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Falk Bräuning
Victoria Ivashina

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ABSTRACT

Global banks use their global balance sheets to respond to local monetary policy. However, sources and uses of funds are often denominated in different currencies. This leads to a foreign exchange (FX) exposure that banks need to hedge. If cross-currency flows are large, the hedging cost increases, diminishing the return on lending in foreign currency. We show that, in response to domestic monetary policy easing, global banks increase their foreign reserves in currency areas with the highest interest rate, while decreasing lending in these markets. We also find an increase in FX hedging activity and its rising cost, as manifested in violations of covered interest rate parity.

Falk Bräuning
Federal Reserve Bank of Boston
600 Atlantic Avenue
Boston, MA 02210
Falk.Braeuning@bos.frb.org

Victoria Ivashina
Harvard Business School
Baker Library 233
Soldiers Field
Boston, MA 02163
and NBER
vivashina@hbs.edu

I. INTRODUCTION

Foreign ("global") banks play an important role in many countries. According to the Bank for International Settlements (BIS), as of June 2015, European and Japanese banks' claims on U.S. nonbank firms were USD 1.61 and 0.72 trillion, respectively. DealScan data indicate 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 the equivalent of USD 0.74 and 0.11 trillion in claims on European and Japanese nonbank companies, respectively. More generally, it is estimated that foreign banks account for about 10 percent of the assets of the French and Italian banking sectors (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) show that global banks actively use fund transfers from their foreign offices to respond to local monetary policy shocks. For example, when the Fed tightens monetary conditions, banks operating in the United States increase their borrowing from their offices in other countries. However, the previous literature overlooks the fact that funding raised through this channel is likely to be denominated in a different currency than the assets that banks intend to fund.[1] Given that such a currency mismatch is typically fully hedged by banks, their use of cross-border internal funding markets is tied to the use of foreign exchange (FX) swaps, a simultaneous spot purchase and forward sale of foreign currency. If the capital flows triggered by monetary policy changes are large, the forward premium (the percentage difference between the forward and spot exchange rates) will rise, increasing the cost of cross-currency (synthetic) funding. This, in turn, will affect the relative attractiveness of lending in different currencies.

The effect of banks' internal capital reallocation on the cost of synthetic funding is further magnified by the banks' global approach to their liquidity management. The intuition is the same: monetary policy changes trigger a cross-border/cross-currency liquidity flow in the

[1] Much of the global banks' funding is denominated in domestic currency. Based on the currency breakdown of bank funding reported in the SNL Financial Database, in 2015, on average 83 percent of all bank deposits were denominated in domestic currency. These data are available for 56 banks from the major currency areas, which include the Eurozone, the United Kingdom, and Switzerland.

direction of the higher interest rate regime, further increasing the swapping activity as well as its marginal cost. Overall, for a capital-constrained bank, an increase in the interest rate differential between foreign and domestic currency would lead to a reduction in foreign lending and a redeployment of capital to an expansion in domestic lending. In the next section, we formalize this basic intuition in a simple model and derive testable predictions that guide the empirical analysis.

Our empirical results can be divided into two parts: (i) aggregate macro evidence and (ii) firm- and loan-level evidence. We start by looking at the Call Report data and point out the substantial cross-country variation in foreign banks' reserve holdings. We show a strong positive relationship between the reserves held by foreign banks at the Fed and the difference in the interest on excess reserves (IOER) rate between the United States and the country where the foreign bank is headquartered. Our estimates suggest that an increase in the IOER rate differential of 25 basis points is associated with an 18 percent increase in deposits held at the Fed. In line with the mechanism of the model, we also show that foreign banks in the United States that are headquartered in countries where the interest rate has been lower increase their internal capital reallocation from their foreign offices toward their U.S. offices and reduce their lending to firms in the United States by up to 10 percent per 25-basis-point increase in the IOER difference.

Using data from the BIS, we show that similar patterns emerge in a cross-country setting: there is a reduction of cross-border bank claims on foreign firms of 2.5 percent and a rise in cross-border claims on the foreign official sector of 6 percent for a 25-basis-point increase in the IOER rate differential between the foreign country and the banks' home country.[2] In line with the transmission mechanism conjectured in this paper, BIS FX swap volume data indicate a sizable increase in banks' swapping activity into high-yield currencies and an increase in the cost of the FX hedge in response to monetary policy easing in the banks' home country. (All results in the paper are robust to other measures of monetary policy, including the overnight interbank rate or government bond yields.)

Our second set of results is based on loan-level data, which are crucial for a tight identification of the mechanism at play. For this purpose, we employ data on syndicated loan

[2] Global liquidity management would likely apply only to stable currency areas. Our cross-country analysis includes six major currency areas: the United States, the Eurozone, the United Kingdom, Japan, Switzerland, and Canada.

originations by 166 major global banks in six major currencies from 2000 to 2015. At the bank level, we find that, in a given quarter, there is a larger contraction in credit in currencies that carry a higher IOER differential with respect to the bank's home country. With regard to lending volume, a 25-basis-point increase in the IOER rate difference is associated with a roughly 1-percentage-point reduction in lending in foreign currency (relative to the bank's lending in both foreign and domestic currency). The impact on the lending share based on the number of loans is equally sizable. In line with our mechanism, the effect of the IOER rate differential on foreign-currency lending is particularly strong for banks with a low equity-to-assets ratio.

A similar picture arises from the bank-firm-level regressions. We see that—among foreign banks—the propensity to lend (extensive margin) and the size of the loan commitment (intensive margin) relate negatively to the difference in interest rates set by the monetary authorities in the host country and the bank's home country. In particular, after controlling for borrower-quarter and lender-quarter fixed effects, we find a roughly 1 percent decline in the probability of lending and about a 3 percent reduction in lending volume for a 25-basis-point differential in IOER. Because loans in our sample are syndicated, each loan has several banks with large commitments. This set-up allows us to include both borrower-quarter and lender-quarter fixed effects, which account for loan demand factors and 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.

We also estimate changes in aggregate credit supply at the domestic-firm level after foreign monetary policy shocks, to analyze whether the reduction in credit is binding for the individual firm. We find that firms that, in the past, had a larger share of foreign global banks in the syndicate (and that subsequently experienced an easing monetary policy shock in their home country) face a stronger contraction in credit than other firms. Economically, we estimate that a one-standard-deviation increase in the past share of foreign global banks is associated with a 6.5 percent lower probability of obtaining a loan, and with a 4 percent reduction in the volume of granted loans after an expansionary monetary policy shock in the foreign bank's home country.

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 of 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). Both papers build on the conceptual framework of Kashyap and Stein (2000) to 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 expand the internal capital market mechanism by taking into consideration differences between funding and investment currency. This insight reveals a more complex effect on lending in domestic and foreign markets due to the effects on the foreign exchange market of global banks' capital movement.

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. Unlike Ivashina, Scharfstein, and Stein (2015), we do not rely on the limits to arbitrage in the FX market, but—although, we do not articulate this formally—our results would be consistent with frictions in the FX market. Indeed, as part of the aggregate results, we show that changes in the difference in interest on excess reserves between two major currency areas are related to the violation of covered interest 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 has an effect primarily on credit supply in the domestic currency. They hypothesize that this is because the cost of funding in a given currency is influenced by that currency area's monetary authority, in a mechanism different 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 present evidence that monetary policy and FX markets are interconnected. In Section V, we conclude.

II. MODEL

Consider a global bank that has investment opportunities in 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 $h(\cdot)$ is a concave function. In addition to the lending opportunities, the bank can hold an amount R^d of reserves at the domestic central bank; these reserves yield a constant return 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 and earn a rate r^f at time t_1.[3] 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.[4] 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 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. It is

[3] Central bank reserves are the narrowest definition of a reserve asset, with a return that is directly set by the central bank and not subject to any counterparty risk or market price fluctuations, such as those present in government bonds or interbank assets. It is, however, important to highlight that the proposed mechanism holds for reserve assets more broadly.

