest rates paid on excess reserves (IOER) rate in 2008, as documented by McCauley and McGuire (2014). We point out the substantial cross-country variation in foreign banks' reserve holdings and show a strong connection between the reserves held by foreign banks at the Fed and the IOER rate difference between the U.S. and the country where the foreign bank is headquartered. Our estimates suggest that an increase in the IOER rate differential by one percentage point is associated with a 73 percent increase in deposits held at the Fed. Using Call Report data for banks with operations in the U.S., we also show that foreign banks from countries with a lower interest rate (and hence lower cost of marginal stable funding) increase their internal capital reallocation from their foreign offices toward their U.S. offices and reduce their lending to firms in the United States.

Similar patterns emerge in a cross-country setting. Using data from the BIS, we find that cross-border bank claims on (non-bank) firms are negatively associated with the interest rate differential between the currencies of the country of the firm and the country of the intermediating banks. On the other hand, banks from low interest rate currency areas hold more claims on the official sector (government and central bank) of high interest rate currency areas. Quantitatively we estimate a reduction of claims on foreign firms by 12 percent and a raise in claims on the foreign official sector by 16 percent for a one-percentage-point increase in the interest rate differential. In line with the transmission mechanism conjectured in this paper, BIS FX swap volume data indicate a sizable increase in banks' swapping activity from domestic into foreign currency in response to monetary tightening abroad.

Our second set of results is based on loan-level data, which is crucial for a tight identification of the mechanism at play. For this purpose, we employ syndicated-loan-level data on loans granted in six major currency areas (United States, Eurozone, United Kingdom, Japan, Switzerland, and Canada) from 2000:Q1 through 2015:Q2. We then look at the firm- and loan-level evidence to address potential selection between foreign banks and their borrowers, as well as the possibility of banks responding to aggregate shocks abroad or at home.

Using borrower-quarter fixed effects, we see that—among foreign banks—the propensity to lend (extensive margin) and the loan commitment (intensive margin) relate negatively to the difference in rates set by the monetary authorities in the host country and the bank's home country. In particular, we find a three percent decline in the probability of lending and about a 12 percent reduction in the lending volume for a one-percentage-point differential in interest rate on excess reserves. Inclusion of both borrower-quarter and lender-quarter fixed effects allows us to also account for bank-time-varying behavior such as the response to the economic conditions in the bank's home country. For example, the shock to the Japanese banks analyzed in Peek and Rosengren (1997, 2000) would lead to an overall contraction in credit, which would be accounted for by lender-quarter fixed effects. Our tightest specification relates remaining cross-country variation in the lending behavior of a bank in a given quarter, holding constant the variation in borrower characteristics.

Moreover, we estimate changes in aggregate credit supply at the domestic firm level after foreign monetary policy shocks to analyze if the reduction in credit is binding for the individual firm. We find that firms that had a larger share of global banks in the syndicate before the monetary policy shock face a stronger contraction in credit after a monetary policy shock that increases the interest rate differential between the currency area of the bank and a foreign country (i.e., an interest-rate decrease in the currency area of the bank). Economically, we estimate that a two-standard-deviation change in the past share of global banks is associated with a thirteen percent lower probability of obtaining a loan and with an eight percent reduction in volume of granted loans after an expansionary monetary policy shock abroad.

This paper fits into a growing literature on global banks and the role they play in transmitting shocks across borders. In addition to the seminal early contributions by Peek and Rosengren (1997, 2000), research in this area includes Acharya and Schnabl (2010), Chava and Purnanandam (2011), Schnabl (2012), Cetorelli and Goldberg (2011), Acharya, Afonso, and Kovner (2013), Correa, Sapriza, and Zlate (2012), and Giannetti and Laeven (2012).

Our work relates most closely to Cetorelli and Goldberg (2012) and Morais, Peydro, and Ruiz (2015), who examine the role of global banks' internal capital markets on the international transmission of monetary policy. As in these papers, we rely on the use of the global balance sheet as a central channel for the cross-border spillovers of monetary policy. However, we point out that taking differences between funding and investment currency into consideration reveals a more nuanced effect on lending in domestic and foreign markets due to the effects of global banks' capital movement on the FX market.

We contribute to the emerging literature on the funding currency effects. As in Ivashina, Scharfstein, and Stein (2015), we directly incorporate the fact that banks fund themselves primarily in their domestic currency and rely on synthetic funding to lend in foreign currencies. This has an effect on how internal capital markets are used, which leads to contrary effects of monetary policy for the domestic and foreign lending of global banks. Although, unlike Ivashina, Scharfstein, and Stein (2015), we do not rely on the limits to arbitrage in the FX market. We do not articulate it formally, but our results would be consistent with frictions in the FX market. Indeed, as part of the aggregate results, we show that the difference in interest on excess reserves between two major currency areas is related to the violation of covered interest rate parity. Recent work by Ongena, Schindele, and Vonnak (2016) analyzes the differential impact of domestic and foreign monetary policy on the local supply of bank credit in domestic and foreign currencies, using micro data from Hungary. The authors establish that domestic monetary policy primarily has an effect on credit supply in the domestic currency. They hypothesize that this is due to the fact that the cost of funding in a given currency is influenced by that currency area's monetary authority, which is a different mechanism from the one articulated here.

Our paper also relates to the theory work by Gabaix and Maggiori (2015), who argue that exchange rates could be influenced by large, international capital flows intermediated by global financial institutions. Due to their limited risk-taking capacity, the financiers require incentives to absorb the global imbalance of demand and supply of assets in different currency denominations. In their model, adjustments of exchange rates provide the mechanism by which risk-taking is compensated. While we do not explicitly analyze the effects of capital flows on the exchange rate, we argue that when global banks hedge their foreign exchange exposure, cross-currency movements of capital lead to real effects through the balance sheets of global banks.

The rest of the paper is organized in four sections. In Section II, we formalize our testable hypotheses. In Section III, we present our core empirical results. In Section IV, we show evidence that monetary policy and FX markets are interconnected. In Section V, we conclude.

II. MODEL

In this section, we present a simple model that formalizes the mechanism through which changes in foreign monetary policy impact global bank lending.

Our model considers a global bank that has investment opportunities in both the domestic country d and in the foreign country f. If the bank lends an amount L^d in the domestic market at time t_0, it earns a return $g(L^d)$ at time t_1, where $g(\cdot)$ is a concave function. Similarly, if the bank lends an amount L^f in the foreign market at time t_0, it earns a return $h(\cdot)$ at time t_1, where, again, $h(\cdot)$ is a concave function. In addition to these lending opportunities, the bank can hold an amount R^d of reserves at the domestic central bank; these reserves yield a constant return equal to the deposit facility rate r^d at time t_1. Moreover, a global bank can—through its network of foreign offices—access the deposit facility of the foreign central bank where it can keep an amount R^f of reserves. Foreign reserves in foreign currency are remunerated at the foreign IOER rate r^f at time t_1.[2] Assets in each country are denominated in local currency; that is, L^d and R^d are denominated in a bank's domestic currency, whereas L^f and R^f are denominated in foreign currency.

Without a loss of generality, we assume that the bank's only funding sources are a fixed amount of capital K and deposits D^d, both denominated in domestic currency.[3] Raising domestic deposits is associated with an increasing cost $d(D^d)$, where $d(\cdot)$ is a convex function. These costs may represent an adjustment cost to the domestic deposit base (Ivashina, Scharfstein, and Stein, 2015), or they may be interpreted as a balance sheet cost (Martin, McAndrews, and Skeie, 2013). The

[2] In line with our empirical analysis, the model focuses on the allocation of funds to loans and reserves. However, it is important to highlight that the proposed mechanism holds more broadly if the bank can invest in another risk-free asset with a constant return and no capacity constraint, such as government bonds.
[3] We take as given that the depository base is primarily denominated in domestic currency. However, our model could be extended to allow for wholesale funding in foreign currency. We leave this extension out of the paper because it does not provide additional insights into the core mechanism of monetary policy transmission.

global bank's total lending faces an overall capital constraint $L^d + L^f \leq K/\alpha$, which we assume is binding in equilibrium. This is a standard constraint that reflects (regulatory or internal) capital requirements, or the prohibitive cost of raising equity in the short run. Note that, unlike lending, reserve balances do not need to be backed up by equity.

To fund its foreign lending and reserve deposits, the global bank uses funds raised in domestic currency. This currency mismatch is typically hedged by banks using FX swaps (Fender and McGuire, 2010).[4] Suppose that the bank swaps an amount S of domestic currency into foreign currency at a normalized spot rate $X^s = 1$ at time t_0 and agrees to do the reverse transaction at the forward rate X^f at time t_1. For the bank, such a swap position of size S is associated with a cost $c(S) = (X^f/X^S - 1)\, S = (X^f - 1)\, S$, where the marginal cost of the hedge $X^f - 1$ is given by the forward premium (the relative difference between the forward and spot FX rate). However, if the capacity to take the other side of the swap transaction is limited by capital-constrained counterparties, this can lead to an increasing forward rate and marginal cost of swapping. Following Ivashina, Scharfstein, and Stein (2015), we consider an arbitrageur in the forward market that has to set aside a haircut proportional to the size of the swap position if it enters the swap transaction. Because the arbitrageur is capital constraint, it has to divert resources from another productive activity, such as lending, or another arbitrage trade. In doing so, the arbitrageur requires an increasing return for entering the forward transaction, which increases the cost of swapping for the bank. We therefore model the cost of a swap position of size S by $c(S)$, where $c(S)$ is a convex function with $c'(S)>0$. Hence, the bank faces a higher cost of swapping as the size of the position increases.

Before formally solving the global bank's optimization problem, it is insightful to discuss the different elements of the model. Let's suppose the bank has no access to the foreign deposit facility such that foreign loans are the only asset denominated in foreign currency. A capital-unconstraint bank would then optimally choose $h'(L^f) - c'(S) = r^d$. Hence, the marginal cost of swapping drives a wedge between the marginal return of foreign lending and the domestic interest rate, which sets the return of the outside option to lending and the marginal cost of funding in domestic currency. If the bank may, in addition to foreign loans, also hold foreign reserves because, say, $r^f > r^d$, then the bank will need to increase its swapping into the foreign currency, which increases

[4] BIS data show that FX swaps are the most actively traded foreign exchange instrument, with an average turnover of $2.2 trillion a day in April 2013; banks account for more than 75 percent of this turnover.

the marginal cost of the swap and makes lending abroad less attractive. As a consequence, a domestic monetary policy tightening will reduce pressure in the forward market and reduce the marginal cost of the swap. Indeed, as we show in the following for a capital-constraint bank, such a domestic monetary policy tightening may in fact lead to an expansion of foreign lending.

Formally, the global bank maximizes profits by choosing the amount of domestic deposits and the portfolio allocation. Given our assumptions, the bank's assets denominated in foreign currency must be equal to the amount of domestic currency that the bank swaps into foreign currency, such that $L^f + R^f = S$. The bank's optimization problem is to choose $\{R^d,\ L^d,\ R^f,\ L^f,\ S,\ D^d\}$ to maximize

$$r^d R^d + g(L^d) + r^f R^f + h(L^f) - c(S) - d(D^d), \tag{1}$$

subject to the balance sheet constraint that $D^d + K - L^d - L^f - R^d - R^f = 0$, the capital constraint $K/\alpha - L^d - L^f \geq 0$, and the condition $S - R^f - L^f = 0$, i.e., all foreign assets must be funded through FX swaps.

The first order conditions for an interior solution for R^d, L^d, R^f, L^f, S, and D^d, respectively, are given by

$$r^d - \lambda = 0 \tag{2}$$

$$g'(L^d) - \lambda - \omega = 0 \tag{3}$$

$$r^f - \lambda - \mu = 0 \tag{4}$$

$$h'(L^f) - \lambda - \mu - \omega = 0 \tag{5}$$

$$-c'(S) + \mu = 0 \tag{6}$$

$$-d'(D^d) + \lambda = 0, \tag{7}$$

where the Lagrange multipliers on the capital constraint, swap condition, and capital constraint are λ, μ, and ω, respectively. Under the usual regularity conditions on the functions *g*, *h*, *c*, and *d*, lending in both currencies will be positive. From the first-order conditions (2) and (7), we find that the total size of the global bank's balance sheet is determined by the interest rate on domestic deposits:

$$d'(D^d) = r^d, \tag{8}$$

which equates the marginal cost of raising additional deposits to the return on holding excess reserves. Moreover, from conditions (2), (4), and (6), we find that the bank taps its domestic deposits and swaps them into foreign currency until the marginal swapping cost equates the difference of the interest rates on reserves in the two currencies:

$$c'(S) = r^f - r^d =: \Delta r. \quad (9)$$

Therefore, the interest rate differential between the two deposit facility rates determines the optimal amount of funds swapped into the foreign currency.[5] Combining equations (2)–(5), we also obtain the result that the bank chooses its lending portfolio in domestic and foreign currencies as a function of the interest rate differential:

$$h'(L^f) = g'(L^d) + \Delta r. \quad (10)$$

That is, the marginal return on lending in the domestic currency exceeds the return on lending in the foreign currency by a wedge that equals the interest rate differential.

