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ABSTRACT

When central banks adjust interest rates, the opportunity cost of lending in local currency changes, but—in absence of frictions—there is no spillover effect to lending in other currencies. However, when equity capital is limited, global banks must benchmark domestic and foreign lending opportunities. We show that, in equilibrium, the marginal return on foreign lending is affected by the interest rate differential, with lower domestic rates leading to an increase in local lending, at the expense of a reduction in foreign lending. We test our prediction in the context of changes in interest rates in six major currency areas.

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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% 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. This is the first paper that provides a framework that shows how monetary policy in one country affects loan supply in different currencies through the balance sheet of global banks. A standard effect of monetary policy is that, by setting the interest rate on reserve assets, it affects the opportunity cost of lending: a higher domestic policy rate raises the required marginal rate of return on domestic lending. We show that, if a global bank is capital constrained—that is, it needs to consider the allocation of a fixed amount of equity to back lending in multiple currencies—monetary policy in one country affects its loan supply in all currencies. This happens because, in equilibrium, marginal returns (expressed in the same currency) on domestic and foreign lending have to be equal. We present a model that formalizes this point and derives testable predictions that guide the empirical analysis. Overall, the central insight of the paper is that global banks' lending decisions in different currencies are interlinked and respond to monetary policy shocks, foreign and domestic.

In addition to lending, banks have a global approach to their liquidity management: they prefer to hold liquidity in countries where reserve assets, such as central bank reserves or government bonds, carry a higher risk adjusted yield. Using the U.S. Call Report and BIS data, we show a strong positive relationship between foreign reserve holdings and the difference in the interest on excess reserves (IOER) rate between foreign and bank's domestic market. While global liquidity management is not essential to derive cross-currency effects of monetary policy on lending, given that these liquidity flows are sizable and respond to monetary policy, we incorporate global bank's liquidity management in our model.

Our empirical results can be divided into two parts: (i) aggregate macro evidence and (ii) firm- and loan-level micro evidence. In line with the central mechanism of the model, we show that foreign banks in the United States that are headquartered in countries where the interest rate has been lowered, decrease their lending to firms in the United States by up to 10% per 25-basis-point increase in the IOER rate differential. The results are robust to using U.S. monetary policy shocks and alternative measures of interest rate differentials. Using BIS data, we show that similar patterns emerge in a cross-country setting: there is a decrease in foreign-currency cross-border claims on foreign firms of 1.2% per 25-basis-point increase in the IOER rate differential between the foreign currency and the currency of the banks' home country. We estimate this effect after controlling for concurrent movements in the spot exchange rate, and, consistent with our model predictions and our findings for the U.S., the reduction of foreign lending is stronger once we take into account the appreciation of the foreign currency.

Our second set of results is based on loan-level data, which are crucial for a tight empirical identification of the mechanism at play. For this purpose, we employ data on syndicated loan originations by global banks in six major currencies from 2000 to 2016. 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 the share of foreign currency lending (relative to the bank's lending in both foreign and domestic currency), which corresponds to a cutback of 2% relative to the mean share of foreign currency lending. 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, and is not confined to the U.S. dollar but holds for all major currencies.

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 1.6% decline in the probability of lending (relative to the mean lending probability) and about a 3.6% 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 setup allows us to include both borrower-quarter and lender-quarter fixed effects, which account for time-varying loan demand factors and bank-time-varying behavior (such as the response to the economic conditions in the bank's home country) to focus on the differential supply of credit in different currencies. For example, the shock to the Japanese banks analyzed in Peek and Rosengren (1997, 2000) would lead to an overall contraction in credit by Japanese banks, 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 12% lower probability of obtaining a loan, and with a 5% reduction in the volume of granted loans after an expansionary monetary policy shock in the foreign bank's home country.

Our paper contributes to several strands of the literature. First, this paper fits into a growing research on global banks and the role they play in transmitting shocks across borders. In particular, our work relates most closely to empirical work by Cetorelli and Goldberg (2012) and Morais, Peydro, and Ruiz (2019).[1] Both papers build on the conceptual framework of Kashyap and Stein (2000)—which is a model contrasting lending behavior of large vs. small banks in a closed economy—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, our paper is the first to take into consideration that banks' global activity has an intrinsic currency component. Incorporating this insight into a simple model reveals a more complex effect on lending in domestic and foreign markets due to the interaction between global banks' capital constraints and interest rate differentials between different currencies.