[4] We take as given that the depository base is primarily denominated in domestic currency. However, in the Appendix we extend our model to allow for wholesale funding in foreign currency. While the main predictions of the model do not change by the inclusion of foreign deposits, this allows us to derive additional comparative statics that we can test in the data.

worthwhile to emphasize 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. Banks typically hedge this currency mismatch using FX swaps (Fender and McGuire 2010).[5] 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. Such a swap position 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 percentage difference between the forward and spot FX rate). However, if the capacity to take the other side of the swap transaction is limited, for example, by capital-constrained counterparties, this leads to an increasing marginal cost of swapping. Following Ivashina, Scharfstein, and Stein (2015), we consider an arbitrageur who has to set aside a haircut proportional to the size of his swap position. Because the arbitrageur is capital constrained, he has to divert resources from another productive activity. In doing so, he demands an increasing return for entering the forward transaction, which increases the bank's cost of swapping. We model the cost of a swap position of size *S* by *c(S)*, where *c(S)* is a convex function with *c'(S)*>0. That is, the bank faces a higher cost of swapping as the size of the position increases.[6]

The global bank maximizes profits by choosing the amount of domestic deposits, the amount of swapping, 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 $\{R^d,$ *Ld, Rf, Lf, S, Dd}* to maximize

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

[5] BIS data show that FX swaps are the most actively traded foreign exchange derivative, with banks accounting for more than 75 percent of the turnover.

[6] The FX swap market is highly concentrated toward global banks. According to the Euromoney Survey, the top 10 banks in terms of volume accounted for about two-thirds of all FX swap activity in 2016, with the top three banks (Citi, Deutsche Bank, and UBS) accounting for more than 30 percent. It is hence reasonable to assume that global banks' cross-currency flows affect the cost of swapping.

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 $S - R^f - L^f = 0$; that is, 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 balance sheet 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 paid on reserves in the two currencies:

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

Therefore, the interest rate differential between the two deposit facility rates determines the optimal amount of funds swapped into the foreign currency.[7] 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:

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

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

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 foreign and domestic lending to reflect the new relative returns set by the two deposit facility rates. Thus, the amount of lending denominated in foreign currency (the foreign market) depends on both the foreign and the domestic interest rate on reserves. Note that the amount of reserves does not affect the bank's lending decision.

We can use the first-order conditions to derive several comparative statics. In particular, using equation (10) and the capital constraint, we obtain

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

the bank's foreign lending as a decreasing function of the interest rate differential, and, similarly, for lending in the domestic currency,

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

Lending in the foreign currency decreases in response to a greater difference between the foreign and domestic rates paid on reserves, while domestic lending increases. This 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 swap activity from the domestic into the foreign currency increases with 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 interest rates paid on reserves,

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

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

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

As an example, let's consider that the bank's domestic central bank decreases its interest paid on excess reserves (Δr increases). All else held constant, the global bank will decrease its domestic depository base to maintain equality between the marginal return of its assets and the marginal cost of raising deposits. Moreover, the bank will hold less reserves at the domestic central bank due to the lower interest rate and, consequently, will lend more domestically as the opportunity cost of lending decreases. This result does not depend on the foreign rate on reserves and would hold even for banks that do not have access to deposits with a foreign central bank.

Importantly, a decrease in the domestic interest rate paid on reserves makes deposits with the foreign central bank more attractive. In turn, the global bank that has access to both deposit facilities allocates less money to reserve assets denominated in the domestic currency and increases the swap amount to fund reserve holdings at the foreign central bank. The increased marginal cost of swapping would consequently make lending abroad relatively less attractive, leading to a contraction in lending in foreign currency, with the bank's capital used to expand lending in domestic currency. Both effects—shift into foreign reserve assets and contraction in lending in foreign currency—happen absent any policy movement by the foreign central bank.

While an increase in foreign reserve holdings is a direct consequence of the higher interest rate differential, the lower lending in foreign currency results from an interaction between the increased interest rate differential and the binding capital constraint. Absent the binding capital constraint, the bank would simply increase its domestic lending to equate the marginal return on its domestic lending to the lower domestic rate on reserves. However, with a binding capital constraint, this equality does not hold. Instead, the bank responds to an increased cost of swapping into a foreign currency by reallocating capital from lending in foreign currency to lending in domestic currency. This rebalancing of the lending portfolio is also reflected in the share of foreign currency relative to total lending, which is decreasing in the IOER rate differential, as $\partial(L^f/((L^f + L^d))/\partial \Delta r < 0$.

III. Empirical Results

In this section, we empirically test the predictions of our model that global banks increase foreign reserve holdings and decrease foreign-currency lending as the interest rate differential between the foreign and domestic central bank increases. We test the model's predictions using a diverse array of macro-, bank-, and loan-level data from different sources. We explain the data along with the discussion of the results. In what follows, we use "foreign" and "domestic" as the terms were defined in the model; that is, with respect to the headquarters location of the lender.

The central explanatory variable in our analysis is the difference in interest rates set by monetary policy in two major currency areas. As a benchmark, we look at the *IOER difference* ($\Delta r = r^f - r^d$), 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 ($IOER^d$).[8] In the main part of our analysis, we focus on interest rates paid on excess reserves by central banks in six major currency areas—the United States, the Eurozone, the United Kingdom, Japan, Switzerland, and Canada—and global banks and borrowers headquartered in these markets. Table I shows changes in the interest rate paid on excess reserves by the U.S. Federal Reserve, the European Central Bank, the Bank of Canada, the Bank of England, the Swiss National Bank, and the Bank of Japan, from 2000 to 2015. The table lists all the dates on which at least one of the above central banks changed its rate. (In the Appendix, we also provide background information on the use of IOER as a monetary policy tool by these six monetary authorities.) In the regressions at a quarterly frequency, we take the quarterly average of the daily IOER rate differentials.

A. Aggregate Evidence: 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. Using these data, we can see that the introduction of the interest rate paid on excess reserves in the United States led to a large inflow of foreign bank capital into the U.S. central banking system. As Figure I shows, at

[8] With large amounts of excess reserves, central banks operate under an effective floor system, where the interest rate paid on excess reserves is the main tool for controlling short-term market interest rates. We therefore use the IOER rate as the main policy variable, but show that our results are robust to alternative monetary policy measures, such as the overnight interbank rate.

its highest point, foreign banks' reserve holdings were USD 1.2 trillion or more than 50 percent of all reserves.[9] Importantly, as Figure II illustrates, there is a strong positive correlation between the reserves held with the 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.

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. Each observation in Figure II corresponds to a foreign banking sector-quarter (for example, the total of Japanese banks' deposits at the Federal Reserve Banks in a given quarter). For the analysis of the reserves, we were able to collect data for foreign banks from 16 currency areas for the period from 2000:Q1 to 2015:Q2. To highlight the role of differences in the IOER rates of the U.S. and the foreign-currency area, we look at quarters 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, highlighting that foreign banks that face a higher interest rate differential hold more dollar liquidity at the Fed.

Table II, column (1) relates to the point illustrated in Figure II, but instead looks at (the logarithm of) reserve holdings at the individual-bank level. Branches and subsidiaries are aggregated at the high-holder level. We also focus on the period after 2008:Q3, when the Federal Reserve introduced the IOER policy and abundant excess reserves were available in the system.[10] 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. Tables II and III are divided into three panels that present results for alternative measures of monetary policy: IOER difference (upper panel), overnight rate difference, and the three-month Treasury yield difference (lower panel). The discussion of the results focuses on the IOER difference, but the results are robust to the use of alternative measures.

[9] As explained in McCauley and McGuire (2014), this specific episode 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. Our focus is on the variation *within* foreign banks at a given point in time, and our results are not driven by this anomaly, as they hold: (i) for different subperiods, (ii) in the cross sections, and (iii) for currencies other than U.S. dollars.

[10] The Fed's introduction of the positive interest rate paid on reserves in October 2008 was not a policy tightening, but was intended as an additional policy tool to stabilize short-term interest rates given the large supply of reserves.

Table II, 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. For example, bank fixed effects control for any differences among foreign banks operating in the United States primarily through subsidiaries versus branches. 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. Quarter fixed effects net out any common time-varying factors, such as an increase in the total supply of reserves or changes in the 2011 FDIC assessment base that led to the surge in foreign banks' reserves held at the Federal Reserve. Based on our estimates, an increase in the IOER rate differential of 25 basis points increases the dollar deposits at the Federal Reserve by 18 percent.