Without the capital constraint ($\omega = 0$), the global bank would optimally choose $h'(L^f) = r^f$ and $g'(L^d) = r^d$, such that, in each currency, the return on reserves determines lending. However, if the bank is constrained in its overall lending activity ($\omega \neq 0$), a change in the domestic IOER rate leads to a rebalancing between both foreign and domestic lending to reflect the new relative returns set by the two deposit facility rates. Hence, the amount of lending denominated in foreign currency (the foreign market) depends on both the foreign and the domestic interest rate on reserves.

We can use the first-order conditions to derive several comparative statics. In particular, using equation (10) and the capital constraint, we can write the bank's foreign lending as a decreasing function of the interest rate differential,

$$\frac{\partial L^f}{\partial \Delta r} = \frac{1}{h''(L^f) + g''(K/\alpha - L^f)} < 0, \quad (11)$$

and, similarly, for the lending in the domestic currency,

$$\frac{\partial L^d}{\partial \Delta r} = -\frac{1}{h''(K/\alpha - L^d) + g''(L^d)} > 0. \quad (12)$$

Hence, lending in the foreign currency decreases as a response to a higher difference between the foreign and domestic rates paid on reserves difference, while domestic lending decreases. This

[5] In a frictionless world, arbitrage ensures that covered interest parity (CIP) holds, i.e., $1 + r^f = X^f\left(1 + r^d\right)$. We can use a logarithmic approximation to show that in this case the marginal cost of swapping is determined by the interest rate differential, $X^f - 1 = r^f - r^d$.

means that an increase in the domestic rate on reserves—a tightening of domestic monetary policy—leads to an expansion of foreign lending and a decrease in domestic lending.

From equation (9), we also obtain the result that the swap activity from the domestic into the foreign currency increases per the difference between the foreign and domestic rates paid on reserves,

$$\frac{\partial S}{\partial \Delta r} = \frac{1}{c''(S)} > 0. \tag{13}$$

Moreover, foreign reserve holdings increase with the difference between the foreign and domestic rates paid on reserves, while domestic reserve holdings decrease with the difference between the foreign and domestic rates paid on reserves:

$$\frac{\partial R^f}{\partial \Delta r} = \frac{\partial S}{\partial \Delta r} - \frac{\partial L^f}{\partial \Delta r} > 0, \tag{14}$$

$$\frac{\partial R^d}{\partial \Delta r} = \frac{\partial D}{\partial \Delta r} - \frac{\partial S}{\partial \Delta r} - \frac{\partial L^d}{\partial \Delta r} < 0. \tag{15}$$

Thus, if the domestic central bank increases its interest paid on excess reserves, all else constant, the global bank will increase its domestic depository basis to maintain equality between the marginal return of its assets and the marginal cost of raising deposits. Moreover, the bank will hold more reserves at the domestic central bank due to the higher interest rate and, consequently, will do less domestic lending. This result does not depend on the foreign rate on reserves and would even hold for banks that do not have access to deposits with a foreign central bank.

Importantly, an increase in the domestic interest rate paid on reserves makes deposits with the foreign central bank less attractive. In turn, the global bank that has access to both deposit facilities allocates more money to assets denominated in the domestic currency and decreases its swap amount to fund foreign assets in the foreign currency. First, the global bank decreases its reserve holdings at the foreign central bank. Second, the global bank increases its lending in the foreign currency. Both effects happen absent any change in the rate paid on reserves in the foreign currency by the foreign central bank.

While the decrease in foreign reserve holdings is a direct consequence of the lower interest rate differential, the higher lending in foreign currency is an interaction between the reduced interest rate differential and the binding capital constraint. Absent the binding capital constraint, the bank would simply reduce its domestic lending to equate the marginal return on its domestic lending to the higher domestic rate on reserves. However, with a binding capital constraint, this equality does not hold, and the bank is better off reallocating resources from lending in domestic currency to lending in foreign currency, where (i) the marginal return net of swapping cost increases due to the lower overall swapping activity into the foreign currency, and (ii) the opportunity cost of lending becomes relatively lower. This rebalancing of the lending portfolio is also reflected in the share of foreign currency relative to total lending, which is decreasing with the IOER rate differential, as $\partial(L^f/((L^f + L^d))/\partial\Delta r < 0$.

III. RESULTS

In this section, we empirically test the main predictions of our model that global banks increase foreign reserve holdings and decrease foreign lending as the interest rate differential between the foreign and domestic central bank gets larger. We should emphasize that, in what follow, we use "foreign" and "domestic" the way it was defined in the model, that is, with respect to the lender. Throughout the analysis, the central explanatory variable is *IOER difference* ($\Delta r^f = r^f - r^d$), defined as the difference between the rate paid on excess reserves in a given foreign currency ($IOER^f$) and the rate paid on excess reserves in the domestic currency of the bank ($IOER^d$). As mentioned earlier, "foreign" here means outside of the home country of a given lender. For instance, if a bank that is headquartered in Japan lends in U.S. dollars, we will consider the difference between the rates paid on reserves in the United States and in Japan at the time of the loan.

Our sample extends from 2000:Q1 to 2015:Q2. In the main part of our analysis, we focus on interest rates paid on excess reserves by central banks in six major currency areas—United States, Eurozone, United Kingdom, Japan, Switzerland, and Canada—and global banks and borrowers headquartered in these markets. Table I shows the interest rate paid on excess reserves by the U.S. Federal Reserve System, the European Central Bank (ECB), the Bank of England, the Bank of Japan, the Swiss National Bank, and the Bank of Canada from 2000 to 2015. The table lists all the dates on which at least one of the above central banks had changed the rate. (In the Appendix, we also provide background information on use of IOER as a monetary policy tool by these six monetary authorities.)

[TABLE I]

A. IOER and Foreign Banks' Reserves in the United States

Due to data availability, the analysis of foreign banks' reserve holdings is constrained to deposits at the Federal Reserve as reported in the quarterly call reports. Figure I illustrates the point previously described by McCauley and McGuire (2014) that since the introduction of the interest rate paid on excess reserves, a large share of dollar deposits at the U.S. central bank is held by foreign banks.

[FIGURE I]

Our focus, however, is the cross-sectional heterogeneity in reserve holdings by foreign banks; specifically, we find a positive correlation between the reserves held with U.S. Federal Reserve Banks and the difference between the rates on reserves paid by the U.S. central bank and the foreign banks' domestic monetary authorities. This point is illustrated in Figure II. The vertical axis in Figure II is (the logarithm of) the deposits net of currency area fixed effects held by foreign banking sectors at U.S. Federal Reserve Banks. The horizontal axis is Δr (the difference between the U.S. deposit rate and the deposit rate of the foreign currency area). For the analysis of the reserves, we were able to collect data for foreign banks from sixteen currency areas for the period from 2000:Q1 to 2015:Q2. Each observation in Figure II corresponds to a foreign banking sector-quarter (e.g., total of Japanese banks' deposits at the Federal Reserve Banks in a given quarter.) To highlight the role of differences in the IOER rates of the United States and the foreign currency area, we focus in the figure on observations with $\Delta r \neq 0$. The positive relation between the IOER rate difference and (the logarithm of) reserve holdings is remarkably strong, with a correlation of 0.80.

[FIGURE II]

Table II, column (1) reiterates the point illustrated in Figure II, but now looking at (the logarithm of) reserve holdings at the individual bank level, as compared to currency-area level in Figure II (we aggregate branches and subsidiaries at the high holder level). We also focus on the period after 2008:Q3, when the Federal Reserve introduced a positive IOER rate, and abundant excess reserves were available in the system. In line with the main analysis of the paper, we restrict the sample to foreign banks from the Eurozone, United Kingdom, Japan, Switzerland, and Canada.

Specification (1) shows that the positive relation between a bank's reserve holdings and the IOER rate differential continues to hold for this sample and is robust to the inclusion of bank fixed effects and, therefore, cannot be driven by compositional shifts in the bank sample. Specification (2), in addition, includes quarter fixed effects and thus indicates that, *for a cross-section of banks*, a higher IOER rate difference between a foreign and a domestic country is associated with higher reserves in the foreign country. Note that quarter fixed effects net out common time-varying factors such as an increase in the total amount of reserves or changes in the FDIC assessment base.[6] Economically, we estimate that an increase in the IOER rate differential of 1 percentage point increases the dollar deposits at the Federal Reserve by 73 percent.

We also use the Call Reports data to analyze internal capital flows between U.S. branches and the headquarters of global banks ("net due to" and "net due from"), as well as commercial and industrial (C&I) loans and total loans and leases by foreign banks. The results are reported in Table II, columns (3) through (6). The coefficient estimate in column (4) indicates that the U.S. branches of global banks that face a 1 percentage point higher IOER rate differential will increase the net due from their head office (internal lending) by about 152 percent. At the same time, column (6) shows that U.S. branches decrease their net due to their respective head office (internal borrowing) by about 66 percent, suggesting a strong internal capital reallocation to the U.S. offices of global banks in response to changes in the interest rate differential between the U.S. monetary policy and the central bank of the country where the bank is headquartered.

[TABLE II]

In columns (7) through (10), we analyze the extent to which foreign banks change their U.S. lending in response to changes in the IOER rate differentials. We find that an increase in the difference of the interest rate on reserves is associated with a strong cutback in both C&I loans (to U.S. addressees) and total loans and leases. Economically, we estimate that a 1 percentage point higher interest rate differential is associated with a decrease of C&I loans by about 41 percent, while total loans and leases decrease by about 48 percent.

[6] As argued by McCauley and McGuire (2014), the large surge of reserves holdings by foreign institutions was driven by changes in the assessment base of the Federal Deposit Insurance Corporation (FDIC) in 2011 that did not apply to a large set of foreign banks in the United States. However, our focus is on the variation *within* foreign banks at a given point in time.

B. Monetary Policy and Foreign Banks' Cross-border Claims

We next provide evidence that differences in monetary policy rates impact global banks' portfolio allocation—in particular, credit supply to foreign firms and holdings of foreign risk-free assets—in a cross-country setting. The analysis reported in Tables III and IV is primarily based on BIS Consolidated Banking Statistics, which has quarterly data on cross-border claims on private, non-bank counterparties (firms) as well as on claims on the official sector (including the central banks). Holdings are disaggregated by country and are available for a large list of foreign banking sectors. For instance, we look at the claims by all Japanese banks on all U.S. firms and the U.S. official sector for each quarter from 2000:Q1 to 2015:Q2. As before, we focus on global banks from the six major currency areas—the United States, Eurozone, United Kingdom, Japan, Switzerland, and Canada. Note that these aggregate data include all forms of claims vis-à-vis domestic firms, including bank loans and syndicated loans, but also corporate bonds. Also note that the high level of aggregation does not allow us to separate claims on the domestic central bank (deposits) from claims on the government (e.g., government bonds).

[TABLES III & IV]

Table III reports the mean and standard deviation of cross-border claims by different banking sectors on the official sectors of the six major currency areas. The sample period runs from 2000:Q1 through 2015:Q2. (Claims are expressed in billion of 2015:Q2 dollars.) As one would expect, there are sizable holdings of U.S. official claims by foreign banks, with an average volume of USD 1.12 trillion during our sample period. However, Table III illustrates that claims on the official sector of other currency areas also play an important economic role. For example, claims on the official sector of the Eurozone and Japan amount on average to USD 685 billion and USD 224 billion, respectively. The magnitudes of these holdings as well as the size of their variation suggest that this is not exclusively a U.S. dollar phenomenon, and it is plausible that monetary policy in other currency areas can generate cross-currency flows large enough to influence the FX market.

In Table IV, columns (1) and (2), we estimate the effect of the interest rate difference between the domestic currency area and the foreign currency area on the foreign banking sector's claims on the domestic firms. In line with our previous findings on U.S. reserve holdings by non-U.S. banks, we find that foreign banks from currency areas with a lower IOER rate hold fewer claims against the domestic (non-bank) firms. This result also holds when we look at the variation for a given country *within* the same quarter and control for banking sector fixed effects; see column (2). Economically, foreign banks from a country with a 1 percentage point lower IOER rate than the domestic country hold 13 percent less claims on the domestic firms.

In columns (3) and (4), we look at the claims of foreign banks on the domestic official sector. Consistent with our model and our previous findings for the U.S., we confirm that foreign banks from countries that face a higher interest rate differential with respect to the home country of the counterparty hold more claims on the domestic official sector, including the central bank and the government.[7] Again, these results hold when we look at the variation within a given currency area and quarter; see column (4). Also, the economic effects are sizable: A 1 percentage point increase in the IOER rate difference increases the claims on the foreign official sector by about 16 percent.

In columns (5) and (6), we analyze the role of FX swaps in funding assets denominated in foreign currency through synthetic funding. Following McGuire and von Peter (2009), we combine the BIS Consolidated Banking Statistics and the BIS Locational Banking Statistics, and compute the FX swap volumes for each currency pair as the difference between assets and liabilities held in each foreign currency by the banking sector of each currency area. For instance, we compute for all U.S. banks the difference between their EUR assets and their EUR liabilities in a given quarter.

As columns (5) and (6) show—and consistent with our theoretical prediction—an increase in the interest rate differential leads to a higher FX swap volume from the global banks' domestic currency into the carry trade currency. Our strongest results in column (6) indicate that a 1 percentage point increase in the interest rate differential increases the FX swap volume by a sizeable amount of about USD 12 billion (or 19 percent relative to the average swap size of USD 63 billion across all currency pairs).

[FIGURE III]

[7] In Appendix Table II, using U.S. data on foreign holdings of U.S. treasury debt securities, we show that indeed countries with a higher IOER rate difference relative to the United States hold more U.S. government debt.