Second, we contribute to the emerging literature that studies currency effects on loan supply. This includes Ivashina, Scharfstein, and Stein (2015) who study how difference in funding in

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[1] In addition to the seminal contributions of Peek and Rosengren (1997, 2000), other 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), Giannetti and Laeven (2012), and Baskaya, di Giovanni, Kalemi-Ozcan, and Ulu (2017).

domestic and foreign currency impact lending. 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. A similar result is found by Takats and Temesvary (2016) in a cross-country context using aggregate data. The existing explanation is that the cost of funding in a given currency is influenced by that currency area's monetary authority—a channel that is also operational in our model but that interacts with the capital constraint to lead to opposite effects for lending in foreign and domestic currency.

Third, our paper relates to the large body of work in international finance and macroeconomics that studies the cross-border transmission of monetary policy, and, specifically, the transmission of the U.S. monetary policy, to global financial markets. At an aggregate level, Rey (2013) and Miranda-Agrippina and Rey (2015) show the central role of U.S. monetary policy in driving the global financial cycle.[2] Mueller, Tahbaz-Salehi, and Vendolin (2017) and Shah (2018) provide evidence of the strong impact of U.S. monetary policy on the FX market. Consistent with the important role of U.S. monetary policy, we find stronger effects of banks' portfolio rebalancing in

[2] Several recent studies have linked the importance of U.S. monetary policy to the dominant role of the dollar in international trade and finance. For example, McCauley, McGuire, and Sushko (2015) and Brauning and Ivashina (2019) show a large sensitivity of emerging market debt to U.S. monetary policy. Wiriadinata (2018) show that differences in the dollarization of countries' external debt drives currency risk premium and exchange rate movements in response to U.S. monetary policy shocks. Zhang (2018) argues that heterogeneous U.S. monetary policy spillovers depend on countries' share of dollar-invoiced trade.

response to interest-rate differential changes for dollar loans, but also show that our results hold more broadly for other major currencies.

Finally, while we do not analyze the effects of capital flows on the exchange rate, our results indicate that—in response to the monetary policy—global banks move significant amount of capital across currencies. This relates to Gabaix and Maggiori (2015) who argue that exchange rates could be influenced by large, international capital flows intermediated by global financial institutions.[3] Similarly, Bruno and Shin (2015, 2017) argue that global banks' risk-taking affects monetary policy spillovers to international capital flows and exchange rates

The rest of the paper is organized in four sections. In Section I, we formalize our testable hypotheses. In Section II, we discuss the data. In Section III, we present our core empirical results. In Section IV, we conclude.

I. Theoretical Framework

A. Model

Consider a representative global bank that has investment opportunities in the domestic country (*d*) and in the foreign country (*f*). All investments are made at time t_0, the returns are

[3] 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 the exchange rate provide the mechanism by which risk-taking is compensated, leading to violations of uncovered interest parity (UIP). More broadly, violations of UIP and currency excess returns had been had been the subject of several studies including Eichenbaum and Evans (1995) and more recent Lustig, Roussanov, and Verdelhan (2011), Colacito, Croce, Gavazzoni, and Ready (2018), and Hassan and Mano (2019).

realized at time t_1. The bank has lending opportunities in both countries. If the bank lends an amount L^d in the domestic market, it earns a gross amount (principal and interest) of $g(L^d)$. Similarly, if the bank lends an amount L^f in the foreign market, it earns back $h(L^f)$. We assume that both $g(\cdot)$and $h(\cdot)$ are concave functions, capturing decreasing returns to scale in the loan market. This could be motivated by a price-setting bank facing a downward-sloping demand curve in the loan market. The notion of bank pricing power in lending is rooted in informational frictions, which are a central explanation for the existence of the banking sector (e.g., Diamond, 1984 and 1991; Rajan, 1992 and a large body of empirical work that collaborates these ideas), and direct evidence on the market power in lending (e.g., Fama, 1985; Cosimano and McDonald, 1998). The basic idea is that banks build a costly expertise in screening and monitor their borrowers, thus producing proprietary information that is not easily transferable. This, in turn, leads to switching costs for the borrowers.

In addition, the bank can hold an amount R^d of reserves at the domestic central bank; these reserves yield a constant return r^d. (While, in the model exposition, we focus on central bank reserves, our proposed mechanism holds for reserve assets more broadly.) A global bank can also 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. Similar to Kashyap, Rajan, and Stein (2002)—and also motivated by the bank pricing-power in the loan market—we assume that the loan return functions do not directly depend on the interest rates on reserve assets. As a result, the pass-through of policy rates to loan markets is a result of credit supply shifts. This assumption can be relaxed, for example, assuming $g'(L^d) = 1 + \gamma r^d + (1-\gamma)G(L^d)$, with $G > 0, G' < 0,$ and $\gamma \in (0,1)$ and a similar function for $h(.)$—that is, assuming direct dependence on policy rates and some direct pass-through—does not alter the mechanism and renders the same predictions.