Similarly, we find that foreign banks operating in the United States increase their holdings of U.S. Treasuries if the interest rate differential between the Fed and the central bank in their home country increases. In column (4), which includes both bank and time fixed effects, we estimate an increase in Treasury holdings of 10 percent per 25-basis-point increase in the IOER difference. In columns (5) through (8), we analyze the extent to which foreign banks adjust their U.S. lending in response to changes in the IOER rate differential. In line with our conjectured mechanism, we find that an increase in the difference of the interest rate on reserves is associated with a strong cutback in both commercial and industrial (C&I) loans (to U.S. addressees) and total loans and leases. We estimate that a 25-basis-points-higher interest rate differential is associated with a decrease in the dollar amount of C&I loans of about 10 percent, while the dollar amount of total loans and leases decreases by about 12 percent.[11]

In Table III, we look at the funding side of the balance sheet. We first use the Call Reports data to analyze internal capital flows between U.S. branches and the foreign offices of foreign global banks ("net due to" and "net due from"). The results are reported in columns (1) through (4) and are consistent with the theory of internal capital markets that banks actively reallocate funds to smooth out local shocks, such as a monetary tightening in the United States. The

[11] While we use the interest rate differential based on the IOER rate as the benchmark case, Table II shows that the results are robust to alternative interest rate differentials based on the overnight interbank rate and the three-month government bond yield, which are closely linked to the IOER rate set by the central bank.

coefficient estimate in column (2) indicates that U.S. branches of global banks that face a 25-basis-points-higher IOER rate differential will reduce the net due from their head office (internal lending) by about 38 percent. At the same time, column (4) shows that U.S. branches increase their net due to their respective head offices (internal borrowing) by about 17 percent. Together, these results suggest a strong internal capital reallocation toward the U.S. offices of global banks in response to an increase in the interest rate differential between the United States and the country where the bank is headquartered.[12]

In Table III, we also look at the volume and cost of FX swaps. Such information is not available from the bank-level Call Reports, and we therefore use, in columns (5) to (6), data on FX swap volumes that are obtained from the FX Volume Survey of the Federal Reserve Bank of New York. Twice a year, these data report the monthly currency-pair-level FX swap volumes by reporting dealers. The results in column (6) indicate that as a response to a 25-basis-point increase in the IOER difference between the U.S. dollar and the foreign currency, the swap volume into U.S. dollars increases by about 3.5 percent. Along with the increase in the swap volume, we also document in columns (7) and (8) an increase in the cost of swapping, as measured by the one-year forward premium (results are similar if we look at the forward premium at other maturities). As Table III shows, the results are robust to alternative measures of interest rate differentials.

B. Aggregate Evidence: Cross-Country Setting

We next provide evidence that differences in monetary policy rates impact global banks' portfolio allocations—in particular, credit supply to foreign firms and holdings of foreign reserve assets—in a cross-country setting. The cross-country analysis reported in Tables IV and V is based primarily on the BIS Consolidated Banking Statistics, which provide quarterly data on cross-border bank claims on private, nonbank counterparties (firms), as well as on claims on the official sector (including the central banks). Holdings are disaggregated by currency area and are available for a large set of foreign banking sectors. The data are hence at the banking-sector, currency-area, quarter level. For instance, we look at the claims by all Eurozone banks on all

[12] The estimated changes in reserve assets, lending, and internal capital reallocation of foreign banks in the United States are qualitatively similar, but quantitatively significantly smaller in the period before the United States introduced the interest on reserves policy in 2008:Q4 and abundant reserves were available in the system.

U.S. firms and the U.S. official sector for each quarter from 2005:Q1 to 2015:Q2. As before, we focus on global banks from (and counterparties in) the six major currency areas—the United States, Eurozone, United Kingdom, Japan, Switzerland, and Canada. One caveat is 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 the high level of aggregation does not allow us to separate claims on the domestic central bank (deposits) from claims on the government (for example, government bonds). However, both central banks and governments issue reserve assets that can trigger large cross-border flows of liquidity.

Table IV reports the means and standard deviations of cross-border claims by different banking sectors on the official sectors of the six major currency areas. The sample period runs from 2005:Q1 through 2015:Q2. (Claims are expressed in billions of 2015:Q2 U.S. dollars.) As one would expect, there are sizable holdings of claims by foreign banks on the official sector of the United States, with an average volume of USD 1.12 trillion during our sample period. However, Table IV 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 foreign holdings of reserve assets are 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 swap market.

In Table V, columns (1) and (2), we estimate the effect of the interest rate differential between the foreign-currency area and the domestic-currency area on the domestic banking sector's claims on foreign firms. In line with our previous findings on U.S. reserve holdings by non-U.S. banks, we find that banks from currency areas with a lower interest rate hold fewer claims against (nonbank) firms in the foreign-currency area with a higher interest rate.[13] This result also holds when we look at the variation of claims on a given foreign-currency area *within* the same quarter and control for banking-sector fixed effects; see column (2). Our estimates indicate that banks from a currency area with a 25-basis-points-lower IOER rate than the foreign-currency area hold 2.6 percent less in claims on foreign firms. The results, based on the

[13] In line with the analysis in Tables II and III, we include in the analysis only claims on and by the United States from 2008:Q4 onward, when the Fed started paying interest on reserves.

overnight rate difference and the three-month Treasury yield difference, are quantitatively similar. Note that specification (1) includes the USD spot rate, as all volumes are reported in USD irrespective of the original currency denomination of the claims.

In columns (3) and (4), we look at the claims of domestic banks on the foreign official sectors. Consistent with our model and our previous findings for the United States, we confirm that banks from currency areas that face a higher interest rate differential with respect to the foreign-currency area of the counterparty hold more claims on the foreign official sector, including the central bank and the government. This result holds when we control for banking-sector fixed effects and look at the variation of cross-border claims within a given currency area and quarter; see column (4). Quantitatively, we estimate that a 25-basis-point increase in the IOER rate difference increases the claims on the foreign official sector by about 6 percent. Again, the results are similar using alternative interest rate differentials based on the overnight interbank lending rate and the three-month Treasury yield.

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 to compute the FX swap volumes for each currency as the difference between total assets and total liabilities held in each foreign currency by the banking sector of each domestic-currency area.[14] Hence, the data are at the banking-sector, currency, quarter level. For instance, we compute for all Eurozone banks the difference between their USD assets and their USD liabilities in a given quarter.

As columns (5) and (6) show—and consistent with our theoretical prediction—an increase in the interest rate differential between the foreign-currency and the home-currency area of the banking sector leads to a higher FX swap volume into the high-yield, carry-trade currency. Our strongest results in column (6) indicate that a 25-basis-point increase in the interest rate differential increases the FX swap volume by a sizable amount of about USD 3.2 billion (or 6.6 percent relative to the median swap size of USD 48.1 billion across all currencies in the sample).

[14] Data on the currency breakdown of total assets and liabilities are consistently available only from 2012:Q2 onward and for USD, EUR, JPY, GBP, and CHF, and for reporting banks from the Eurozone, Japan, United Kingdom, Switzerland, and Canada. The difference in data availability explains the change in the number of observations in columns (5) to (8).

In columns (7) and (8), we show that the increase in the demand for FX swaps by banks is accompanied by an increase in the cost of hedging currency risk. Specifically, we find that the cost of the FX swap—as measured by the one-year forward premium—increases by about 30 basis points per 25-basis-point increase in the IOER differential. Results are similar if we use the forward premium at other maturities. All findings are robust to other measures of interest rate differentials presented in separate panels.

In line with the model's predictions, these results confirm that our findings for the United States also hold in a cross-country setting: domestic banks from currency areas with a lower interest rate (that is, a higher interest rate differential vis-à-vis the foreign-currency area) increase their cross-border claims on the foreign official sector (central bank and government), move capital into the foreign currency at a rising hedging cost, and reduce their cross-border credit to foreign firms.