In line with our model's predictions, these results show an increase in carry trade activity, a surge in FX swaps and a contraction in aggregate credit to domestic firms provided by foreign banks from currency areas with a lower interest rate (i.e., a higher interest rate differential vis-à-vis the domestic currency area). This point is also illustrated in Figure III, which shows the quarterly change in claims on domestic firms by foreign banks in the periods surrounding an increase in the IOER rate difference between the country of the firms and the country of the foreign banks. As the figure highlights, after an increase in the IOER rate difference, the mean foreign credit growth declines from the pre-shock level of 2 percent by 6 percentage points, leading to a contraction of credit in the magnitude of –4 percent.

C. Monetary Policy and Foreign Lending Activities

To improve the identification of the impact of international monetary policy differences on global banks' lending activities, we next analyze data at the micro (firm and loan) level, which allows us to better control for confounding effects. To do so, we use syndicated loan data from Thomson Reuters DealScan on loans, denominated in U.S. dollars (USD), British pounds (GBP), Japanese yen (JPY), Swiss francs (CHF), and Canadian dollars (CAD), made by global banks operating in these currency areas to firms located the United States, Eurozone, United Kingdom, Japan, Switzerland, or Canada. The sample is constrained to banks with large loan commitments, which we identify based on roles that they receive in the lending syndicate as reported by DealScan.[8]

C.1 Bank-Level Analysis

In Table V, we look at the share of a bank's lending in a given foreign currency as a fraction of the sum of its domestic lending and its lending in a given foreign currency. In terms of the notation used in the previous section, we are looking at $L^f/(L^f + L^d)$. For example, for Japanese banks lending in U.S. dollars, the dependent variable is lending in U.S. dollars as a fraction of lending in U.S. dollars and yen. The explanatory variable in this case would be $(IOER^{USD} -$

[8] Lender syndicate roles are granted to distinguish lenders with large commitments and are used toward construction of league tables. The default role for small commitments is "Participant." To identify top tier lenders, we include all lenders that receive a syndicate title other than "Participant."

$IOER^{JPY}$).[9] In columns (1) to (4) of Table V, we analyze the share based on the volume of lending, and in columns (5) to (8) of Table V, we analyze the share based on the number of loans. The regressions in Table V are based on observations at the bank-currency-quarter level. Given the focus on the cross-section, we include quarter fixed effects in all specifications. We also include bank fixed effects, which control for time-invariant differences in the cross-section of banks.

To construct the dependent variable, we convert all loan amounts to U.S. dollars using exchange rates reported in DealScan. Movements in exchange rates could mechanically introduce variation in $L^f/(L^f + L^d)$. To make sure that we pick up variation in loan volumes, and not just variation in exchange rates, specifications using loan volume include controls for the exchange rate between the U.S. dollar and the currency of the loan. As expected, we find this mechanical effect to be present in the data as loans reported during quarters with a weaker U.S. dollar—a higher value of *Spot FX rate (USD)*—have higher foreign currency loans amount when expressed in U.S. dollars. Note that the result using the number of loans is insensitive to this critique.

The sample is constrained to global banks with foreign offices in at least one of the six currency areas. (Although the amount of cross-border lending by banks without foreign offices is relatively small, and our results are not sensitive to their inclusion.) Throughout the analysis, we aggregate bank branches and subsidiaries at the high-holder level. A complete list of the global banks included in our sample as well as the list of currency areas where they have access to the monetary authority is presented in the Appendix.

Consistent with our hypothesis, we find that global banks lend less (more) in foreign currencies that are associated with higher (lower) interest rate. The coefficients in Table V, column (1) indicated that a 1-percentage-point increase in the IOER rate difference is associated with a 3.2-percentage-point reduction in the lending volume share. The impact is economically significant: relative to the average lending share in foreign currencies of 41.1 percentage points, this implies a reduction of 8 percent. The impact on the number of loans, reported in column (5), is equally sizable: global banks cut down the share of loans in a given currency by about 2.5 percentage points as a response to an increase in the IOER rate differential of 1 percentage point (or a decline of 7 percent relative to the average share of 35 percentage points).

[9] Our results are similar if we consider (the logarithm of) the amount of foreign lending in a given currency instead of the relative share of foreign lending.

In columns (2) and (6), we look at the effect of bank capital on the international monetary policy transmission mechanism. Our model predicts that the effect of the IOER rate difference has a stronger impact on the foreign lending of banks with lower capital. Indeed, for a capital-unconstraint bank our proposed channel does not bind, and foreign lending does not depend on domestic monetary policy. We therefore include in columns (2) and (6) an interaction term between the variables *IOER difference* and *Equity*, defined as the bank's equity-to-assets ratio according to the previous reporting year.[10] In line with our model prediction, we find that the IOER rate difference affects more the foreign lending of banks with low capital. For instance, a bank with an equity ratio of 2 standard deviations below the mean cuts down the share of lending in a given currency by about 17 percent (a reduction of 56 percentage points relative to average share of 33.96 percentage points) as a response to an increase in the IOER rate differential of 1 percentage point (column (3)). On the other hand, the effect is significantly muted for banks with an equity ratio above the mean. In fact, for a bank with an equity ratio of 2 standard deviations above the mean, the IOER rate difference has no significant impact on its foreign lending. Note that the equity ratio is demeaned; hence, the negative coefficient of *IOER difference* captures the effect for the average capitalized bank in the sample.

[TABLE V]

We are ultimately interested in the monetary spillover to lending of global banks in foreign markets, rather than currencies. In columns (3), (4), (7), and (8), we condition our sample to borrowers headquartered in the foreign currency area (e.g., a U.S. firm borrowing in USD from a Japanese bank). Thus, this analysis excludes lending in a foreign currency to borrowers in the same location as the bank (i.e., excluding USD lending to Japanese firms.) We find that global banks also reduce their lending to foreign borrowers as a response to a negative IOER rate difference. Economically, in column (3), we estimate that a 1-percentage-point increase in *IOER difference* is associated with a 2.9-percentage-point decrease in the lending volume share. Relative to the average share of 37.16 percentage points, this is a reduction of 8 percent. Column (7) points to a

[10] Due to data availability, we are not able to collect balance sheet information for all bank-quarters in the sample. Hence, the different number of observations in columns (1) and (2).

reduction of 6 percent (relative to the average share of 30.72 percentage points), due to an increase in the interest rate differential by 1 percentage point.

Finally, in columns (4) and (8), we condition the sample to lending to foreign borrowers but only consider quarters after a change in the IOER rate difference triggered by the change in the IOER rate paid in the domestic currency of the banks (e.g., a U.S. firm borrowing in USD from a Japanese bank after monetary policy changes in Japan). While this leads to a substantial drop in the number of observations, the estimated coefficient of *IOER difference* remains negative and significant. In addition, as column (4) suggests, the economic magnitude of the estimated effect increases strongly, with a reduction in the lending volume share of 7.5 percentage points per 1-percentage-point increase in the interest rate differential (which equals 22 percent when compared to the mean share of 34.2 percentage points).[11]

C.2 Loan- and Borrower- Level Analysis

The results presented in Table V are sensitive to compositional shifts in the borrower base within the same lending bank. For example, if U.S. global banks tend to lend to foreign firms that export goods to the United States, improving macroeconomic conditions in the United States, with a subsequent rise in $IOER^{USD}$ (drop in *IOER differential* in this case), it would improve the investment opportunities of foreign borrowers and lead to an expansion in credit. To address this possibility, we expand our results to look at (i) within-loan variation in lending commitments of foreign banks from different currency areas and (ii) the propensity of a given foreign lender to lend to the same borrower as well as the loan volume.

In Table VI, we analyze the composition of lenders from different currency areas at the loan level (package level). For each syndicated loan, we compute the share of banks from each foreign currency area relative to the total number of banks as well as the volume share provided by banks from each foreign currency area (recall that we focus on the United States, Eurozone, United Kingdom, Japan, Switzerland, and Canada). For example, for a given U.S.-dollar-denominated loan, we compute the share of banks (and volume) from the Eurozone and Switzerland as a fraction of the total number of banks (total volume). We then look at how the difference between the U.S. IOER rate and the foreign banks' domestic IOER rate (in this case, the ECB and SNB IOER rates)

[11] The results are robust to the exclusion of USD-denominated loans; see Appendix Table A.3.

impacts the aggregate share of the foreign banks (in this case, aggregated separately at the Eurozone level and at the Swiss bank level). Again, we include only those foreign banks that have a foreign office in the currency area associated with the currency of the loan. The prediction is that, for a given loan, the commitment by lenders headquartered in different currency areas should be inversely related to the IOER rate differential.

The results in Table VI, columns (1) through (4) correspond to the share of banks from a given currency area, whereas the results in columns (5) through (8) correspond to the share of loan volume held by the banks from a given currency. The information on the actual share held by the banks is particularly scarce for the international sample, so instead of using this share data, we pro-rate bank shares. Again banks are aggregated at the bank holding company. If two subs of the same bank participate in a loan, they are counted as one for purposes of bank share calculations. However, if a bank has two subs, we consider that its share of loan volume is twice as large as compared to the bank with one sub, which explains the difference in results.

[TABLE VI]

Comparing the syndicate composition of lenders from foreign currency areas, we confirm that banks from a currency with a higher interest rate differential with respect to the currency of the loan, on average, hold a lower share of the loan. The results are robust to the inclusion of loan fixed effects, which control for the loan volume, currency denomination, borrower risk, and any other loan-specific characteristics, such as the number of lenders in the syndicate. Also, when we condition the sample on loans to borrowers that are located in the currency area associated with the currency of the loan (e.g., a U.S. firm borrowing in USD), we find, in columns (2) and (6), a significant negative effect of the IOER rate difference of about the same economic magnitude. Economically, column (2) indicates that a 1-percentage-point increase in the interest rate differential by decreases the share of foreign banks by 0.72 percentage points (or 3.5 percent when compared to the average share of 20.67 percentage points). In columns (3) and (7), we find that our result is robust to the inclusion of additional macroeconomic controls: the FX spot and 3-month forward rate, and the differences in GDP growth and inflation (CPI growth) between the country of the borrower and the country of the firm. Finally, columns (5) and (8) indicate that this effect is robust to alternative measures of the interest rate differential between the currency area of the firm and the currency area of the respective foreign banks by using the difference between the overnight interbank rate, another common monetary policy target rate (i.e., the fed funds rate for the United States).

In Table VII, we further strengthen the identification of our proposed channel. In particular, in addition to the within-loan analysis, we now look at the borrower-lender dimension and hold constant time-varying bank-specific characteristics by including quarter-lender fixed effects identified from different loan commitments in the same quarter by the same bank. Again, we look at two margins of credit: the probability of lending (extensive margin) and the volume of loan commitment (intensive margin). To estimate the effects on the extensive margin of credit (loan probability), we take any borrower-lender-currency pair for which we observe at least one loan in the sample and construct a dummy variable that is equal to one in quarters when the borrower-lender pair has a lending in the given currency, and zero otherwise. For the intensive margin of credit, we consider (the logarithm of) the total volume of granted loans in a given currency provided by the lender to the borrower in the given quarter. As before, we include in our analysis only those banks that have foreign offices in the currency area associated with the currency of the loan.

Table VII, columns (1) to (5) refer to the linear probability models for the extensive margin of credit[12]. In column (1), where we control for borrower, lender, and time fixed effects, we find that a 1-percentage-point increase in the IOER rate difference is associated with a 13.6 basis points lower probability of lending (4.8 percent decline relative to the mean). In columns (2) to (5), we condition the sample to comply with the restrictions needed to identify the strongest set of fixed effects: that is, banks with multiple loans in foreign currency per quarter and borrowers with more than one top tier lender in the lending syndicates.[13] While this changes the sample, the estimated effect does not change under the same set of fixed effects (column 2). In column (3), we add bank-quarter fixed effects, i.e., we analyze the within-bank variation in the same quarter and again find the interest rate differential has a negative effect (though the estimate coefficient decreases by about 40 percent). By analyzing the within-bank variation, we control for any time-varying heterogeneity at the bank level, such as changes in domestic monetary policy, bank size, or bank health that might affect the bank's overall lending in a given quarter. In column (4), we additionally

[12] We estimate linear probability models due to the presence of a large set of fixed effects.
[13] Circumstances in which the same borrower obtains more than one syndicated loan per quarter are rare. In such circumstance, we aggregate the loan volume.

control for borrower-quarter fixed effects to control for time-varying borrower characteristics. That is, we compare the loan conditions in the same quarter to the same borrower between banks from different currency areas. Given that the vast majority of borrowers has only one loan per quarter, borrower-quarter fixed effects effectively resemble loan fixed effects, as in Table VI. If a given firm's investment opportunities increase as a result of macroeconomic conditions in a foreign country, this should affect all senior secured lenders' willingness to lend (all first-lien lenders in the syndicate) and, therefore, cannot explain variation across lenders at the borrower level. With this strongest set of fixed effects, we estimate that a 1-percentage-point increase of the interest rate differential amounts to a reduction in the probability of lending of about 9.7 basis points (a decline of 3.4 percent relative to the sample mean). The result is also robust if we directly control for *differences* in macroeconomic conditions between the borrower and lender countries; see column (5), where we include the FX spot and 3-month forward rate, and the differences in GDP growth and inflation as additional variables.