All investments have to be in local currency; that is, investments in the foreign country are in foreign currency, and domestic investments are in domestic currency. Let X_0 be the period zero spot exchange rate expressed in terms of units of domestic currency per foreign currency. Then, $X_0 L^f$ and $X_0 R^f$ are the foreign currency loans and reserves expressed in bank's domestic currency, respectively. (L^d and R^d are already expressed in bank's domestic currency.)

We assume that the bank's only funding sources for all investments are a fixed amount of capital K and deposits D^d, both denominated in domestic currency. Capital is required to fund a share α of lending: $\alpha\,(L^d + X_0 L^f) \leq K$, and we assume this standard capital constraint to be binding in equilibrium.[4] Raising 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).

To fund its foreign currency operations, the global bank converts funds raised in domestic currency into foreign currency in the spot market. This, however, generates a currency mismatch between its assets and liabilities, which banks typically hedge using foreign exchange swaps by combining the spot purchase of foreign currency with its forward sale.[5] The bank's FX swap volume is denoted by S (in foreign currency) and the forward exchange rate is X^{Fwd}, again

[4] In line with current practices, we assume that assets in foreign currency are converted with the spot exchange rate for accounting and capital requirement purposes, see, for example, https://www.pwc.com/us/en/cfodirect/assets/pdf/accounting-guides/pwc-guide-foreign-currency.pdf, and the Basel capital requirement guidelines: https://www.bis.org/bcbs/publ/d457.pdf.

[5] See Fender and McGuire (2010). Also, BIS data show that FX swaps are the most actively traded foreign exchange derivative, with banks accounting for more than 75% of the turnover.

expressed as domestic per foreign currency. While, the bank can choose to leave part (U) of its FX exposure unhedged, regulatory requirements force banks to fund a share α' of such unhedged positions with equity capital. To account for it, we extend the standard capital constraint to $\alpha(L^d + X_0 L^f) + \alpha' X_0 U \leq K$. That is, the bank needs to fund, in addition to foreign and domestic lending activity, any unhedged currency exposure with a share of its capital.

The risk-neutral global bank maximizes expected profits in domestic currency by choosing the amount of deposits, the amount of hedged and unhedged foreign currency exposure, and the portfolio allocation. The bank takes as given the foreign and domestic interest rates, the spot (X_0) and forward (X^{Fwd}) FX rates, and its capital. The formal maximization problem is:

$$\max \ (1+r^d)R^d + g(L^d) + SX^{Fwd} + UE[X_1] - d(D^d),$$

s.t.

$$K - \alpha(L^d - X_0 L^f) - \alpha' X_0 U \geq 0,$$

$$S + U - (1+r^f)R^f - h(L^f) = 0,$$

$$D^d + K - R^d - L^d - X_0 R^f - X_0 L^f = 0,$$

$$D^d \geq 0, L^d \geq 0, L^f \geq 0, R^d \geq 0, R^f \geq 0, S \geq 0, U \geq 0.$$

We focus on an interior solution for the bank's balance sheet positions (deposits, and reserves and lending in both currencies) and swap amount.[6] An interior solution for lending exists if the functions h and g satisfy the Inada conditions. (We will return to the conditions required for the interior solution for reserve holdings.) The exogenous variables in this problem are the spot exchange rate, the foreign and domestic interest rate, which pin down the FX forward premium,

[6] We only differentiate between a corner solution and an interior solution for unhedged exposure, *U*.

and the capital requirements on lending and unhedged exposure. Endogenous variables are the bank's choice variables.

The first-order conditions (FOC) are given by:

$$\partial\mathcal{L}/\partial R^d = (1 + r^d) + \lambda = 0 \tag{1}$$

$$\partial\mathcal{L}/\partial R^f = \lambda X_0 - \mu\,(1 + r^f) = 0 \tag{2}$$

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

$$\partial\mathcal{L}/\partial L^f = -\omega X_0 + \lambda X_0 - \mu h'(L^f) = 0 \tag{4}$$

$$\partial\mathcal{L}/\partial D^d = -d'(D^d) - \lambda = 0 \tag{5}$$

$$\partial\mathcal{L}/\partial S = X^{Fwd} + \mu = 0 \tag{6}$$

$$\partial\mathcal{L}/\partial U = E[X_1] - \omega X_0 + \mu + \gamma = 0 \tag{7}$$

$$\partial\mathcal{L}/\partial\omega = K - \alpha(L^d - X_0 L^f) - \alpha' X_0 U = 0 \tag{8}$$

$$\partial\mathcal{L}/\partial\mu = S + U - (1 + r^f)R^f - h(L^f) = 0 \tag{9}$$

$$\partial\mathcal{L}/\partial\lambda = R^d + L^d + X_0 R^f + X_0 L^f - D^d - K = 0 \tag{10}$$

The Lagrange multiplier on the balance sheet constraint, foreign exchange constraint, and capital constraint are given by λ, μ, and ω, respectively, and γ is the multiplier on the non-negativity constraint on U.