Our key finding that cross-border lending decreases after an increase in the interest rate differential is also illustrated in Figure III, which shows the quarterly change in claims on foreign firms by domestic banks in the periods surrounding an increase in the IOER rate difference between the currency area of the foreign firms and the currency area of the domestic banks. As the figure highlights, after an increase in the IOER rate difference, the mean cross-border 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. Micro Evidence on 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 (bank, firm, and loan) level, which allows us to control better for confounding effects. To do so, we use data on syndicated loan originations from Thomson Reuters DealScan. In these data, we can observe the currency denomination of the loans, and we look at loans denominated in U.S. dollars (USD), euro (EUR), British pounds (GBP), Japanese yen (JPY), Swiss francs (CHF), and Canadian dollars (CAD) made by global banks from the United States, the Eurozone, the United Kingdom, Japan, Switzerland, and Canada to firms located in these currency areas. The sample covers the period from 2000:Q1 to 2015:Q2 and is limited to banks with large loan commitments, which we

identify based on the roles they receive in the lending syndicate as reported by DealScan.[15] Our final sample contains 166 global banks with foreign offices in at least one of the six currency areas, and we look at their lending in foreign currencies where they have foreign offices in the corresponding currency area. (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.

C.1 Bank-Level Evidence

In Table VI, we look at the share of a bank's lending in a given foreign currency as a fraction of the sum of its lending in the domestic currency and its lending in the given foreign currency. In terms of the notation used in the previous section, we are looking at $L^f/(L^f + L^d)$. Hence, the regressions in Table V are based on observations at the bank-currency-quarter level. For example, for a Japanese bank lending in U.S. dollars, the dependent variable is lending in U.S. dollars as a fraction of the sum of lending in U.S. dollars and lending in yen. The explanatory variable in this case would be $(IOER^{USD} - IOER^{JPY})$. We analyze the share based on the volume of lending in columns (1) to (4), and the share based on the number of loans in columns (5) to (8). 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.

The results using the number of loans are mechanically sensitive to spot FX fluctuations. To construct the volume-based 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, the specifications based on 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: loans reported during quarters with a weaker U.S.

[15] 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."

dollar—a higher value of *Spot FX rate (USD)*—have higher foreign-currency loan amounts when expressed in U.S. dollars.

Consistent with our hypothesis, we find that global banks lend less (more) in foreign currencies that are associated with a higher (lower) interest rate. The coefficients in Table VI, column (1) indicate that a 25-basis-point increase in the IOER rate difference is associated with a 0.8-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 2 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 0.6 percentage points as a response to an increase in the IOER rate differential of 25 basis points (or a decline of about 2 percent relative to the average share of 35 percentage points).[16]

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 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 (in percent) in the previous reporting year.[17] In line with our model prediction, we find that the IOER rate difference has a larger effect on the foreign lending of banks with low capital. For example, a bank with an equity ratio of 2.46 percentage points (one standard deviation) below the sample mean of 5.32 percent cuts down the share of lending in a given currency by an additional 1 percent (an additional reduction of 0.9 percentage points relative to the average share of 33.96 percentage points) as a response to an increase in the IOER rate differential of 25 basis points; see column (2). On the other hand, the effect of the interest rate differential is significantly muted for banks with an equity ratio above the mean. In fact, for a bank with an equity ratio of two

[16] 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. Moreover, in Appendix Table II, we show that the results are robust to the exclusion of USD-denominated loans. Hence, the mechanism is not confined to the United States, although the economic effects are strongest for USD-denominated loans.

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

standard deviations above the mean, the IOER rate differential has no significant impact on its foreign lending.

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 therefore condition our sample to borrowers headquartered in the foreign-currency area (for example, 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 (that is, 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 25-basis-point increase in *IOER difference* is associated with a 0.73-percentage-point decrease in the lending volume share. Relative to the average share of 37.16 percentage points, this is a reduction of about 2 percent. Column (7) points to a reduction of 1.5 percent (relative to the average share of 30.72 percentage points), due to an increase in the interest rate differential of 25 basis points.

Finally, in columns (4) and (8), we condition the sample to lending to foreign borrowers, but consider only quarters after a change in the IOER rate difference triggered by a monetary policy change in the IOER rate paid in the domestic currency of the banks (for example, 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 1.88 percentage points per 25-basis-point increase in the interest rate differential (which equals 5.5 percent when compared with the mean share of 34.2 percentage points).

C.2 Borrower-Level Evidence: Foreign-Bank Lending

The results presented so far are consistent with the "swap channel" proposed in this paper, but they could also be reflecting a shift in demand for credit if investment opportunities of foreign borrowers are correlated with the monetary policy movements in banks' home countries. 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—and a subsequent rise in the $IOER^{USD}$ (drop in *IOER difference*)—would improve the investment opportunities of such

foreign borrowers and lead to an expansion in foreign credit by U.S. banks.[18] Alternatively, to the degree that easing monetary policy (a rise in the *IOER difference*) is a response to a negative shock to the domestic banking sector, we would expect retrenchment of foreign lending activities similar to that shown in Peek and Rosengren (1997, 2000), and potentially a substitution toward domestic lending as in Giannetti and Laeven (2012). To strengthen the identification of the proposed channel, we look at lending to individual borrowers (Table VIII) and at differential lending behavior of banks within a given loan (Table VII). This addresses credit-demand issues. To separate our channel from other aggregate forces that might be at work, we control in addition for bank-quarter-level effects, and focus exclusively on across-currency (and currency-zone) variation in a given bank lending behavior within the same quarter.

In Table VII, the unit of observation is borrower-lender quarter. In the tightest specification, we control for time-varying, bank-specific characteristics by including bank-quarter fixed effects (D_{it}). These fixed effects are identified from different loan commitments in the same quarter by the same bank. In addition, we control for time-varying firm characteristics by including firm-quarter fixed effects (D_{jt}). That is, we compare the lending behavior in the same quarter to the same borrower across banks from different currency areas. Inclusion of these fixed effects is possible because loans are syndicated, and there are multiple lenders to the same firm in the same quarter.[19] 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 loan origination 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.

[18] Note that it would also increase investment opportunities of the U.S. firms; hence, the overall effect in this case is actually not clear.

[19] As background, this setting is comparable to analysis using credit registry data commonly employed in the empirical banking literature to identify credit supply effects. In both cases, the idea is to use within-borrower variation in behavior across different creditors. While a credit registry has a complete coverage of loans, it cannot be used in a cross-country setting. The additional advantage of the syndicated loan data is that we know for a fact that all banks in the syndicate receive exactly the same terms in and out of bankruptcy.

In Table VII, columns (1) to (5) refer to the linear probability models for the extensive margin of credit. We estimate linear probability models due to the presence of a large set of fixed effects. In column (1), where we control for borrower, lender, and time fixed effects, we find that a 25-basis-point increase in the IOER rate difference is associated with a 3.4-basis-point-lower probability of lending (1.2 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.[20] 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; that is, we analyze the within-bank variation in the same quarter and again find the interest rate differential has a negative effect (although the estimated 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 control for borrower-quarter fixed effects to control for time-varying borrower characteristics. Given that the vast majority of borrowers have only one loan per quarter, borrower-quarter fixed effects effectively resemble loan fixed effects. 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 25-basis-point increase in the interest rate differential amounts to a reduction in the probability of lending of about 2.4 basis points (a decline of 0.85 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 a three-month forward rate, and the differences in GDP growth, CPI growth, and the unemployment rate as additional variables.

In columns (6) to (10), we analyze the effect of the monetary policy differential on (the logarithm of) the loan amount provided at the borrower-lender level in a given currency in a given quarter. Again, we start by controlling for lender, borrower, and time fixed effects in

[20] Circumstances in which the same borrower obtains more than one syndicated loan per quarter are rare. In such circumstances, we aggregate the loan volume.

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 of about 3.2 percent for an IOER rate differential of 25 basis points. Once again, the 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 a three-month forward rate, and the differences in GDP growth, CPI growth, and the unemployment rate. Our finding is quantitatively robust to the inclusion of these additional macroeconomic controls.