[TABLE VII]

In columns (6) to (10), we analyze the effect of the monetary policy differential on (the logarithm of) the loan amount provided at the lender-borrower level in a given currency in a given quarter. Again, we start by controlling for lender, borrower, and time fixed effects in column (6) with the full sample and then restrict the sample to comply with the identification of the fixed effects in columns (7) to (10). For all specifications and samples, we find that the IOER difference has a negative effect on the loan amount. This finding is robust to the inclusion of both lender-quarter fixed effects (column 8) and borrower-quarter fixed effects (column 9). The estimated economic effect in column (9) amounts to a reduction in the lending amount by about 12.8 percent for an IOER rate differential of 1 percentage point. Note, again, that the strong identification with lender-quarter and borrower-quarter fixed effects controls for any observed and unobserved heterogeneity across lenders and borrowers. In particular, we thereby control for the macroeconomic conditions in the borrower or lender country that may be correlated with the IOER rate difference and could also affect loan demand and supply. In column (10), in addition, we control directly for *differences* in macroeconomic conditions between the borrower and lender country by including the FX spot and 3-month forward rate, and the differences in GDP growth and inflation. However, our finding is quantitatively robust to the inclusion of these additional macroeconomic controls.

C.3 Real Effects at Firm Level

Our results, so far, indicate a substantial contraction in credit from foreign banks in response to an increase in a foreign IOER rate and/or drop in a borrower's domestic IOER rate. We showed that for a given borrower, lenders facing a higher IOER rate differential with respect to the currency of the loan were more likely to cut the lending and reduce the loan amount. This, however, allows for the possibility that borrowers substitute away to other lenders. To measure the potential substitution effect directly, in this section, we look at whether bank responses to monetary policy actually impair the funding conditions of firms.

To study the effects at the firm level, we compare the extensive and intensive margin of credit for the firm after a monetary policy shock. For the extensive margin, for each firm–quarter borrowing in a given currency, we construct a dummy variable that equals one if there is a loan and zero otherwise. For the intensive margin, we construct the percentage change (first difference of the logarithm) of the amount of the loan in this quarter and the amount of the last loan in the same currency. We then estimate the probability of a loan and the change in the loan amount provided to a firm after a foreign monetary policy shock that increases the interest rate differential with respect to the currency of the loan. As a key explanatory variable of interest, we use the share of foreign global banks participating in the last loan prior to the change in monetary policy. We denote this variable as *Foreign Bank Reliance*. We base the share only on those foreign banks that are subject to the monetary policy shock. For instance, if a U.S. firm borrowed a USD loan from two Eurozone bank and one Japanese bank, the variable *Foreign Bank Reliance* would take the value of 1/3 if the Bank of Japan lowered its interest rates and the ECB didn't change its rate. On the other hand, if the ECB also lowered its deposit rate, *Foreign Bank Reliance* would take the value one.[14] With this variable we capture the idea that if a given firm relies more on credit from foreign global banks which are subject to a foreign monetary policy change, then we expect that after a decrease in foreign banks' domestic IOER rate (an increase in IOER rate differential), these borrowers will experience a credit contraction. The results are reported in Table VIII.

[14] In the example, if the Fed increased the IOER rate, all three banks would be affected as we are looking at the U.S. dollar lending, and the variable *Foreign Bank Reliance* would again be one.

In Table VIII, columns (1) to (3), we examine the probability of a loan during the same quarter as a positive shock to an IOER rate differential. In column (1), we find that the past share of global banks that lent to the firm has a negative effect on the probability of obtaining a loan after a positive monetary policy shock. As we observe multiple such shocks during our sample period, we also add firm and time fixed effects to control for unobserved factors that may be correlated with our variable of interest. Compared to the mean loan probability, a two-standard-deviation change in the past foreign bank reliance corresponds to a relative change in the probability of a loan of 23 percent. Our results remain robust and economically similar in column (2), where we only consider periods where the positive IOER rate shock was triggered by a foreign central bank (located in another currency area than the firm). In column (3), we also restrict the sample to firms that are located in the currency area associated with the loan (e.g., U.S. firms borrowing in USD) and analyze how the foreign global bank share affects credit to those domestic firms after a foreign monetary policy shock. Hence, in this specification, we precisely estimate the spillover of monetary policy shocks to other markets. A two-standard-deviation change in the past foreign bank reliance corresponds to a relative change in the probability of a loan by 13 percent, relative to the average loan probability.

[TABLE VIII]

In columns (4) to (6), we analyze the change in (the logarithm of) the loan amount of the loans that are granted in the quarter of an IOER rate shock, as compared to (the logarithm of) the volume of the last loan of the same borrower before the shock. In column (4), we find a negative effect of the past share of global banks, after controlling for time and firm fixed effects. Economically, our estimate implies that a two standard deviation larger foreign bank reliance corresponds to a relative reduction in the loan amount of granted loans by 8 percent. This result is quantitatively robust if conditioned on periods after a positive IOER rate shock that was triggered by a foreign monetary policy shock (column 5), and also if we additionally restrict the sample to firms that are located in the currency area associated with the loan (e.g., U.S. firms borrowing in USD); see column (6).

IV. IMPLICATIONS FOR FOREIGN EXCHANGE MARKETS

In this section, we analyze the implications for foreign exchange markets. Specifically, our model predicts that an increase in the difference between the foreign and domestic rate on reserves leads to increased swapping from the currency with the lower rate to the currency with the higher rate. Our results, from Table III, empirically support this view. Moreover, the increased desire of banks to swap into high-yield currencies may lead to short-term deviations from the covered interest rate parity (CIP) due to limited arbitrage in the FX market or slow moving capital (albeit we do not formalize this in our model). We therefore next test if changes in the IOER differential is related to deviation from the CIP. In our empirical analysis, we focus on currency pairs based on five major currencies (USD, EUR, GBP, JPY, and CHF).

[TABLE IX]

In Table IX, we estimate the effect of changes in the IOER rate differential on deviations from the covered interest rate parity. We find that a higher IOER rate differential implies a significant positive change in the basis of the currency with the higher IOER rate, leading to a deviation from the covered interest rate parity. The positive sign on the currency basis reflects the increased cost of hedging (an increase in the forward premium) as triggered by the increasing demand to swap from the low-interest-rate currency to the high-interest-rate currency. These results hold for the 3-month, 1-year, and 5-year basis constructed using the return of government bonds. For the 3-month basis, we estimate that a 1-percentage-point change in the IOER rate differential is associated with a 7-basis-point change in the 3-month basis, as indicated in column (6). For the 1-year basis, we estimate a change of 13 basis points (column 9), and for the 5-year basis, we estimate a change of 10 basis points (column 12).

V. FINAL REMARKS

Multinational banks play a prominent role in economies around the world. Not surprisingly, there is an important and growing literature that studies cross-border propagation of different shocks through the balance sheets of global banks. In this paper, we study the role that global banks play in the cross-border effects of monetary policy. The existing academic and policy view postulates that monetary policy in one country has a broad impact on the lending portfolio of multinational banks. For example, tightening monetary actions by the ECB would lead to a contraction in credit by Eurozone banks in Mexico (Morais, Peydro, and Ruiz, 2015), but would, in turn, make these global banks' responses at home more muted (Cetorelli and Goldberg, 2012). In many ways, the mechanism affecting the transmission of the shock in this setting is similar to the way in which large U.S. banks transmit shocks from one geographic region to another (e.g., Bord, Ivashina, and Taliaferro, 2015). In both cases, the banks engage their internal capital markets to smooth the shocks.

In this paper, we emphasize that use of the internal capital markets creates a cross-currency capital flow, which, in turn, can affect banks' lending decisions through its impact on the cost of exchange risk hedging. The cross-currency flows are triggered not only by a bank's desire to smooth monetary policy shocks, but also due to the liquidity management: it is more attractive to invest excess liquidity in the market with the tightening monetary policy. (Although, this part of the mechanism is only true for major currency areas and, for example, is unlikely to be at work for Mexico.) Large cross-currency flows would affect the lending of any bank that needs to manage exchange rate risk. Thus, the traditional view of how internal markets operate for purposes of lending abroad is weakened and, for major currencies, breaks down.

We test our prediction in the context of changes in the IOER rate in six major currency areas between 2000:Q1 and 2015:Q2. We show that, for foreign banks, there is substantial cross-bank variation in response to monetary policy: banks facing a larger IOER rate differential abroad (vis-à-vis their home country) tend to hold more reserves with the foreign monetary authority and to lend less abroad. This result holds within-borrower, and even within-lending syndicate, across groups of banks from different currency areas. In aggregate, we show that borrowers exposed to this type of shock from foreign banks are less likely to receive a loan or, conditional on getting a loan, more likely to receive a smaller loan, as compared to unaffected borrowers. We verify that the propagation of such shocks is associated with raising the volume of FX swapping activities.

References

Acharya, V., G. Afonso, and A. Kovner, 2013, “How do Global Banks Scramble for Liquidity? Evidence from the Asset-Backed Commercial Paper Freeze of 2007,” *Federal Reserve Bank of New York Staff Reports*, Number 623, August 2013.

Acharya, V., and P. Schnabl, 2010, “Do Global Banks Spread Global Imbalances? Asset-Backed Commercial Paper during the Financial Crisis of 2007-09,” *IMF Economic Review* 58, 37-73.

Amiti, M., and D. Weinstein, 2011, “Exports and Financial Shocks,” *Quarterly Journal of Economics* 126, 1841-1877.

Bord, V., V. Ivashina, and R. Taliaferro, 2015, “Large Banks and the Transmission of Financial Shocks,” Working Paper.

Bowman, D., E. Gagnon, and M.P. Leahy, 2010, "Interest on Excess Reserves as a Monetary Policy Instrument: the Experience of Foreign Central Banks," International Finance Discussion Papers 996, Board of Governors of the Federal Reserve System.

Cetorelli, N., and L. Goldberg, 2012, “Banking Globalization and Monetary Transmission,” *Journal of Finance* 67, 1811-1843.

Cetorelli, N., and L. Goldberg, 2011, “Global Banks and International Shock Transmission: evidence from the Crisis,” International Monetary Fund Economic Review 59(1): 41-76.

Chava, S., and A. Purnanandam, 2011, “The Effect of Banking Crisis on Bank-Dependent Borrowers”, *Journal of Financial Economics* 99, 116-135.

Correa, R., H. Sapriza, and A. Zlate, 2012, “Liquidity Shocks, Dollar Funding Costs and the Bank Lending Channel during the European Sovereign Crisis,” Working paper.

Fender, I., and P. McGuire, 2010, “Bank Structure, Funding Risk and the Transmission of Shocks across Countries: Concepts and Measurements,” *BIS Quarterly Review*, 63-79.

Gabaix, X., and M. Maggiori, 2015, “International Liquidity and Exchange Rate Dynamics,” *Quarterly Journal of Economics* 130, 1369–1420.

Giannetti, M., and L. Laeven, 2012, “The Flight Home Effect: Evidence from the Syndicated Loan Market During Financial Crises,” *Journal of Financial Economics* 104, 23-43.

Ivashina, V., D. Scharfstein and J. Stein, 2015, “Dollar Funding and the Lending Behavior of Global Banks,” *Quarterly Journal of Economics* 130, 1241-1282.

Kashyap, A., and J. Stein, 2000, “What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?” American Economic Review 90, 407-428.

Martin, A., J. McAndrews, and D. Skeie, 2013, “Bank Lending in Times of Large Bank Reserves.” Federal Reserve Bank of New York Staff Reports no. 497.

Morais, B., J.-L. Peydro, and C.R. Ortega, 2015, "The International Bank Lending Channel of Monetary Policy Rates and Quantitative Easing: Credit Supply, Reach-for-Yield, and Real Effects", World Bank Policy Research Working Paper no. 7216

McCauley, R.N., and P. McGuire, 2014, "Non-US Banks' Claims on the Federal Reserve," *BIS Quarterly Review*, March.

Ongena, S., I. Schindele, and D. Vonnak, 2016, "In Lands of Foreign Currency Credit, Bank Lending Channels Run Through?," Working Paper.

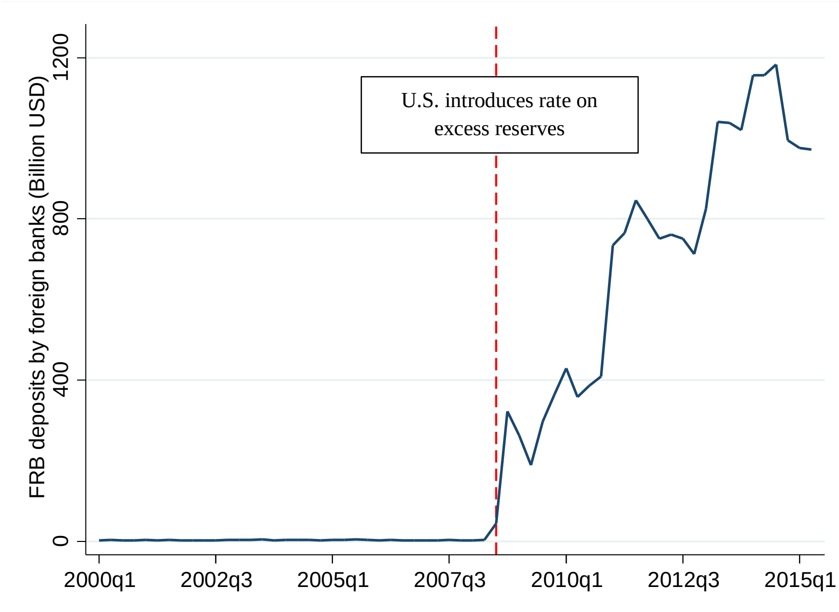
Peek, J., and E. Rosengren, 1997, "The International Transmission of Financial Shocks: The Case of Japan," *American Economic Review* 87(4), 495-505.