From the FOC (1) and (5), the total size of the global bank's balance sheet is determined by the interest rate on domestic deposits:

$$d'(D^d) = 1 + r^d, \tag{11}$$

which equates the marginal cost of raising additional deposits to the return on holding domestic excess reserves.

Using (1), the FOC for domestic lending in equation (3) can be rewritten as:

$$g'(L^d) = (1 + r^d) + \omega \tag{12}$$

where $g'(L^d)$ is the marginal return on domestic lending and ω is the Lagrange multiplier on the bank's capital constraint. This condition highlights that the binding capital constraint restricts domestic lending and imposes an additional (shadow) cost: the bank could increase profits by expanding lending until the marginal return on lending equates the cost of borrowing $(1 + r^d)$, but the lack of additional equity capital restricts its lending.

Using (1) and (6), we can express equation (4), the FOC for foreign lending as:

$$\frac{X^{Fwd}}{X_0} h'(L^f) = (1 + r^d) + \omega \tag{13}$$

where $h'(L^f)$ is the marginal return on foreign lending, and $\frac{X^{Fwd}}{X_0}$ is the forward premium. Equation (13) shows that the marginal return on foreign lending *net* of the forward premium equals the cost of raising domestic deposits plus the shadow cost of capital. From (1), (2) and (6), covered interest parity holds: the forward premium equals the interest rate differential, $\frac{X^{Fwd}}{X_0} = \frac{1+r^d}{1+r^f}$.[7] Thus, if the domestic interest rate decreases but the foreign interest rate stays constant (hence, the forward premium falls), the net marginal return on foreign lending falls. Without the capital constraint, this

[7] To simplify notation, we express exchange rates as unit of domestic currency per one unit of foreign currency. As a result, the forward premium falls when the interest rate differential between foreign and domestic currency widens.

decline in marginal return does not impact foreign lending because it is offset by the benefits of lower cost of domestic funding. However, with a binding capital constraint, the lower net marginal return on foreign lending makes it more attractive to use scarce capital to expand domestic lending. As a result, under the capital constraint, the drop in domestic interest rate will trigger an expansion in domestic lending and contraction in foreign lending until the margin returns net of the forward premium is equal between the two markets.

Substituting out the forward premium, we can rewrite equation (13) as:

$$h'(L^f) = (1 + r^f) + \frac{1 + r^f}{1 + r^d}\omega. \tag{14}$$

This further illustrates that, in a world without a binding capital constraint ($\omega = 0$), there would be no spillovers of monetary policy, and foreign lending would simply be pinned down by the foreign interest rate ($1+r^f$). The wedge ($\frac{1+r^f}{1+r^d}\omega$), which reflects cross-currency spillover of monetary policy, arises because the interest rate differential affects the opportunity cost of capital backing foreign lending. As long as foreign and domestic lending requires scarce equity capital, the interest rate differential change affects lending in *both* currencies. (The capital requirement on unhedged currency exposure is not necessary for foreign and domestic lending to become interlinked. We illustrate this point in the Internet Appendix.)

Combining equations (12) and (14), it is easy to see that the bank chooses its lending portfolio in domestic and foreign currencies as a function of the interest rate differential:

$$g'(L^d) = \frac{1 + r^d}{1 + r^f} h'(L^f). \tag{15}$$

This equation highlights the central point of the paper: for a capital-constrained bank, the foreign and domestic lending decisions are connected.

To obtain predictions on banks' global reserves holdings, we need to derive the equilibrium swap market volumes, which requires introducing a swap counterparty.[8] We assume that bank's swap counterparty is a representative foreign institution that invests in foreign and domestic markets (e.g., large corporation or a pension fund). We assume that the payoff of a foreign investment is $g_I(.)$ $(g_I' > 0, g_I'' < 0)$. The investor also has access to domestic projects with payoff of $h_I(.)$ $(h_I' > 0, h_I{}'' < 0)$. Concavity of the payoff functions captures decreasing returns to scale.[9] The investor does not hold foreign or domestic reserves; this could be due to different liquidity needs or lack of access to reserve assets.