C.3 Borrower-Level Evidence: Overall Effect

Previous results indicate a substantial contraction in credit from foreign banks in response to a decrease in the foreign IOER rate and/or an increase 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 at the extensive margin (the decision to grant a loan) and reduce the loan amount for granted loans. However, it is plausible that borrowers substitute away to other lenders. To measure the potential substitution effect directly, we look in this section at whether banks' 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 a given 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 the firm obtains 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 *Past Foreign Bank Reliance*. We base the share only on those foreign banks that subsequently are subject to the monetary policy shock. For instance, if a U.S. firm borrowed a USD loan from two Eurozone banks and one Japanese bank, the variable *Past Foreign Bank Reliance* would take the value of 1/3 if the Bank of Japan lowered its interest rates and the ECB did not change its rate. If the ECB alone cut its rate, the variable would take the value of 2/3. On the other hand, if both the ECB and the Bank of Japan lowered their IOER rates, *Past Foreign Bank Reliance* would take the value of one.[21] With this variable, we capture the idea that if a given firm relies more on credit from foreign global banks that are subject to a foreign monetary policy change, then we expect that after a decrease in foreign banks' domestic IOER rate (an increase in the IOER rate differential), these borrowers will experience a credit contraction.

The firm-level results are reported in Table VIII. In 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 such multiple 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 with the mean loan probability, a one-standard-deviation change in past foreign bank reliance corresponds to a relative change in the probability of a loan of 11.5 percent. Our results remain robust and economically similar in column (2), where we consider only periods where the IOER rate differential increase was triggered by a foreign central bank that cut its IOER rate (located in a currency area other than that of the firm). In column (3), we also restrict the sample to firms that are located in the currency area associated with the loan (for example, 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 one-standard-deviation change in past foreign

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

bank reliance corresponds to a change in the probability of a loan of 6.5 percent, relative to the average loan probability.

In columns (4) to (6), we analyze the change in (the logarithm of) the amount of the loans granted in the quarter of an IOER rate shock, as compared with (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 one-standard-deviation larger past foreign bank reliance corresponds to a relative reduction in the loan amount of granted loans of 4 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 (for example, U.S. firms borrowing in USD); see column (6).

IV. Implications for Foreign Exchange Markets and Policy Actions

Our model predicts that an increase in the difference between the foreign and domestic interest rate leads to increased swapping from the currency with the lower rate to the currency with the higher rate. The results in Tables III and V empirically support this view by showing that increased demand for FX swaps is tied to a rising cost of hedging. The increased desire of banks to swap into high-yield currencies may also lead to short-term deviations from 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).

Since the unravelling of the 2008 financial crisis, persistence in CIP violation for practically all major currencies vis-à-vis the U.S. dollar has been a notable and puzzling development. (For the most recent evidence see Du, Tepper, and Verdelhan 2016, or Borio et al. 2016.) Although the specific frictions underlying this CIP violation are not yet fully understood, and are currently subject to debate in both policy circles and academia, the cross-currency capital flows triggered by international monetary policy differences are large and could be a contributing factor that is putting the strain on the FX markets. Note that, in the current economic environment, such pressure might be particularly large. First, the large positive interest rate differential between the

United States and major foreign countries is a relatively recent phenomenon. Second, the current large amount of excess liquidity in all major currency areas amplifies cross-border movements of liquidity into high-yielding reserves. Third, current global macroeconomic conditions are characterized by a divergence of economic growth between the United States and other major currency areas, in particular the Eurozone and Japan.

In Table IX, we assess this connection empirically by estimating the effect of changes in the IOER rate differential on deviations from the CIP. 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 covered interest rate parity. The positive sign on the currency basis reflects the increased cost of hedging (an increase in the forward premium beyond the CIP-implied value), 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 three-month, one-year, and five-year basis, constructed using the yields of government bonds. For the three-month basis, we estimate that a 25-basis-point change in the IOER rate differential is associated with a 1.73-basis-points change in the three-month basis, as indicated in column (2). For the one-year basis, we estimate a change of 3.25 basis points (column 4), and for the five-year basis, we estimate a change of 2.5 basis points (column 6). The results are quantitatively larger if we consider only currency pairs against the U.S. dollar. This highlights the particular relevance of cross-currency flows into the U.S. dollar and is consistent with our finding that lending in U.S. dollars reacts most strongly to changes in the interest rate differential

In the Appendix, we evaluate the role of stable-dollar funding of foreign banks and central bank dollar swap lines in helping to mitigate the adverse effects on lending. We use the Call Reports to analyze the role of subsidiaries versus branches of foreign banks in the United States. Banks that have a larger number of subsidiaries (as a fraction of all U.S. offices) presumably have better access to stable, direct-dollar funding. This corresponds to a higher b in the model. We find that banks with a larger share of subsidiaries have more lending in terms of both C&I loans and Total Loans and Leases, and their sensitivity to changes in the interest rate differential is significantly muted. We also find that the swap lines had a strong positive relation to global banks' dollar lending. That said, the result cannot be interpreted as causal, given that the timing of the introduction of swap lines was not exogenous. (We would find the same effect if the swap

lines had been implemented later, when the pressure had already been lifted from the FX market.)

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 the 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 portfolios 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 (for example, 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 in the global setting 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 are also due to the global approach to liquidity management: it is more attractive to invest excess liquidity in the market with tightening monetary policy. (Although this part of the mechanism is true only for major currency areas and, is, for example, 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 the purpose 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 their 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, are more likely to receive a smaller loan, as compared with unaffected borrowers. We confirm that the propagation of such shocks is associated with raising the volume of FX swapping activities.

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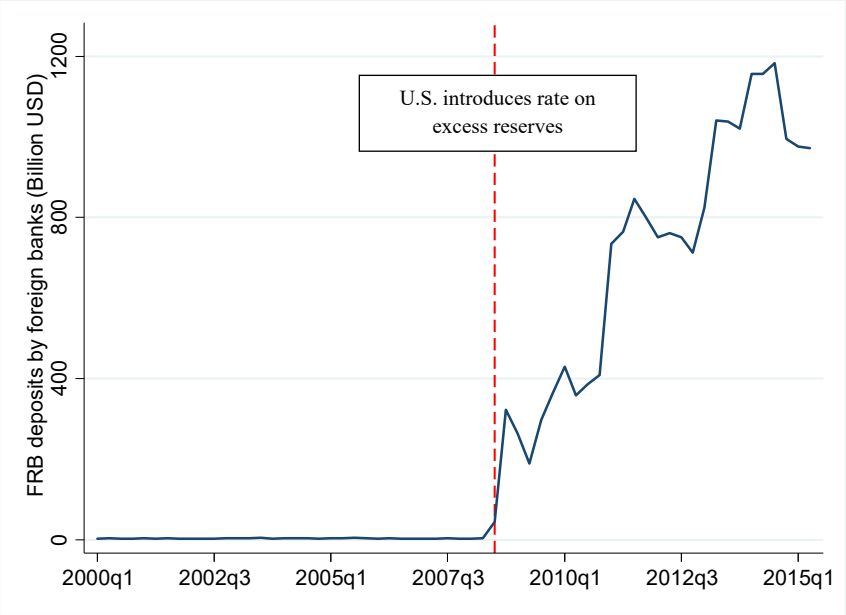
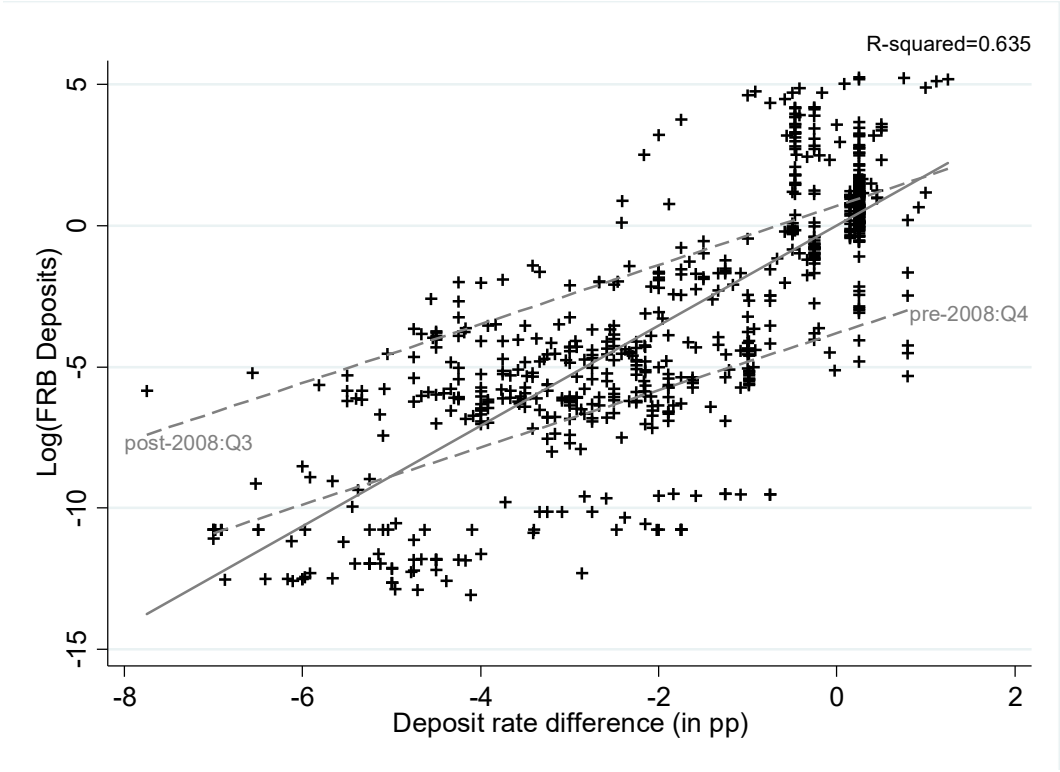
FIGURE I
FOREIGN BANKS' RESERVE HOLDINGS AT THE FEDERAL RESERVE