Peek, J., and E. Rosengren, 2000, "Collateral Damage: Effects of the Japanese Bank Crisis on Real Activity in the United States," *American Economic Review* 90(1), 30-45.

Schnabl, P., 2012, "The International Transmission of Bank Liquidity Shocks: Evidence from an Emerging Market," *Journal of Finance* 67(3), 897-932.

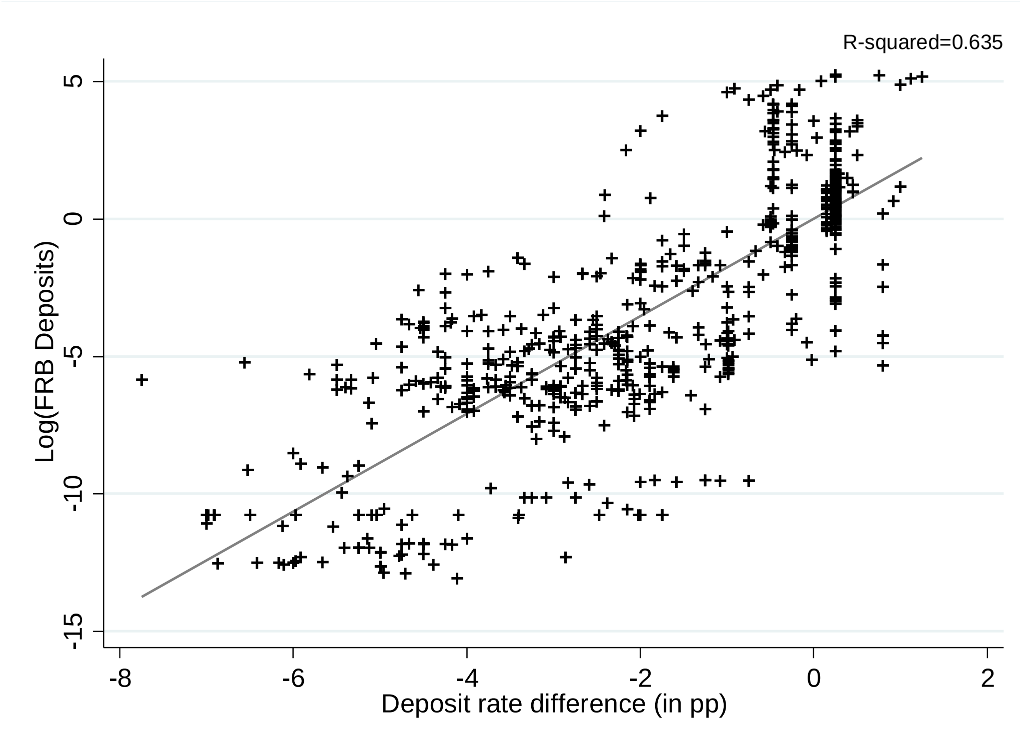
World Bank, 2008, *Global Development Finance: The Role of International Banking.*

FIGURE I



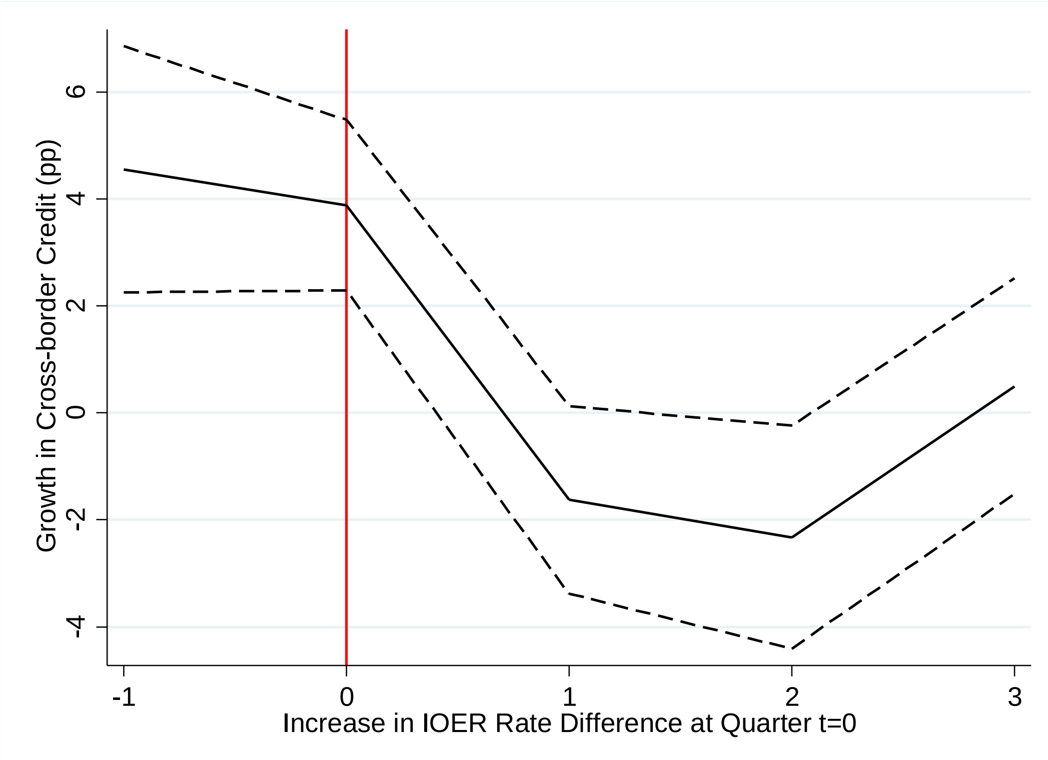
Note: This figure shows the deposits (in billion USD) held by foreign banks at U.S. Federal Reserve Banks for the period from 2000:Q1 to 2015:Q2. The vertical dashed line indicates 2008:Q4, when the Federal Reserve started paying interest on reserves held against deposits.

FIGURE II



Note: The sample covers 16 currency areas from 2000:Q1 to 2015:Q2. *Log(FRB Deposits)* are adjusted for currency area fixed effects.

FIGURE III



Note: Growth in Cross-border Credit is defined as the percentage change in cross-border claims on private, non-bank entities (firms). The sample covers the period from 2000:Q1 to 2015:Q2 and includes banks and non-bank firms from the United States, Eurozone, United Kingdom, Japan, Switzerland, and Canada. The solid line is the mean response, and the dashed lines refer to the interquartile range.

TABLE I
CHANGES IN INTEREST RATE PAID ON EXCESS RESERVES, 2000-2015

Date	US	EA	CA	GB	CH	JP
01/03/00	0.00	2.00	4.50	0.00	0.00	0.00
02/03/00	0.00	2.00	4.75	0.00	0.00	0.00
02/04/00	0.00	2.25	4.75	0.00	0.00	0.00
03/17/00	0.00	2.50	4.75	0.00	0.00	0.00
03/22/00	0.00	2.50	5.00	0.00	0.00	0.00
04/28/00	0.00	2.75	5.00	0.00	0.00	0.00
05/17/00	0.00	2.75	5.50	0.00	0.00	0.00
06/09/00	0.00	3.25	5.50	0.00	0.00	0.00
09/01/00	0.00	3.50	5.50	0.00	0.00	0.00
10/06/00	0.00	3.75	5.50	0.00	0.00	0.00
01/23/01	0.00	3.75	5.25	0.00	0.00	0.00
03/06/01	0.00	3.75	4.75	0.00	0.00	0.00
04/17/01	0.00	3.75	4.50	0.00	0.00	0.00
05/11/01	0.00	3.50	4.50	0.00	0.00	0.00
05/29/01	0.00	3.50	4.25	0.00	0.00	0.00
06/27/01	0.00	3.50	4.25	4.25	0.00	0.00
07/17/01	0.00	3.50	4.00	4.25	0.00	0.00
08/02/01	0.00	3.50	4.00	4.00	0.00	0.00
08/28/01	0.00	3.50	3.75	4.00	0.00	0.00
08/31/01	0.00	3.25	3.75	4.00	0.00	0.00
09/17/01	0.00	3.25	3.25	4.00	0.00	0.00
09/18/01	0.00	2.75	3.25	3.75	0.00	0.00
10/04/01	0.00	2.75	3.25	3.50	0.00	0.00
10/23/01	0.00	2.75	2.50	3.50	0.00	0.00
11/08/01	0.00	2.75	2.50	3.00	0.00	0.00
11/09/01	0.00	2.25	2.50	3.00	0.00	0.00
11/27/01	0.00	2.25	2.00	3.00	0.00	0.00
01/15/02	0.00	2.25	1.75	3.00	0.00	0.00
04/16/02	0.00	2.25	2.00	3.00	0.00	0.00
06/04/02	0.00	2.25	2.25	3.00	0.00	0.00
07/16/02	0.00	2.25	2.50	3.00	0.00	0.00
12/06/02	0.00	1.75	2.50	3.00	0.00	0.00
02/06/03	0.00	1.75	2.50	2.75	0.00	0.00
03/04/03	0.00	1.75	2.75	2.75	0.00	0.00
03/07/03	0.00	1.50	2.75	2.75	0.00	0.00
04/15/03	0.00	1.50	3.00	2.75	0.00	0.00
06/06/03	0.00	1.00	3.00	2.75	0.00	0.00
07/10/03	0.00	1.00	3.00	2.50	0.00	0.00
07/15/03	0.00	1.00	2.75	2.50	0.00	0.00
09/03/03	0.00	1.00	2.50	2.50	0.00	0.00
11/06/03	0.00	1.00	2.50	2.75	0.00	0.00
01/20/04	0.00	1.00	2.25	2.75	0.00	0.00
02/05/04	0.00	1.00	2.25	3.00	0.00	0.00
03/02/04	0.00	1.00	2.00	3.00	0.00	0.00
04/13/04	0.00	1.00	1.75	3.00	0.00	0.00
05/06/04	0.00	1.00	1.75	3.25	0.00	0.00
06/10/04	0.00	1.00	1.75	3.50	0.00	0.00
08/05/04	0.00	1.00	1.75	3.75	0.00	0.00
09/08/04	0.00	1.00	2.00	3.75	0.00	0.00
10/19/04	0.00	1.00	2.25	3.75	0.00	0.00
03/14/05	0.00	1.00	2.25	4.50	0.00	0.00
08/04/05	0.00	1.00	2.25	4.25	0.00	0.00
09/07/05	0.00	1.00	2.50	4.25	0.00	0.00
10/18/05	0.00	1.00	2.75	4.25	0.00	0.00
12/06/05	0.00	1.25	3.00	4.25	0.00	0.00
01/24/06	0.00	1.25	3.25	4.25	0.00	0.00
03/07/06	0.00	1.25	3.50	4.25	0.00	0.00
03/08/06	0.00	1.50	3.50	4.25	0.00	0.00
04/25/06	0.00	1.50	3.75	4.25	0.00	0.00
05/18/06	0.00	1.50	3.75	3.50	0.00	0.00
05/24/06	0.00	1.50	4.00	3.50	0.00	0.00
06/15/06	0.00	1.75	4.00	3.50	0.00	0.00
08/03/06	0.00	1.75	4.00	3.75	0.00	0.00
08/09/06	0.00	2.00	4.00	3.75	0.00	0.00
10/11/06	0.00	2.25	4.00	3.75	0.00	0.00
11/09/06	0.00	2.25	4.00	4.00	0.00	0.00
12/13/06	0.00	2.50	4.00	4.00	0.00	0.00
01/11/07	0.00	2.50	4.00	4.25	0.00	0.00
03/14/07	0.00	2.75	4.00	4.25	0.00	0.00
05/10/07	0.00	2.75	4.00	4.50	0.00	0.00
06/13/07	0.00	3.00	4.00	4.50	0.00	0.00
07/05/07	0.00	3.00	4.00	4.75	0.00	0.00
07/10/07	0.00	3.00	4.25	4.75	0.00	0.00
12/04/07	0.00	3.00	4.00	4.75	0.00	0.00
12/06/07	0.00	3.00	4.00	4.50	0.00	0.00
01/22/08	0.00	3.00	3.75	4.50	0.00	0.00
02/07/08	0.00	3.00	3.75	4.25	0.00	0.00
03/04/08	0.00	3.00	3.25	4.25	0.00	0.00
04/10/08	0.00	3.00	3.25	4.00	0.00	0.00
04/22/08	0.00	3.00	2.75	4.00	0.00	0.00
07/09/08	0.00	3.25	2.75	4.75	0.00	0.00
10/08/08	0.00	3.25	2.25	4.75	0.00	0.00
10/09/08	0.75	3.25	2.25	3.50	0.00	0.00
10/20/08	0.75	3.25	2.25	4.25	0.00	0.00
10/21/08	0.75	3.25	2.00	4.25	0.00	0.00
10/23/08	1.15	3.25	2.00	4.25	0.00	0.00
10/29/08	0.65	3.25	2.00	4.25	0.00	0.00
11/06/08	1.00	3.25	2.00	2.75	0.00	0.00
11/12/08	1.00	2.75	2.00	2.75	0.00	0.00
11/17/08	1.00	2.75	2.00	2.75	0.00	0.10
12/04/08	1.00	2.75	2.00	1.75	0.00	0.10
12/09/08	1.00	2.75	1.25	1.75	0.00	0.10
12/10/08	1.00	2.00	1.25	1.75	0.00	0.10
12/16/08	0.25	2.00	1.25	1.75	0.00	0.10
01/08/09	0.25	2.00	1.25	1.25	0.00	0.10
01/20/09	0.25	2.00	0.75	1.25	0.00	0.10
01/21/09	0.25	1.00	0.75	1.25	0.00	0.10
02/05/09	0.25	1.00	0.75	0.75	0.00	0.10
03/03/09	0.25	1.00	0.25	0.75	0.00	0.10
03/05/09	0.25	1.00	0.25	0.50	0.00	0.10
03/11/09	0.25	0.50	0.25	0.50	0.00	0.10
04/08/09	0.25	0.25	0.25	0.50	0.00	0.10
07/20/10	0.25	0.25	0.50	0.50	0.00	0.10
09/08/10	0.25	0.25	0.75	0.50	0.00	0.10
04/13/11	0.25	0.50	0.75	0.50	0.00	0.10
07/13/11	0.25	0.75	0.75	0.50	0.00	0.10
11/09/11	0.25	0.50	0.75	0.50	0.00	0.10
12/14/11	0.25	0.25	0.75	0.50	0.00	0.10
07/11/12	0.25	0.00	0.75	0.50	0.00	0.10
06/11/14	0.25	-0.10	0.75	0.50	0.00	0.10
09/10/14	0.25	-0.20	0.75	0.50	0.00	0.10
12/18/14	0.25	-0.20	0.75	0.50	-0.25	0.10
01/15/15	0.25	-0.20	0.75	0.50	-0.75	0.10
01/21/15	0.25	-0.20	0.50	0.50	-0.75	0.10
07/15/15	0.25	-0.20	0.25	0.50	-0.75	0.10
12/09/15	0.25	-0.30	0.25	0.50	-0.75	0.10
12/17/15	0.50	-0.30	0.25	0.50	-0.75	0.10