The representative bank's counterparty in the FX swap market has a fixed amount of wealth, W.[10] As with the banks, the idea is that the institution's primary funding is denominated in domestic currency, but foreign investments are denominated in foreign currency. The focus of the

[8] Conditions (1), (2), and (6) indicate that the bank's swap demand is infinitely elastic at the CIP forward premium. Thus, in an interior equilibrium with positive domestic and foreign reserve holdings, the global bank acts effectively as an arbitrageur in the market for reserves and the swap market. This is consistent with anecdotal evidence such as the BNP Paribas 2014 FX/XCCY Swap market overview available through the ECB. https://www.ecb.europa.eu/paym/groups/pdf/mmcg/20140909/item_4.pdf.

[9] This is in line with assumptions in Gabaix and Maggiori (2015) where they assume that the financiers' cost of intermediation in the FX market is increasing in scale. In our setting, decreasing returns to scale imply a sloped swap supply curve, which ensures that the equilibrium swap volumes are pinned down (recall that the bank's swap demand is infinitely elastic).

[10] We assumed that the foreign investor is fully equity funded; this would be consistent with the counterparty being a pension fund, insurance company or a mutual fund. In the Internet Appendix, we allow for leverage and investor's return functions to depend on interest rates directly.

paper is banks, so with what follows we will continue using "foreign" and "domestic" terms from the banks' perspective. Thus, W is denominated in foreign currency (i.e., it is denominated in the currency of the bank's counterparty). Similar to banks (but in the opposite direction), we assume that foreign institutions use the FX swap market to manage the currency mismatch when investing abroad.

The investor chooses the swap volume S to maximize expected profits taking FX rates as given:

$$g_I(W - S) + \frac{h_I(SX^0)}{X^{Fwd}}.$$

The FOC implicitly defines the supply curve of foreign currency swaps:

$$-g_I{}'(W - S) + X^0 \frac{h_I{}'(SX^0)}{X^{Fwd}} = 0.$$

To obtain analytical solutions for the equilibrium swap quantity, we assume logarithmic return functions, $g_I(.) = \theta\log(.)$ and $h_I(.) = \log(.)$, with scaling factor $\theta > 0$.[11] In this case, we can derive the counterparty's (inverse) swap supply function in closed form:

$$X^{Fwd} = \frac{W - S}{\theta S} \tag{16}$$

To compute the equilibrium quantity in the swap market, for simplicity, assume there is a unit mass of N global banks and a unit mass of N foreign investors. Equating aggregate demand and supply gives the aggregate equilibrium swap amount:

[11] Our focus is on situations where foreign and domestic reserves holdings are non-zero, which is when bank's FX swap demand is perfectly elastic. Using a scale parameter θ ensures that an equilibrium exists in this region.

$$\hat{S} = \frac{1 + r^f}{1 + r^f + (1 + r^d)\theta} W, \tag{17}$$

which, assuming an equilibrium where each bank demands the same swap amount, also equals each individual bank and counterparty's swap volume (*S*).

B. Partial Effects of Changes in Interest Rate Differential

We can obtain several partial derivatives that characterize the effect of a change in the interest rate differential between foreign and domestic markets (Δr) on the bank's portfolio choices. We focus on the case when then banks is fully hedged, $U = 0$.[12] From equations (15), and the capital constraint (8), using the logarithmic approximation $\log((1 + r^d)/(1 + r^f)) \approx r^d - r^f = -\Delta r$, we obtain $\log(h'(L^f)) = \log(g'(K/\alpha - X_0 L^f)) + \Delta r$. Therefore, foreign lending is an implicit function of the interest rate differential, the spot exchange rate, and capital. Using implicit differentiation, we obtain the partial derivative:

$$\frac{\partial L^f}{\partial \Delta r} = \left(\frac{h''}{h'} + \frac{g''}{g'} X_0\right)^{-1} < 0. \tag{18}$$

That is, the bank's foreign lending (expressed in foreign currency) is a decreasing function of the interest rate differential between foreign and domestic country. For lending in the domestic currency, we obtain:

$$\frac{\partial L^d}{\partial \Delta r} = -X_0 \frac{\partial L^f}{\partial \Delta r} > 0. \tag{19}$$

[12] The complementary slackness condition requires that $\gamma > 0$ if $U = 0$ and $\gamma = 0$ if $U > 0$. In the Internet Appendix, we discuss the case of unhedged currency exposure.

Equations (18) and (19) indicate that lending in foreign currency decreases in response to a larger difference between the foreign and domestic interest rates, while domestic lending increases. This means that an increase in the domestic rate—a tightening of domestic monetary policy—leads to an expansion of foreign lending and a decrease in domestic lending.