Note: This figure shows the deposits (in billions of 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.

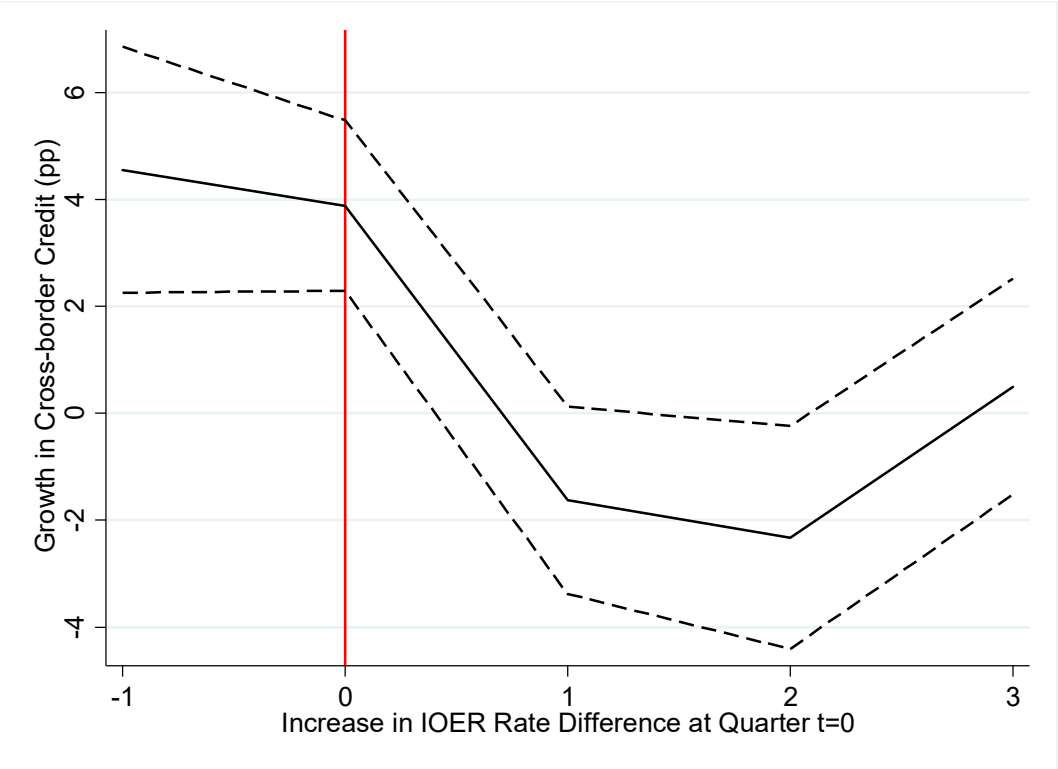
FIGURE II

IOER DIFFERENTIAL AND FOREIGN BANKS' RESERVE HOLDINGS AT THE FEDERAL RESERVE



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

FIGURE III
CROSS-BORDER CREDIT AFTER INCREASE IN IOER RATE DIFFERENCE



Note: Growth in Cross-border Credit is defined as the percentage change in cross-border claims on private, nonbank entities (firms). The sample covers the period from 2000:Q1 to 2015:Q2 and includes banks and nonbank firms from the United States, the Eurozone, the 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 ASSETS AND BANK LENDING BY FOREIGN BANKS IN THE UNITED STATES

Dependent Variable:	Reserve Assets				Bank Lending			
	Log(Reserves)		Log(Treasuries)		Log(C&I Loans)		Log(Loans and Leases)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IOER Difference (pp)	1.185***	0.731***	0.608***	0.396***	-0.157***	-0.410**	-0.196***	-0.479***
	(8.26)	(6.33)	(5.17)	(3.17)	(-3.69)	(-2.31)	(-3.66)	(-2.78)
R-sq.	0.765	0.8	0.832	0.844	0.928	0.93	0.929	0.932
ON Rate Difference (pp)	1.056***	0.609***	0.521***	0.295**	-0.171***	-0.414***	-0.202***	-0.459***
	(5.82)	(3.71)	(5.43)	(2.51)	(-4.39)	(-3.10)	(-4.36)	(-3.85)
R-sq.	0.762	0.8	0.831	0.844	0.928	0.93	0.929	0.932
3M Rate Difference (pp)	1.477***	0.478	0.760***	0.472*	-0.222***	-0.556***	-0.282***	-0.617***
	(4.09	(1.60)	(3.98)	(1.92)	(-4.87)	(-5.68)	(-4.72)	(-7.40)
R-sq.	0.761	0.799	0.831	0.844	0.928	0.93	0.929	0.932
Fixed Effects:								
Bank (D_i)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter (D_t)	--	Yes	--	Yes	--	Yes	--	Yes
Observations	1,599	1,599	689	689	1,530	1,530	1,579	1,579

Notes: The dependent variables are selected balance sheet positions of foreign branches and subsidiaries in the United States, consolidated at the high-holder (bank) level. *Reserves* is the amount of reserves held against deposits at the Federal Reserve Banks. *Treasuries* is the amount of U.S. treasury debt securities. *C&I Loans* are commercial and industrial loans (business loans). *Loans and Leases* refers to total loans and leases. The independent variables are: (i) *IOER Difference*, the difference (in percentage points) between the IOER rate of the U.S. (r^{US}) and the rates of the country where the bank is headquartered (r^{d}); (ii) *ON Rate Difference*, the overnight interbank lending rate, and (iii) *3M Rate Difference*, the three-month government bond yield. 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 the Eurozone, the United Kingdom, Japan, Switzerland, and Canada. 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—INTERNAL CAPITAL REALLOCATION BY FOREIGN BANKS IN THE UNITED STATES AND THE USD FX SWAP MARKET

Dependent Variable:	Internal Capital Reallocation				USD FX Swapping Activity			
	Log(Internal Lending)		Log(Internal Borrowing)		Log(USD FX Swap)		Cost of USD FX Swap	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IOER Difference (pp)	-0.539***	-1.522***	0.236**	0.660***	0.130***	0.141***	0.306**	0.609***
	(-3.99)	(-4.21)	(2.29)	(5.11)	(4.77)	(5.15)	(2.51)	(6.99)
R-sq.	0.591	0.665	0.781	0.79	0.756	0.914	0.634	0.865
ON Rate Difference (pp)	-0.524***	-1.390***	0.224**	0.608***	0.150***	0.165***	0.396**	0.706***
	(-3.23)	(-5.57)	(2.11)	(4.43)	(4.63)	(7.17)	(2.75)	(8.69)
R-sq.	0.590	0.666	0.781	0.790	0.761	0.918	0.670	0.910
3M Rate Difference (pp)	-1.000***	-2.006***	0.341***	0.870***	0.240**	0.229**	0.932***	1.174***
	(-3.97)	(-6.62)	(2.97)	(3.53)	(2.62)	(2.76)	(3.20)	(13.94)
R-sq.	0.596	0.671	0.781	0.790	0.765	0.920	0.708	0.925
Fixed Effects:								
Bank/Currency (D_i)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter/Month (D_t)	--	Yes	--	Yes	--	Yes	--	Yes
Observations	708	708	1,130	1,130	70	70	70	70