TABLE II

RESERVE HOLDINGS, INTERNAL CAPITAL REALLOCATION, AND BANK LENDING BY FOREIGN BANKS IN THE U.S.

Dependent Variable:	Log(Reserves)		Log(Internal Lending)		Log(Internal Borrowing)		Log(C&I Loans)		Log(Loans and Leases)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
IOER Difference (pp)	1.185***	0.731***	-0.539***	-1.522***	0.236**	0.660***	-0.157***	-0.410**	-0.196***	-0.479***
	(8.26)	(6.33)	(-3.99)	(-4.21)	(2.29)	(5.11)	(-3.69)	(-2.31)	(-3.66)	(-2.78)
Fixed Effects:										
Bank (D_i)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter (D_t)	--	Yes	--	Yes	--	Yes	--	Yes	--	Yes
Observations	1,599	1,599	708	708	1,130	1,130	1,530	1,530	1,579	1,579
R-squared	0.765	0.800	0.591	0.665	0.781	0.790	0.928	0.930	0.929	0.932

Notes: The dependent variables are selected balance sheet positions of foreign branches and subsidiaries in the U.S., consolidated at the high holder (bank) level. *Reserves* is the amount of reserves held against deposits at the Federal Reserve Banks. *Internal Lending* is the net due from non-U.S. offices (asset side), and *Internal Borrowing* is the net due to non-U.S. offices (liability side). *C&I Loans* are commercial and industrial loans (business loans). *Loans and Leases* refers to total loans and leases. The independent variable *IOER Difference* is the difference (in percentage points) between the IOER rate of the U.S. (r^{US}) and the country where the bank is headquartered (r^d). Specification (2) corresponds to:

$$Log(Reserves)_{it} = D_i + D_t + \beta(r_t^{US} - r_t^d) + \epsilon_{it} ,$$

where D_i are bank fixed effects, and D_t are quarter fixed effects. The sample period runs from 2008:Q4 to 2015:Q2 and includes banks from Eurozone, United Kingdom, Japan, Switzerland, and Canada. A constant is included when possible, but is omitted from the output. Robust *t*-statistics are in parentheses. Standard errors are clustered at the quarter level.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE III
BANKS' CLAIMS ON FOREIGN OFFICIAL SECTOR

Banks from:	Claims on the Official Sector of :					
	US	EA	GB	JP	CH	CA
US	--	136.51	49.60	74.17	12.88	14.53
		(41.79)	(30.12)	(33.52)	(13.48)	(6.95)
EA	162.38	--	48.26	94.11	16.46	11.54
	(134.61)		(30.83)	(51.96)	(19.21)	(4.74)
GB	197.07	177.11	--	44.44	18.52	15.26
	(102.12)	(72.97)		(19.42)	(20.53)	(6.05)
JP	398.09	242.49	39.38	--	0.85	18.62
	(103.19)	(31.41)	(8.29)		(0.24)	(2.73)
CH	194.78	97.44	42.13	n/a	--	4.13
	(86.79)	(34.45)	(20.46)			(1.58)
CA	207.18	31.77	17.76	12.07	n/a	--
	(40.89)	(3.86)	(5.06)	(2.64)		

Note: The table reports mean and standard deviation (in parentheses) of cross-border claims by different banking sectors on official sectors of the six major currency areas. Claims are expressed in billions of 2015:Q2 dollars. The sample period runs from 2000:Q1 through 2015:Q2. The data is compiled from BIS consolidated banking statistics.

TABLE IV
CROSS-BORDER CLAIMS BY FOREIGN BANKS AND FX SWAP VOLUMES

Dependent Variable:	Log(Claims on Firms)		Log(Claims on Official Sector)		FX Swap Volume (USD Billion)	
	(1)	(2)	(3)	(4)	(5)	(6)
IOER Difference (pp)	-0.101***	-0.131***	0.067***	0.159***	16.059***	11.832***
	(-9.74)	(-13.65)	(3.25)	(5.52)	(7.31)	(4.30)
Spot FX Rate (USD)	0.675***	--	0.640***	--	42.073***	--
	(10.98)		(2.91)		(3.15)	
Fixed Effects:						
Quarter (D_t)	Yes	--	Yes	--	Yes	--
Country (D_f)	Yes	--	Yes	--	Yes	--
Banking Sector (D_d)	Yes	Yes	Yes	Yes	Yes	Yes
Currency Area × Quarter (D_{ft})	--	Yes	--	Yes	--	Yes
Observations	1,023	1,023	1,019	1,019	848	848
R-squared	0.868	0.878	0.776	0.810	0.538	0.577

Note: Claims on Firms refers to cross-border claims by a banking sector headquartered in currency area *d* on private non-bank entities in foreign currency area *f* in quarter *t*. *Claims on Official Sector* denotes the cross-border claims by a banking sector headquartered in currency area *d* on the foreign official sector (including central bank deposits and government debt holdings) in currency area *f* in quarter *t*. *FX Swap Volume* (in USD billion) of a banking sector in currency area *d* is computed as total assets minus total liabilities in each foreign currency *f* in quarter *t*. Positive values indicate swapping into the foreign currency (e.g., Japanese banks swapping JPY into USD). *IOER Difference* is the difference (in percentage points) between the IOER rates in the currency area of the counterparty (r^f) and the currency area of the banking sector (r^d). Specifications (2), (4), and (6) contain the tightest set of controls; specification (2) corresponds to:

$$Log(Claims\ on\ Firms)_{fdt} = D_d + D_{ft} + \beta\left(r_t^f - r_t^d\right) + \epsilon_{fdt}\ ,$$

where D_d are fixed effect for the currency area of the banking sector, and D_{ft} are currency area × quarter fixed effects. *Spot FX Rate (USD)* controls for the exchange rate as all volumes are expressed in USD. The sample period runs from 2000:Q1 to 2015:Q2 and includes claims by banks (against counterparties) from the United States, Eurozone, United Kingdom, Japan, Switzerland, and Canada. The change in number of observations in columns (5) through (6) is due to different data sources explained in the main text; in particular it is missing information for CAD. Robust *t*-statistics are in parentheses. Standard errors are clustered at the quarter level.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE V
SHARE OF FOREIGN CURRENCY LENDING

Dependent Variable:	Share of Foreign Currency Lending (Loan Volume)				Share of Foreign Currency Lending (Number of Loans)			
	All Markets		Foreign Market		All Markets		Foreign Market	
				r_d Shock				r_d Shock
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IOER Difference (pp)	-3.194***	-3.207***	-2.857***	-7.532***	-2.483***	-3.015***	-1.955***	-2.050***
	(-11.14)	(-9.21)	(-10.11)	(-6.70)	(-12.69)	(-12.63)	(-10.90)	(-3.28)
IOER Difference × Equity	--	0.487***	--	--	--	0.589***	--	--
		(4.85)				(6.66)		
Equity (% of Assets)	--	-0.212	--	--	--	-0.101	--	--
		(-0.48)				(-0.27)		
FX Spot (USD/Foreign Currency)	14.912***	11.614***	15.002***	28.766***	--	--	--	--
	(10.49)	(6.41)	(11.05)	(5.93)				
Fixed Effects:								
Bank (D_i)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter (D_t)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,821	4,685	8,212	1,390	9,821	4,685	8,212	1,390
R-squared	0.658	0.563	0.675	0.529	0.677	0.584	0.673	0.527

Note: The dependent variable is the share of lending (in percent) in a given foreign currency relative to the sum of lending in the domestic and the given foreign currency. Each observation in the analysis is bank (i) × foreign currency (f) × quarter (t). *IOER Difference* is the difference (in percentage points) between the IOER rates in the foreign currency (r^f) and the currency of the country where the bank is headquartered (r^d). Specification (1) corresponds to:

$$L_{it}^f/(L_{it}^f + L_{it}^d) = D_i + D_t + \beta(r_t^f - r_t^d) + FX\ Spot_t^{USD/f} + \varepsilon_{it}^f,$$

where D_i and D_t are bank and quarter fixed effects. *FX Spot* controls for the exchange rate as all volumes are expressed in USD. *Equity* is equity over total assets (in percent), and demeaned with the sample mean. The sample period runs from 2000:Q1 to 2015:Q2 and includes lending denominated in USD, EUR, GBP, JPY, CHF, and CAD. Sample used in columns (4) and (8) only includes observations in the period after a decrease in the banks' domestic IOER rate; i.e., we exclusively look at the effects of monetary policy abroad. Robust *t*-statistics are in parentheses. Standard errors are clustered at the quarter level.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE VI
LOAN PARTICIPATION BY BANKS FROM FOREIGN CURRENCY AREA

Dependent Variable:	Loan Share (Share of Banks)				Loan Share (Share of Volume)			
	All Markets	Foreign Market	Foreign Market	Foreign Market	All Markets	Foreign Market	Foreign Market	Foreign Market
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IOER Difference (pp)	-0.828***	-0.722***	-0.663***	--	-1.052***	-0.973***	-1.019***	--
	(-5.93)	(-6.59)	(-5.96)		(-5.37)	(-4.65)	(-3.88)	
Overnight Rate Difference (pp)	--	--	--	-0.819***	--	--	--	-0.970***
				(-6.55)				(-6.15)
Fixed Effects: Loan (D_l)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro Controls	--	--	Yes	Yes	--	--	Yes	Yes
Observations	25,785	21,528	21,528	21,528	25,785	21,528	21,528	21,528
R-squared	0.617	0.676	0.678	0.679	0.758	0.781	0.783	0.783

Note: The dependent variable is the share of banks (expressed in percentage) on a given loan for a given currency area. Thus, each observation in the sample is loan (l) × lenders aggregated at the currency area (d). Lenders from the same currency area as the loan are excluded from the sample; e.g., we exclude U.S.-banks loans in USD. In columns (2)–(4) and (6)–(8), the sample is constrained to loans granted to the borrowers headquartered in other currency areas than the lenders. As before, the central explanatory variable is *IOER Difference*, defined as the difference (in percentage points) between the IOER rates of the currency of the loan (r^f) and the currency of the country in which the bank is headquartered (r^d). Similarly, *Overnight Rate Difference* is the difference (in percentage points) between the overnight interbank rates on the currency of lending and the currency of the country where the bank is headquartered. Specification (3) includes the most comprehensive set of controls and it corresponds to:

$$Loan\ Share_{ld} = D_l + \beta\left(r_t^f - r_t^d\right) + Macro\ Controls_t^{f/d} + \epsilon_{ld},$$

where D_l are loan fixed effects. *Macro Controls* are the spot and 3-month forward exchange rate, and the difference between the GDP growth and CPI growth of the debtor currency area (*f*) and the lender currency area (*d*). The sample period runs from 2000:Q1 to 2015:Q2 and includes lending denominated in USD, GBP, EUR, JPY, CAD, and CHF. Robust *t*-statistics are in parentheses. Standard errors are clustered at the quarter level.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE VII
LOAN PARTICIPATION AND AMOUNT AT BORROWER-LENDER LEVEL