Using equation (17), it becomes clear that the equilibrium swap volume increases in Δr:

$$\frac{\partial S}{\partial \Delta r} = \frac{e^{\Delta r}\theta W}{(e^{\Delta r} + \theta)^2} > 0. \tag{20}$$

Using equation (9) and the response of the equilibrium swap amount in (20), it follows that foreign reserve holdings increase with the difference between the foreign and domestic interest rates paid on reserves,

$$\frac{\partial R^f}{\partial \Delta r} = \frac{1}{1 + r^f}\left[\frac{\partial S}{\partial \Delta r} - h' \frac{\partial L^f}{\partial \Delta r}\right] > 0. \tag{21}$$

This increase in foreign reserve holdings comes from a higher swap amount in equilibrium and the cutback in foreign lending. On the other hand, domestic reserve holdings decrease with the difference between the foreign and domestic interest rates paid on reserves,

$$\frac{\partial R^d}{\partial \Delta r} = \frac{\partial D}{\partial \Delta r} - X^0 \frac{\partial L^f}{\partial \Delta r} - \frac{\partial L^d}{\partial \Delta r} - X^0 \frac{\partial R^f}{\partial \Delta r} < 0. \tag{22}$$

To highlight the economics behind these derivatives, let's consider that domestic interest rates decrease (Δr increases). An increase in the interest rate differential would make lending abroad relatively less attractive. Given the capital constraint, this would lead to a contraction in lending in foreign currency, with the global bank's capital used to expand lending in domestic currency. In addition, for a global bank, a decrease in the domestic interest rate makes foreign reserves more attractive. In equilibrium, FX swapping activity increases along with an increase in foreign reserve holdings. Both effects—contraction in lending in foreign currency and shift into foreign reserve assets—happen absent of any policy movement by the foreign central bank.

As discussed above, 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 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, the bank responds to a wider interest rate differential 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 lending relative to total lending, which is decreasing in Δr, as $\partial(L^f/((L^f + L^d))/\partial\Delta r < 0$.

C. Empirical Implications

To test the theoretical predictions (partial effects), our goal is to measure the effect of changes in the interest rate differential on global bank's cross-currency flows, net of other confounding effects. However, in the data, to isolate the direct effect of the interest rates movement, we need to account for concurrent factors that are correlated with changes in interest rates. To understand the potential indirect effect of concurrent movements in the spot exchange rate (through the exchange rate channel of monetary policy), we use our economic model to derive *total* effects of a change in the interest rate differential. For example, the total derivative for foreign lending with respect to an interest rate differential is:

$$\frac{dL^f}{d\Delta r} = \frac{\partial L^f}{\partial \Delta r} + \frac{\partial L^f}{\partial X_0}\frac{dX_0}{d\Delta r} + \frac{\partial L^f}{\partial K/\alpha}\frac{dK/\alpha}{d\Delta r},$$

which takes into account indirect effects of a change in the interest rate differential through changes in the spot rate ($dX_0/d\Delta r$) and capital ($dK/\alpha/d\Delta r$). Assuming bank capital is not affected by changes in the interest rate differential—that is, focusing on the exchange rate channel—we have:[13]

$$\frac{dL^f}{d\Delta r} = \left(\frac{h''}{h'} + \frac{g''}{g'} X^0\right)^{-1} \left(1 - \frac{g''}{g'} L^f \frac{dX_0}{d\Delta r}\right) < \frac{\partial L^f}{\partial \Delta r} < 0,$$

under the condition that the spot rate increases (foreign currency appreciates) when the interest rate differential increases, $dX_0/d\Delta r > 0$. A large literature has shown that empirically this condition is typically borne out in the data, see Engel (2014) and the reference therein. Thus, when we account for the appreciation of foreign currency, the withdrawal of foreign lending in response to an increase in the interest rate differential is accelerated. All else equal, foreign lending decreases when the foreign currency appreciates ($\partial L^f/\partial X_0 < 0$) because bank's funding is domestic and its value in foreign currency shrinks.

Similarly, one can show that the total effects of other variables have the same sign as the partial effects: $dS/d\Delta r > 0$; $dR^f/d\Delta r > 0$; $dR^d/d\Delta r > 0$; $dL^d/d\Delta r > 0$. Moreover, we can derive predictions on the relative size of the total as compared to the partial effects. In particular, we can show that $dS/d\Delta r < \partial S/\partial \Delta r$ and $dR^f/d\Delta r < \partial R^f/\partial \Delta r$; that is, the total effect of a change in interest rate differential on swap activity and foreign reserve assets is smaller compared with the partial effect (because the stronger foreign currency makes foreign reserve holdings less profitable).