Notes: The dependent variables in columns (1) to (4) are selected balance sheet positions of foreign branches and subsidiaries in the United States, consolidated at the high-holder (bank) level. *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). *USD FX Swaps* refers to the amount of FX swaps from each foreign currency into USD between reporting dealers in the biannual FX Volume Survey of the NY Fed. *Cost of USD FX Swap* is the forward premium for a one-year swap in percentage points. *IOER Difference, ON Rate Difference,* and *3M Rate Difference* are the difference (in percentage points) between the IOER rates, overnight interbank rates, and three-month government bond yields, respectively, between the currency area of the counterparty (r^f) and the currency area of the banking sector (r^d). Empirical specifications are similar to those presented in Table II, with exception of columns (5) to (8), where, due to the nature of the data, D_i refers to currency fixed effects, and D_t to month fixed effects. The sample period for columns (1) to (4) runs from 2008:Q4 to 2015:Q2 and includes banks from the Eurozone, the United Kingdom, Japan, Switzerland, and Canada. Columns (5) to (8) are based on biannual observations from October 2008 through April 2015 for FX swaps from EUR, GBP, JPY, CHF, or CAD versus the USD. Robust *t*-statistics are in parentheses. Standard errors are clustered at the quarter/month level.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

TABLE IV—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 the 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 U.S. dollars. The sample period runs from 2005:Q1 through 2015:Q2. The data are compiled from BIS Consolidated Banking Statistics.

TABLE V—CROSS-BORDER CLAIMS AND FX SWAP VOLUMES BY BANKING SECTOR

Dependent Variable:	Cross-Border Claims				FX Swapping Activity			
	Log(Claims on Firms)		Log(Claims on Official Sector)		FX Swap Volume		Cost of FX Swap	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IOER Difference (pp)	-0.071***	-0.103***	0.097**	0.246***	13.58**	12.65*	1.21***	1.23***
	(-6.75)	(-9.24)	(3.84)	(7.04)	(2.42)	(2.11)	(7.03)	(6.96)
R-sq.	0.871	0.880	0.796	0.836	0.604	0.607	0.970	0.986
ON Rate Difference (pp)	-0.079***	-0.128***	0.073**	0.224***	11.02	3.76	1.38***	1.41***
	(-6.40)	(-12.37)	(3.39)	(7.13)	(1.73)	(0.48)	(9.04)	(8.97)
R-sq.	0.871	0.882	0.795	0.835	0.604	0.607	0.975	0.989
3M Rate Difference (pp)	-0.077***	-0.130***	0.083**	0.236***	13.50***	13.52**	1.17***	1.20***
	(-6.05)	(-11.64)	(3.70)	(8.29)	(6.36)	(2.35)	(17.11)	(17.03)
R-sq.	0.871	0.882	0.795	0.835	0.604	0.607	0.981	0.992
Fixed Effects:								
Banking Sector (D_d)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country (D_f)	Yes	--	Yes	--	Yes	--	Yes	--
Quarter (D_t)	Yes	--	Yes	--	Yes	--	Yes	--
Country × Quarter ($D_f \times D_t$)	--	Yes	--	Yes	--	Yes	--	Yes
Observations	889	889	885	885	273	273	273	273

Note: Claims on Firms and *Claims on Official Sector* refer to cross-border claims by a banking sector headquartered in currency area *d* on private nonbank entities and foreign official sector (including central bank deposits and government debt holdings) in foreign country *f*. *FX Swap Volume* (in USD billions) of a banking sector in currency area *d* is computed as total assets minus total liabilities in each foreign currency *f*. *Cost of FX Swap* is the one-year forward premium in percentage points. Note that cross-border claims are at the banking-sector currency-area level, whereas FX swapping activity is at the banking-sector currency level; that is, in specifications (5) through (8), *f* corresponds to a currency and not a country. All data are quarterly. Specification (2) corresponds to:

$$Log(Claims\ on\ Firms)_t{}^{fd} = D_d + D_f \times D_t + \beta\left(r_t^f - r_t^d\right) + \epsilon_t{}^{fd},$$

where D_d are fixed effects for the currency area of the banking sector, and $D_f \times D_t$ are currency area interacted with quarter fixed effects. The sample period runs from 2005:Q1 to 2015:Q2 and includes claims by banks from the United States, the Eurozone, the United Kingdom, Japan, Switzerland, and Canada. The change in the number of observations in columns (5) through (8) is due to different data sources, as explained in the main text. Robust *t*-statistics are in parentheses. Standard errors are clustered at the quarter level. The difference in the number of observation is due to the missing data.

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

TABLE VI—SHARE OF FOREIGN CURRENCY LENDING AT BANK LEVEL

Dependent Variable:	Share of Foreign Currency Lending (Loan Volume)				Share of Foreign Currency Lending (Number of Loans)			
	All Markets		Foreign Market Spillover		All Markets		Foreign Market Spillover	
				Shock to r^d				Shock to r^d
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IOER Difference (pp)	-3.194***	-5.796***	-2.857***	-7.532***	-2.483***	-6.149***	-1.955***	-2.050***
	(-11.14)	(-7.94)	(-10.11)	(-6.70)	(-12.69)	(-10.19)	(-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. The unit of observation 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 rate of 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. Because all volumes are expressed in U.S. dollars, in specifications (1)–(4), we control for *FX Spot*, the exchange rate with respect to the U.S. dollar. *Equity* is a bank's equity over total assets (in percent) measured as of the preceding quarter. The sample period runs from 2000:Q1 to 2015:Q2 and includes lending denominated in USD, EUR, GBP, JPY, CHF, and CAD. The sample used in columns (4) and (8) includes only observations in the period after a decrease in each bank's domestic IOER rate; that is, we look exclusively 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 VII—LOAN PARTICIPATION AND AMOUNT AT THE 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 one 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 zero 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; for example, 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 three-month forward exchange rate, and the difference between the GDP growth, CPI growth, and unemployment rate 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 U.S. dollars. 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 AT THE FIRM LEVEL AFTER A POSITIVE SHOCK TO THE IOER RATE DIFFERENCE

Dependent Variable:	Probability of Getting a Loan			ΔLog(Amount)		
	All Markets	All Markets Shock to r^d	Foreign Market Shock to r^d	All Markets	All Markets Shock to r^d	Foreign Market Shock to r^d
	(1)	(2)	(3)	(4)	(5)	(6)
Past 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 one if the borrower *j* obtains a loan in currency *f* after a positive shock to an IOER rate differential, and zero otherwise. Note that the sample is *conditional* on changes in IOER for a given currency pairing. The 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 *Past 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 increase in ($r^{USD} - r^{JPY}$), we look only 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 to quarters where the IOER difference increases due to a drop in r^d. Specifications (1)–(3) correspond to:

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

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 covered interest parity, computed based on government bond yields of three-month, one-year, and five-year maturities. The CIP deviations are expressed as a cost, that is, a mark-up over the CIP-implied forward premium. Δ*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 THE ROLE OF DIRECT ACCESS TO FOREIGN CURRENCY FUNDING

The basic model that we discussed in Section II highlights the key mechanism of international monetary policy transmission through the balance sheets of global banks. Here, we extend the model to incorporate the gathering of foreign-currency deposits into the model.

A. Deposit-Gathering Abroad

Suppose that, in addition to synthetic funding through the FX swap market, the bank can directly raise an amount D^f of deposits denominated in foreign currency. We assume that, similar to raising deposits in domestic currency, raising foreign-currency deposits is associated with an increasing cost $f(D^d)$, where $f(\cdot)$ is a convex cost function. The bank's augmented maximization problem then becomes:

$$r^d R^d + g(L^d) + r^f R^f + h(L^f) - c(S) - d(D^d) - f(D^f),$$

subject to the balance sheet constraint, capital constraint, and the constraint that foreign assets must be funded through a mix of foreign deposits and swaps, $S + D^f - R^f - L^f = 0$.