Dependent Variable:	Probability of Getting a Loan (in %)					Log(Amount)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
IOER Difference (pp)	-0.136***	-0.147***	-0.083***	-0.097***	-0.101***	-0.005*	-0.011***	-0.024***	-0.128*	-0.122*
	(-15.34)	(-14.96)	(-4.89)	(-2.70)	(-3.00)	(-1.94)	(-4.13)	(-3.61)	(-1.88)	(-1.68)
FX Spot (USD/Foreign Currency)	--	--	--	--	--	1.483***	1.330***	1.373***	1.755***	1.712***
						(20.90)	(19.25)	(18.51)	(4.21)	(4.31)
Fixed Effects:										
Bank (D_i)	Yes	Yes	--	--	--	Yes	Yes	--	--	--
Quarter (D_t)	Yes	Yes	--	--	--	Yes	Yes	--	--	--
Borrower (D_j)	Yes	Yes	Yes	--	--	Yes	Yes	Yes	--	--
Bank × Quarter (D_{it})	--	--	Yes	Yes	Yes	--	--	Yes	Yes	Yes
Borrower × Quarter (D_{jt})	--	--	--	Yes	Yes	--	--	--	Yes	Yes
Macro Controls	--	--	--	--	Yes	--	--	--	--	Yes
Observations	2,727,596	2,321,002	2,321,002	2,321,002	2,321,002	72,433	60,975	60,975	60,975	60,975
R-squared	0.013	0.013	0.018	0.651	0.652	0.760	0.794	0.805	0.974	0.974

Note: The dependent variable in columns (1) though (5) is a dummy variable that equals 1 if the borrower j obtains a loan in a given currency *f* (recall that *d* is the domestic currency of the lender) during quarter *t* from a bank i, and 0 otherwise. The dependent variable in columns (6) to (10) is the log of the amount of loans in a given currency *f* a borrower j obtains during a quarter t from a bank i. Lenders from the same currency area as the loan are excluded from the sample; e.g., U.S. banks are excluded when looking at the lending in U.S. dollars. As before, the central explanatory variable is *IOER Difference*, defined as the difference (in percentage points) between the IOER rates of the currency of lending (r^f) and the currency of the country where the bank is headquartered (r^d). Specifications (5) and (10) include the tightest set of controls; specification (5) corresponds to:

$$I(Loan^f)_{jit} = D_{it} + D_{jt} + \beta\left(r_t^f - r_t^d\right) + Macro\ Controls_t^{f/d} + \varepsilon_{jit}^f ,$$

where D_{it} are bank × quarter fixed effects, and D_{jt} are borrower × quarter fixed effects. *Macro Controls* are the spot and 3-month forward exchange rate, and the difference between the GDP growth and CPI growth of the debtor currency area (*f*) and the lender currency area (*d*). *FX Spot* controls for the exchange rate as all volumes are expressed in USD. The sample period runs from 2000:Q1 to 2015:Q2 and includes lending denominated in USD, EUR, GBP, JPY, CHF, and CAD. Robust *t*-statistics are in parentheses. Standard errors are clustered at the borrower-lender level.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE VIII
LOAN ISSUANCE AND GROWTH AFTER POSITIVE SHOCK TO IOER RATE DIFFERENCE

Dependent Variable:	Probability of Getting a Loan			ΔLog(Amount)		
	All Markets	All Markets r_d Shock	Domestic Market r_d Shock	All Markets	All Markets r_d Shock	Domestic Market r_d Shock
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Bank Reliance	-0.026***	-0.018***	-0.018***	-0.228***	-0.172**	-0.238***
	(-21.18)	(-12.97)	(-10.75)	(-3.17)	(-2.18)	(-2.67)
FX Spot (USD/Foreign Currency)	--	--	--	0.089	0.080	1.124**
				(0.81)	(0.56)	(1.99)
Fixed Effects:						
Firm (D_j)	Yes	Yes	Yes	Yes	Yes	Yes
Quarter (D_t)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,294,044	1,031,249	953,504	18,868	16,217	15,474
R-squared	0.052	0.060	0.064	0.230	0.241	0.241

Note: The dependent variable in columns (1) to (3) is a dummy variable equal to 1 if the borrower *j* obtains a loan in currency *f* after a positive shock to an IOER rate differential, and 0 otherwise. (Note that the sample is *conditional* on changes in IOER for a given currency pairing.) IOER rate differential is defined as the difference between the IOER rates of the currency of lending abroad (r^f) and the currency of the country where the bank is headquartered (r^d). The dependent variable in columns (4) to (6) is the change in the log amount of granted loans in currency *f* relative to the last loan in the same currency before the monetary shock. The central explanatory variable is *Foreign Bank Reliance*, defined as the share of foreign banks from the currency area *d* in the last lending syndicate to the borrower j. For example, for an increases in $(r^{USD} - r^{JPY})$, we only look at the share of Japanese banks in the last dollar denominated loan received by the same borrower. In columns (2)–(3) and (5)–(6), the sample is constrained on quarters where the IOER difference increases due to a drop in r^d. Specifications (1)–(3) correspond to:

$$I(Loan^f)_{jt} = D_j + D_t + \beta Foreign\ Bank\ Reliance^f_{jt} + \varepsilon^f_{jt} \ ,$$

where D_j are firm fixed effects, and D_t are quarter fixed effects. *FX Spot* controls for the exchange rate as all volumes are expressed in USD. The sample period runs from 2000:Q1 to 2015:Q2 and includes lending denominated in USD, EUR, GBP, JPY, CHF, and CAD. Robust *t*-statistics are in parentheses. Standard errors are clustered at the borrower level.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE IX
DEVIATIONS FROM COVERED INTEREST RATE PARITY

Dependent Variable:	3M Basis (pp)		1Y Basis (pp)		5Y Basis (pp)	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔIOER Difference (pp)	0.098*	0.069*	0.151***	0.130***	0.125**	0.103***
	(1.91)	(1.69)	(4.11)	(5.52)	(2.57)	(3.17)
Fixed Effects						
Currency Pair (D_{fd})	--	Yes	--	Yes	--	Yes
Observations	312	312	312	312	312	312
R-squared	0.012	0.589	0.052	0.745	0.021	0.714

Note: The dependent variables are deviations from the covered interest parity, computed based on government bond yields of 3-month, 1-year, and 5-year maturities. The CIP deviations are expressed as a cost, i.e., a mark-up over the CIP-implied forward premium. $\Delta IOER$ *difference* is the quarterly change in the difference (in percentage points) between the IOER rates of the two currencies under consideration. Specifications (2), (4) and (6) correspond to:

$$Basis_{fdt} = D_{fd} + \beta\Delta\left(r_t^f - r_t^d\right) + \epsilon_{fdt} ,$$

where D_{fd} are currency-pair fixed effects. All regressions include only observations where the change in the IOER difference is nonzero. The sample period runs from 2000:Q1 to 2015:Q2 and includes all currency pairs constructed from the USD, GBP, EUR, JPY, and CHF. Robust t-statistics are in parentheses. Standard errors are clustered at the currency pair level.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

APPENDIX

A.I. IOER AS A MONETARY POLICY INSTRUMENT

Below, we provide background information for the use of interest rates on excess reserves in the six currency areas analyzed in this paper over the period of our sample, 2000:Q1 though 2015:Q2.[15]

United States—The Federal Reserve (Fed) started paying interest rates on both required reserves and excess reserves, effectively on October 9, 2008, to eliminate the opportunity cost of holding required reserves and to also help establish a lower bound on the federal funds rate. Initially set to be the lowest federal funds rate during each reserve maintenance period less 75 basis points, the formula for the IOER rate was revised several times. On October 23, 2008, and November 6, 2008, the Fed adjusted the IOER rate to be the lowest federal funds rate less 35 basis points and, subsequently, the lowest target federal funds rate over the maintenance period. On December 16, 2008, the Fed gave up the IOER rate formula based on the federal funds rate and set the IOER rate to be 0.25 percent. Finally, on December 17, 2015, the Fed increased the IOER rate to 0.5 percent.

Eurozone—In the euro area, the deposit facility rate can be effectively seen as the interest rate on excess reserves. Until October 9, 2008, the marginal lending and the deposit rates operate at the standing facilities corridor of ±100 basis points around the main refinancing rate. On October 9, 2008, the ECB reduced the corridor width to ±50 basis points around the main refinancing rate to help limit the variation in market interest rates. After market conditions normalized in early 2009, the ECB widened the corridor back to ±100 basis points on January 21, 2009, but once again narrowed the corridor to ±75 basis points. On July 11, 2012, the ECB adopted a zero deposit facility rate. The zero deposit rate regime was effective for nearly two years until June 11, 2014,

15 Sources: http://www.federalreserve.gov/pubs/ifdp/2010/996/ifdp996.pdf
http://www.boj.or.jp/en/mopo/measures/mkt_ope/oth_a/index.htm/;
https://www.snb.ch/en/iabout/monpol/id/qas_gp_ums; http://www.bis.org/publ/bppdf/bispap12u.pdf;
http://blogs.ft.com/maverecon/2008/03/how-do-the-bank-of-england-and-the-monetary-policy-committee-manage-liquidity-operational-and-constitutional-issues/#axzz3znKLoESH;
http://www.bankofengland.co.uk/markets/Documents/marketnotice081020.pdf;
https://www.boj.or.jp/en/mopo/measures/mkt_ope/oth_a/;
https://www.snb.ch/en/iabout/monpol/id/qas_gp_ums

when the ECB became the first major central bank to introduce a negative deposit rate of -0.1 percent to battle the sluggish growth and encourage bank lending. Subsequently, the ECB further reduced the deposit rate twice to its current level of -0.4 percent.

Japan—In October 2008, the Bank of Japan (BoJ) introduced its Complementary Deposit Facility as a temporary measure effectively on November 17, 2008, to facilitate the provisioning of sufficient liquidity until March 16, 2009. The interest rate was stipulated to be the targeted uncollateralized overnight call rate decided at the Monetary Policy Meeting less a spread that will be determined by the Bank. However, the Bank decided to establish simply 0.1 percent interest rate paid on the deposit facility. At the February 19, 2009, and subsequent July, 15, 2009, meetings, the BoJ decided to postpone the end date of this temporary deposit facility to December 16, 2009. Finally, on October 30, 2009, the BoJ decided to extend the period of the complementary deposit facility for the time being, and the deposit facility rate was officially set to be 0.1 percent when BoJ established the "temporary rules regarding funds-supplying operation against pooled collateral". On January 29, 2016, in a surprise move, the BoJ decided to adopt a negative deposit facility rate of -0.1%.

Switzerland—The Swiss National Bank (SNB) used not to pay interest rate on the excess reserves. The SNB implements its monetary policy by fixing a target range for its reference interest rate, the Libor rate for three-month interbank loans in Swiss francs. The target range normally has a bandwidth of 100 basis points around the Libor rate. During the financial crisis, the Libor target range was narrowed as the interest rate approached zero. On December 18, 2014, the SNB decided to charge an interest rate of -0.25% on the portion of the sight deposit account balance that exceeds a certain threshold. With the announcement of a negative interest rate, the target range for the Libor extended to its usual width of 1 percentage point. On January 15, 2015, the SNB lowered the interest rate on sight deposits to -0.75% and moved the target range downwards to between -1.25% and -0.25%.

Canada—Currently, the Bank of Canada (BoC) has no reserve requirement. However, it operates under a similar framework around Canada's Large Value Payment System, through which the BoC can pay a deposit rate on the excess cash left in the payment system. The Bank of Canada conducts its monetary policy by targeting the overnight interest rate through its operating band. The top of the band, the Bank Rate, is always 0.25 percentage points above the overnight rate target. This is the rate at which the BoC will lend money overnight to the financial institutions in the Large Value Payment systems. On the other hand, the bottom of the operating band is the interest rate on the overnight deposits at the BoC. Thus, the operating bands are no other than the lending and deposit facility rates. Under normal times, the deposit rate is 0.25 percentage points less the overnight target rate. During the crisis, however, the BoC lowered the overnight target rate to 0.25 percent, which the BoC considers to be the "effective lower bound" for the overnight interest rate, and so operated under an asymmetric operating band, with the deposit rate equal to the target rate.

U.K.—The deposit facility was introduced on June 27, 2001. The interest rate received on deposits in the facility was initially set at 1 percentage point below the main policy rate. On March 14, 2005, the ±100 basis point corridor was narrowed to ±25 basis points to stabilize the overnight rate ahead of the introduction of remunerated reserves. From May 18, 2006, to October 20, 2008, the deposit facility rate was 1 percentage point below the Bank Rate on all days except the last day of a maintenance period, when it was 0.25 percentage points below the Bank Rate. On October 20, 2008, BoE raised the rate of interest paid in its deposit facility to 0.25 percentage points below the official Bank Rate on all days of the maintenance period. Finally, on March 5, 2009, the BoE started paying interest on all reserves at the Bank Rate of 0.5 percent and also lowered the deposit rate to zero. With this change, the deposit rate became largely irrelevant for reserve-scheme participants.