In the next sections, we test the model predictions in a linear regression framework. As discussed above, foreign lending—our main variable of interest—is an implicit function of the

[13] For simplicity, we assume that FX exposure is fully hedged.

interest rate differential, the spot exchange rate, and capital. Assuming the implicit function theorem applies, we can use a Taylor expansion to write L^f as:

$$L^f(\Delta r, X_0, K/\alpha) = constant + \frac{\partial L^f}{\partial \Delta r}\Delta r + \frac{\partial L^f}{\partial X_0}X_0 + \frac{\partial L^f}{\partial\ K/\alpha}\ K/\alpha + other\ terms.$$

Thus, the economic model suggests that we should in our empirical tests control for the spot exchange rate as well as bank capitalization to recover the partial effects of interest rates differential. Without controlling for the spot rate, the estimated coefficient on Δr corresponds to the total derivative, which is also economically interesting to understand the total effect. Therefore, we will report it throughout.

II. Data

In the empirical analysis, we use several bank-activity data sources, which provide us a window into different elements of the mechanisms outlined in the previous section. First, to understand the connection between lending and reserve assets holdings, we use the Call Reports, which include the quarterly balance sheet data on global bank activity in the U.S. collected as part of bank supervision. Moreover, the Call Reports enables us to see the movement of capital between U.S. and foreign offices of global banks, which is the key element of their international operations. These data is the core of the analysis in Cetorelli and Goldberg (2012). We consolidate the branch and subsidiary-level data at the parent, so the unit of observation in these data is bank-quarter.

We complement the aggregate analysis with data on FX swap volumes from the survey conducted by the Federal Reserve Bank of New York. The survey is administered twice a year and collects information on swap volume from individual currencies to U.S. dollars for months of April and October for dealer banks and non-financial sector. We focus on the former. The data are reported at the currency-pair level. In addition, for the same sample as the survey data, we use forward premium for a one-year FX swap downloaded from Bloomberg.

The second aggregate data source is Bank for International Settlements (BIS) Locational Banking Statistics, which provides quarterly data on cross-border bank claims on private, nonbank counterparties (firms), claims on the official sector (including government and the central bank), as well as intragroup claims on related bank offices. One shortcoming of these data is that claims on firms include corporate bonds and other claims held by the banks, and not just loans. BIS data aggregates banks at the country levels; however, unlike Call Reports, it gives information for a range of countries and disaggregates holdings by currency denomination. Thus, the unit of observation for this data set is country-currency-quarter level.

The third and most granular data source of bank activity is from Thompson Reuters DealScan database of global corporate loan issuance. This data set contains information on individual loan issuance and allows us to identify borrowers and their home country, lenders in the syndicate, and contractual details including the loan amount, currency denomination. The difference between DealScan coverage as compared to Call Reports or BIS data is that it primarily covers syndicated loans, that is loans funded by a group of lenders (under the same credit agreement). Thus, loans covered in DealScan are a subset of activity captured in our aggregate data sources, corresponding to the largest loans. Based on the sample covered by Shared National Credits (SNC) Program, in the United States, in 2006, there was $4.1 trillion in syndicated loans committed and $2.0 trillion outstanding (i.e., drawn). This is comparable to the stock of C&I held by the entire commercial banking sector. SNC indicates that about 45% of the syndicated loan commitments was held by U.S. banks, and 34% was held by foreign banking institutions. Revolving lines tend to be primarily funded primarily by banks. In that sense, in 2016, as a lower bound syndicated loans represented about 45% of the U.S. C&I lending activity. Overall, syndicated lending activity captures a substantial fraction of commercial credit.

Syndicated loans often have multiple facilities within the same loan; in our analysis, we look at the total loan volume without distinguishing between individual loan parts. In addition, we focus on top-tier lenders within a syndicate by excluding lenders with a role marked as "Participant," which is typically reserved for lenders with small financial commitments. The information on the share held by the banks is scarce for international sample, so, when looking at the individual bank lending volume, we pro-rate the loan amount among lenders in our sample.[14] As with the Call Report data, loans are aggregated at the lender-parent level. Our sample has 166 global banks with foreign offices in at least one of the six currency areas. A complete list of the global banks included in the sample, as well as the list of currency areas where they have access to the monetary authority, is reported in the Internet Appendix.

Although BIS and DealScan data enable us to see the underlying currency of the transaction, all activity is reported in U.S. dollars. Therefore, movements in dollar exchange rate (relative to the currency of the loan) could mechanically introduce variation in loan volumes. To make sure that we pick up variation in actual loan volumes and not just variation in dollar exchange rates, all

[14] All of the loans in our sample are syndicated. The exact share of loan kept by the lenders is scarcely reported, especially for international sample. However, we know that effectively there are three tiers of lenders in a syndicate which can be detected based on the title of the role they receive in the syndicate: (i) the originators/arrangers (tier 1), (ii) other anchor investors (e.g., "co-arrangers"), and (iii) an array of small investors (tier 3) which receive an undistinguished title "participant". (The titles are important because they are used to compute league tables.) We compute loan share by dividing the loan amount by the number of anchor lenders. Exclude "tier 3"-lenders from the sample helps us to reduce the measurement bias.

specifications based on loan volume include controls for the exchange rate between the U.S. dollar and the currency of the loan. (The coefficient estimates are not reported in the tables.)