From the first-order conditions, we obtain the same key predictions as discussed in Section II. To obtain additional predictions on the role of direct foreign funding, we need to impose further assumptions on the function $f(D^f)$. Following Peek and Rosengren (1995), we assume that the amount of foreign deposits is an affine function of the interest rate the bank pays on these deposits, such that $D^f = a + b \cdot i^f$, with parameters $a>0$ and $b>0$. The cost of raising the amount D^f of foreign deposits then becomes:

$$f(D^f) = \frac{D^f(D^f - a)}{b}.$$

The key parameter of interest is b, which influences how costly it is for the bank to raise foreign funding. As b increases, it becomes cheaper to collect foreign deposits. It is then straightforward to show that the amount of foreign lending is increasing in b,

$$\frac{\partial L^f}{\partial b} = f''(D^f) \cdot \frac{\partial D^f}{\partial b} \cdot \frac{1}{h''(L^f) + g''(L^d)} > 0.$$

Thus, as it becomes more costly for the banks to access foreign funding (b decreases), the bank will reduce its lending in foreign currency. On the other hand, if the bank has better access to

foreign funding markets—for example, through foreign subsidiaries or central bank swap-line agreements—this will have a positive effect on the bank's foreign-lending activities.

We can also get insights on how foreign lending changes with respect to interest rate differential changes as the ability to raise foreign deposits increases. The intuition is that banks with a better ability to collect direct foreign-currency funding are less sensitive to changes in the interest rate differential that affect the cost of synthetic foreign-currency funding. This gives us:

$$\frac{\partial L^f}{\partial \Delta r \partial b} = \frac{-1}{(h''(L^f)+g''(K/\alpha - L^f))^2} \cdot \frac{\partial L^f}{\partial b} \cdot \left(h'''(L^f) - g'''\left(\frac{K}{\alpha} - L^f\right)\right) > 0,$$

under the condition that $g'''(K/\alpha - L^f) > h'''(L^f)$. Intuitively, this condition is satisfied when the decreasing marginal return of lending in domestic currency is less affected by a change in domestic lending than the decreasing marginal return of lending in foreign currency is affected by foreign lending.

B. Direct-Dollar Funding through Subsidiaries and Central Bank Swap-Line Agreements

In Appendix Table III, columns (1) and (2), we use the Call Reports to analyze the role of subsidiaries versus branches of foreign banks in the United States. Banks that have a larger number of subsidiaries (relative to all offices in the United States) presumably have better access to stable, direct-dollar funding. This corresponds to a higher *b* in the model. We find that banks with a larger share of subsidiaries have more lending (in terms of both C&I loans and Total Loans and Leases). Because we control for bank and time fixed effects, the identification of the coefficient comes from changes in the ratio of subsidiaries to branches for a given bank. We also find the second prediction confirmed in the data. Those banks with relatively more subsidiaries not only have more lending in the United States, but their sensitivity to changes in the interest rate differential is also significantly muted, as shown in columns (1) and (2). Indeed, for a bank that operates in the United States only through subsidiaries, our estimates suggest that the negative effect of the interest rate differential on lending is almost entirely offset.

Our second set of results on the role of direct foreign-currency funding comes from the central bank swap-line agreements. In Appendix Table III, columns (3) to (5), we look at the share of foreign-currency lending (relative to domestic lending) in six major currencies (same dependent variable as in Table VI). The dummy variable CB Swap Line takes the value one if, in a given

quarter, the central banks between the foreign currency of the loan and the domestic currency have established a swap-line agreement, and zero otherwise. We find that the share of foreign-currency lending increased strongly by 13 to 16 percent when the central bank swap-line agreements were established. Because the swap-line agreements between different central banks were not all introduced at the same time, we can also add time fixed effects to our specification to control for common time trends that may confound our analysis. Moreover, in columns (3) and (4), we find that for USD lending, the introduction of the swap lines decreases the effect of the interest rate differential. This result is in line with the swap lines taking pressure from the FX swap market, as direct-dollar funding was made available and banks did not need to rely on synthetic funding.

APPENDIX A.II 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.[22]

United States—The Federal Reserve (Fed) started paying interest rates on both required reserves and excess reserves on October 9, 2008, with the objective 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 effectively be seen as the interest rate on excess reserves. Until October 9, 2008, the marginal lending and the deposit rates operated 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 May 13, 2009. On July 11, 2012, the ECB adopted a zero-deposit facility rate. The zero-deposit-rate regime was effective

22 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

for nearly two years until June 11, 2014, when the ECB became the first major central bank to introduce a negative deposit rate of -0.1 percent to battle 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 (effective on November 17, 2008), the Bank of Japan (BoJ) introduced its Complementary Deposit Facility to facilitate the provisioning of sufficient liquidity. The interest rate was stipulated to be the targeted uncollateralized overnight call rate decided at the Monetary Policy Meeting less a spread to be determined by the Bank. However, the Bank decided to establish simply a 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 (initially scheduled for March 16, 2009) 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 percent.

Switzerland—The Swiss National Bank (SNB) used to not pay interest 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 percent 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 percent and moved the target range downwards to between -1.25 percent and -0.25 percent.

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 none other than the lending and deposit facility rates. In normal times, the deposit rate is 0.25 percentage points less than 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.

United Kingdom—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 a quarterly frequency, for all banks except foreign banks in the Eurozone and foreign banks in Japan, for both of which cases only the list of foreign banks in 2015 is available.

TABLE A.II
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 extensions of the analysis reported in Table VI. 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; that is, 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.

TABLE A.III
THE ROLE OF DIRECT FUNDING

Dependent Variable:	Deposits in Foreign Currency		Cross-Currency Swap Lines		
	Log(C&I Loans)	Log(Loans and Leases)	Share of Foreign Currency Lending		
			USD Lending	USD Lending	All Currencies
	(1)	(2)	(3)	(4)	(5)
IOER Difference (pp)	-0.388**	-0.431**	-4.357***	-3.189***	-3.014***
	(-2.31)	(-2.75)	(-5.42)	(-4.63)	(-10.14)
Share of Subsidiaries (Relative to all Offices)	1.698***	3.535***	--	--	--
	(3.68)	(7.81)			
IOER Difference * Share of Subsidiaries	0.314***	0.412***	--	--	--
	(3.19)	(3.54)			
CB Swap Line	--	--	0.659	13.318***	15.570***
			(0.39)	(2.99)	(10.44)
IOER Difference * CB Swap Line	--	--	3.364***	3.505***	-0.101
			(3.13)	(3.30)	(-0.13)
Fixed Effects:					
Bank	Yes	Yes	Yes	Yes	Yes
Quarter	Yes	Yes	--	Yes	Yes
Observations	1,521	1,570	3,865	3,865	9,821
R-sq.	0.931	0.943	0.643	0.679	0.667

Notes: In this table we examine two sources of direct funding in foreign currency: (i) deposits (columns (1) and (2)), and (ii) cross-currency swap lines (columns (3)-(5)). The dependent variables in columns (1) and (2) are the logarithm of commercial and industrial loans (*C&I Loans*) and the logarithm of Total Loans and Leases (*Loans and Leases*) of foreign branches and subsidiaries in the United States, consolidated at the high holder (bank) level. *Share of Subsidiaries* is the number of subsidiaries the bank has in the United States relative to all offices (subsidiaries and branches) in the quarter prior to the loan. The dependent variable in columns (3) to (4) 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. *CB Swap Line* is a dummy that equals one if there is a central bank FX swap line established between the foreign currency of lending and the domestic currency of the country where the bank is headquartered at the quarter of the loan, and zero otherwise. *IOER Difference* is the difference (in percentage points) between the IOER rates in the foreign currency and the currency of the country where the bank is headquartered. Column (5) also includes a control for the exchange rate (not reported), as all volumes are expressed in USD. The sample period in column (1) and (2) runs from 2008:Q4 to 2015:Q2; the sample period in columns (3)-(5) runs from 2000:Q1 to 2015:Q2. For further details see Table II and Table VI. 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.