TABLE A.I
DEPOSITORY OFFICES OF GLOBAL BANKS

Bank name	Country	Depository Office Currency Area: CA	CH	EA	GB	JP	US
BMO	CA	1	0	1	1	0	1
Canadian Imperial Bank of Commerce	CA	1	0	0	1	0	1
Desjardins Capital Markets	CA	1	0	1	0	0	1
National Bank of Canada	CA	1	0	0	1	0	1
RBC	CA	1	1	1	1	1	1
Scotiabank	CA	1	0	1	1	0	1
Toronto Dominion Bank	CA	1	0	1	1	0	1
Banque Cantonale de Geneve	CH	0	1	1	0	0	0
Banque Internationale de Commerce	CH	0	1	1	0	0	0
Banque de Commerce et de Placements	CH	0	1	1	0	0	0
CBI-Union Bancaire Privee	CH	0	1	1	1	0	0
Credit Suisse	CH	1	1	1	1	1	1
EFG Group	CH	0	1	1	1	0	0
UBS	CH	1	1	1	1	1	1
Bank fur Tirol und Vorarlberg	AT	0	1	1	0	0	0
Erste Bank	AT	0	0	1	1	0	1
Oesterreichische Volksbanken	AT	0	1	1	0	0	0
Raiffeisen Zentralbank Osterreich	AT	0	0	1	0	0	1
Vorarlberger Landes-und Hypotheken-bank	AT	0	1	1	0	0	0
Banque Degroof Luxembourg	BE	0	0	1	0	0	0
Dexia Bank SA	BE	0	0	1	0	0	1
KBC Group	BE	0	0	1	1	0	1
Aareal Bank	DE	0	0	1	0	0	0
Allianz [AZAG]	DE	0	0	1	0	0	0
BayernLB	DE	0	0	1	1	0	1
Berenberg Bank	DE	0	1	1	0	0	0
Commerzbank	DE	0	1	1	1	1	1
DZ Bank	DE	0	1	1	1	0	1
DekaBank Deutsche Girozentrale	DE	0	0	1	0	0	1
Deutsche Bank	DE	1	1	1	1	1	1
Deutsche Hypothekenbank	DE	0	0	1	1	0	0
HRE Group [Hypo Real Estate Holding]	DE	0	0	1	1	0	0
HSH Nordbank	DE	0	0	1	0	0	1
KfW Bankengruppe	DE	0	0	1	0	0	1
Landesbank Baden-Wurttemberg [LBBW]	DE	0	1	1	1	0	1
Landesbank Berlin [LBB]	DE	0	0	1	0	0	0
Landesbank Hessen-Thuringen GZ [Helaba]	DE	0	1	1	1	0	1
MM Warburg Hypothekenbank	DE	0	1	1	0	0	0
Maple Bank GmbH	DE	1	0	1	0	0	0
NordLB	DE	0	0	1	1	0	1
Portigon	DE	0	0	1	1	0	1
Abanca [ex-NCG Banco [Novagalicia Banco]]	ES	0	1	1	0	0	0
Banca March	ES	0	0	1	1	1	0
Banco Bilbao Vizcaya Argentaria [BBVA]	ES	0	1	1	1	0	1
Banco Santander	ES	0	1	1	1	0	1
Banco de Sabadell	ES	0	0	1	1	0	1
Bankia [Banco Financiero y de Ahorros]	ES	0	0	1	0	0	1
Caixabank	ES	0	0	1	0	0	0
Caja de Ahorros de Valencia Castellon y Alicante	ES	0	0	1	0	0	0
Caja de Ahorros del Mediterraneo [CAM]	ES	0	0	1	0	0	1
Confederacion Espanola de Cajas de Ahorros [CECA]	ES	0	0	1	1	0	0
Grupo Banco Popular	ES	0	0	1	0	0	1
AXA Group	FR	0	0	1	0	0	0

BNP Paribas	FR	1	1	1	1	1	1
CM-CIC	FR	0	1	1	1	0	1
Credit Agricole	FR	0	1	1	1	1	1
Groupe BPCE	FR	0	0	1	1	0	1
Societe Generale	FR	1	1	1	1	1	1
Union de Banques Arabes et Francaises [UBAF]	FR	0	0	1	0	1	0
Alpha Bank AE	GR	0	0	1	1	0	0
National Bank of Greece	GR	0	0	1	1	0	0
Piraeus Bank	GR	0	0	1	1	0	0
Allied Irish Banks [AIB]	IE	0	0	1	1	0	1
Bank of Ireland Group	IE	0	0	1	1	0	1
Hypo Public Finance Bank Dublin	IE	0	0	1	0	0	0
Banca Carige	IT	0	0	1	0	0	0
Banca Monte dei Paschi di Siena [MPS]	IT	0	0	1	1	0	1
Banca Popolare di Milano SCaRL [BPM]	IT	0	0	1	0	0	0
Banca Popolare di Sondrio SCRL [BPS]	IT	0	1	1	0	0	0
Banca Popolare di Vicenza SCaRL	IT	0	0	1	0	0	1
Banca Sella	IT	0	0	1	0	0	0
Banco Popolare Societa Cooperativa Scrl [BP]	IT	0	0	1	1	0	0
Cardine Banca	IT	0	0	1	0	0	0
Intesa Sanpaolo [ISP]	IT	0	1	1	1	1	1
UniCredit	IT	0	1	1	1	1	1
Banque et Caisse d'Epargne de L'Etat Luxembourg [BCEE]	LU	0	0	1	0	0	0
ABN AMRO Bank NV	NL	0	0	1	1	0	1
F van Lanschot Bankiers	NL	0	1	1	0	0	0
ING Group	NL	0	0	1	1	1	1
NIBC	NL	0	0	1	0	0	0
Rabobank	NL	1	0	1	1	0	1
Triodos Bank NV	NL	0	0	1	1	0	0
Banco BPI	PT	0	0	1	0	0	1
Banco Comercial Portugues [BCP]	PT	0	0	1	0	0	0
Banco Espirito Santo [BES]	PT	0	0	1	1	0	1
Banco Internacional do Funchal [BANIF]	PT	0	0	1	0	0	0
Caixa Economica Montepio Geral [CEMG]	PT	0	0	1	0	0	1
Caixa Geral de Depositos [CGD]	PT	0	0	1	1	0	1
Barclays	GB	1	1	1	1	1	1
HSBC	GB	1	1	1	1	1	1
Habibsons Bank	GB	0	1	1	1	0	0
Leeds Building Society	GB	0	0	1	1	0	0
Lloyds	GB	0	1	1	1	0	1
Nationwide Building Society	GB	0	0	1	1	0	0
Royal Bank of Scotland [RBS]	GB	1	1	1	1	1	1
Standard Chartered	GB	0	0	1	1	1	1
Aozora Bank	JP	0	0	0	0	1	1
Bank of Fukuoka	JP	0	0	0	0	1	1
Bank of Yokohama	JP	0	0	0	0	1	1
Chiba Bank	JP	0	0	0	1	1	1
Chugoku Bank	JP	0	0	0	0	1	1
Daiwa Securities Capital Markets	JP	0	0	0	0	1	0
Gunma Bank	JP	0	0	0	0	1	1
Hachijuni Bank	JP	0	0	0	0	1	0
Hiroshima Bank	JP	0	0	0	0	1	0
Hokkoku Bank	JP	0	0	0	0	1	0
Hokuriku Bank	JP	0	0	0	0	1	1
Hyakugo Bank	JP	0	0	0	0	1	0
Iyo Bank	JP	0	0	0	0	1	1
Joyo Bank	JP	0	0	0	0	1	1
Mitsubishi UFJ Financial Group	JP	1	1	1	1	1	1
Mizuho Financial Group	JP	1	1	1	1	1	1
Nishi-Nippon City Bank	JP	0	0	0	0	1	0
Nomura Holdings	JP	0	0	1	1	1	0
Norinchukin Bank	JP	0	0	0	1	1	1

Ogaki Kyoritsu Bank	JP	0	0	0	0	1	0
Resona Holdings	JP	0	0	0	0	1	0
San-In Godo Bank	JP	0	0	0	0	1	0
Shinkin Central Bank	JP	0	0	0	0	1	1
Shinsei Bank	JP	0	0	0	0	1	0
Shizuoka Bank	JP	0	0	0	0	1	1
Shoko Chukin Bank	JP	0	0	0	0	1	1
Sumitomo Mitsui Financial Group	JP	1	0	1	1	1	1
Sumitomo Mitsui Trust Holdings	JP	0	0	1	1	1	1
AIG Private Bank	US	0	0	0	0	0	1
American Express Co	US	0	0	0	0	0	1
Bank of America Merrill Lynch	US	1	0	1	1	1	1
Bank of New York Mellon	US	1	0	1	1	1	1
Brown Brothers Harriman	US	0	0	1	0	0	1
CIT Group	US	0	0	0	0	0	1
Capital One Financial	US	1	0	0	0	0	1
Caterpillar Financial Services	US	0	0	1	0	0	1
Citi	US	1	1	1	1	1	1
Comerica	US	1	0	0	0	0	1
Fifth Third Bank	US	1	0	0	0	0	1
First National Bank	US	0	0	0	0	0	1
General Electric Capital	US	0	1	1	1	0	1
Goldman Sachs	US	0	1	1	1	1	1
IBM Credit	US	0	0	1	0	0	1
JP Morgan	US	1	1	1	1	1	1
Leumi Group	US	0	1	1	1	0	1
Morgan Stanley	US	0	1	1	1	1	1
M&T Bank	US	1	0	0	0	0	1
Northern Trust	US	1	0	1	1	0	1
PNC Bank	US	1	0	0	0	0	1
Silicon Valley Bancshares	US	0	0	0	1	0	1
State Street Bank	US	1	1	1	1	1	1
US Bancorp	US	1	0	0	1	0	1
United Bank	US	0	0	0	0	0	1
United National Bank	US	0	0	0	1	0	1
Wells Fargo	US	1	0	1	1	1	1
Wintrust Financial	US	0	0	0	0	0	1

Note: This table shows the names of the global banks in the sample, the country where each bank is headquartered, and its foreign depository offices (subsidiaries or branches) as of 2015:Q2. The sample includes banks headquartered in CA, CH, EA, UK, JP and US. The depository office information was retrieved from the national central banks and other national authorities for our sample period in quarterly frequency, for all banks except foreign banks in the Eurozone and foreign banks in Japan, in which case only the list of foreign banks in 2015 is available.

TABLE A.II
FOREIGN HOLDINGS OF U.S. TREASURY DEBT SECURITIES

Dependent Variable:	Total U.S. Treasury Debt		Short-Term Debt		Long-Term Debt	
	(1)	(2)	(3)	(4)	(5)	(6)
IOER Difference (pp)	0.158***	0.627***	-0.062	0.282***	0.203***	0.713***
	(3.02)	(4.27)	(-1.28)	(3.08)	(3.14)	(4.12)
Fixed Effects:						
Month *(D_t)*	Yes	Yes	Yes	Yes	Yes	Yes
Investor Currency Area *(D_d)*	Yes	Yes	Yes	Yes	Yes	Yes
Macro Controls:	--	Yes	--	Yes	--	Yes
Observations	220	176	220	176	220	176
R-squared	0.995	0.997	0.980	0.987	0.994	0.996

Note: The data used in this table is from the Treasury International Capital (TIC) System. This dependent variables are (the logarithm of) U.S. treasury debt securities held by foreigners (including private and official sector). The data is monthly, and the sample period runs from September 2011 to June 2015 and includes holdings by the Eurozone, United Kingdom, Japan, Switzerland, and Canada. The independent variable *IOER Difference* is the difference (in percentage points) between the IOER rate of the U.S. (r^{US}) and the country where the investors' currency area (r^{d}). Specification (2), (4), and (6) include the tightest set of controls; specification (2) corresponds to:

$$Total\ U.S.Treasury\ Debt_{dt} = D_d + D_t + \beta(r_t^{US} - r_t^{d}) + Macro\ Controls_t^{US/d} + \epsilon_{dt}\ ,$$

where D_d are investor's currency area fixed effects, and D_t are month fixed effects. *Macro Controls* are the spot and 3M forward exchange rate, and the difference between the GDP growth and CPI growth of United States and the foreign currency area. Robust *t*-statistics are in parentheses and based on standard errors clustered at the month level.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE A.III
SHARE OF FOREIGN CURRENCY LENDING: USD VS. NON-USD DENOMINATIONS

Dependent Variable:	Share of Foreign Currency Lending (Loan Volume)		Share of Foreign Currency Lending (Number of Loans)	
	USD Loans	Non-USD Loans	USD Loans	Non-USD Loans
	(1)	(2)	(3)	(4)
IOER Difference (pp)	-3.099***	-1.035***	-2.682***	-0.249
	(-4.63)	(-3.35)	(-4.88)	(-0.81)
Fixed Effects:				
Bank (D_i)	Yes	Yes	Yes	Yes
Quarter (D_t)	Yes	Yes	Yes	Yes
Observations	3,865	5,903	3,865	5,903
R-squared	0.577	0.308	0.514	0.250

Note: The results reported here are an extension of the analysis reported in Table V. The dependent variable is the share of lending (in percent) in a given foreign currency relative to the sum of lending in the domestic and the given foreign currency. Each observation in the analysis is bank (i) × foreign currency (f) × quarter (t). *IOER Difference* is the difference (in percentage points) between the IOER rates in the foreign currency (r^f) and the currency of the country where the bank is headquartered (r^d). The sample in columns (1) and (3) contains only USD loans, i.e. $f = USD$. The sample in column (2) and (4) contains only non-USD loans. (Column (2) also includes a control for the exchange rate (not reported), as all volumes are expressed in USD). The sample period runs from 2000:Q1 to 2015:Q2 and includes lending denominated in USD, EUR, GBP, JPY, CHF, and CAD. Robust *t*-statistics are in parentheses. Standard errors are clustered at the quarter level.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.