Throughout our analysis, the central explanatory variable is the difference in interest rates on reserve assets between two currency areas. As a benchmark, we look at the *IOER difference* ($\Delta r = r^f - r^d$), defined as the difference between the interest rate paid on excess reserves in a given foreign currency and the interest rate paid on excess reserves in the domestic currency of the bank.[15] As in the model, "foreign currency" (investment currency) is defined relative to the bank's domestic currency (funding currency), which is the currency of the country where the bank is headquartered. Unless stated otherwise, 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 IOER rates for the six major currencies from 2000 to 2016. As robustness, we show results based on the overnight interbank lending rate. All interest rate data are from Haver Analytics, collected at a daily frequency (in the regressions, we take the quarterly average of the daily variables).

(Table I here)

[15] 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.

Finally, when using Call Reports (U.S. only), we focus on the period 2008:Q3 through 2016:Q4, a period during which the excess reserves in the system were abundant.[16] For the rest of our analysis, we use data for the sample period from 2000:Q1 to 2016:Q4.

III. Empirical Results

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 find that the introduction of the interest rate paid on excess reserves in the United States led to a large increase in foreign banks' deposits at the U.S. central banking system. As Figure 1 shows, at its highest point, foreign banks' reserve holdings were USD 1.2 trillion. While the large rise in value of reserve holdings is also related to the increase in reserve supply through the Fed's unconventional monetary policy, we also find the relative share of foreign banks' holdings increased to more than 50% of all reserves.[17]

(Figure 1 here)

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[16] The Fed started paying interest on reserves in October 2008 to have an additional policy tool to stabilize short-term interest rates given the large supply of reserves, see https://www.federalreserve.gov/monetarypolicy/20081006a.htm.

[17] 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.

However, an important cross-sectional heterogeneity in reserve holdings stands out: As Figure 2 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.

(Figure 2 here)

The vertical axis in Figure 2 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 2 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 2016:Q4. 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 here)

Table II, Panel A, Column (1), relates to the point illustrated in Figure 2, but instead looks at the individual-bank level and focuses on banks from the major currency areas.[18] The positive

[18] In Table II, standard errors are clustered at the bank and quarter level. When using multi-currency micro data, first, we will cluster standard errors at the bank and currency*quarter level. In the borrower level analysis, we will cluster at the bank*borrower and currency*quarter level. This reflects our view that

coefficient estimate on the IOER differential confirms 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 through the Fed's large-scale asset purchases 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 15% (the coefficient estimate is marginally significant with a *t*-statistics of 1.68).

The estimated effects in column (2) correspond to a total effect that includes indirect effects on reserve holdings through concurrent movements in the spot exchange rate (see our theoretical discussion in Section II). To isolate the direct (partial) effect of a change in the IOER differential, we include in column (3) the spot exchange rate between the U.S. and the foreign country. Consistent with our theoretical prediction, the coefficient estimate increases and is significant at the 5% level, suggesting a 19% increase in reserve deposits per 25-basis-point increase in the IOER rate differential. Panel A shows similar results when using the overnight interest rate differential. (Unreported results based on the three-month interest rate differential confirm this finding.)

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investments are likely to be correlated within bank-borrower and across banks for investments made in the same currency and quarter.

Policy rates could be endogenous to economic conditions, potentially raising concerns about a causal interpretation of the estimated effects. Therefore, in columns (4) and (5), we instrument the interest rate differentials with two different monetary policy shocks identified from high-frequency financial market data. First, we use surprise changes in the federal funds rate identified from fed funds future movements on Federal Open Market Committee (FOMC) announcement days (e.g., Bernanke and Kuttner, 2005; Gürkaynak, Sack, and Swanson, 2007). Second, we use the monetary policy shock measure by Nakamura and Steinsson (2017) that incorporates other high-frequency asset price changes in a narrow 30-minute window around FOMC statement.[19] Because movements in a tight time window around FOMC statements are likely to be unrelated to changes in both U.S. and foreign economic conditions, these shocks qualify as exogenous instruments. In line with the rest of our data, we aggregate the monetary policy shocks to a quarterly frequency and use current and lagged values of these aggregated monetary policy shocks as instruments for the interest rate differential. (Kleinbergen-Paap statistic suggests that these instruments are relevant with an LM statistic of 15.77 and p-value < 1% for the fed funds shocks, and LM statistic of 14.83 and p-value < 1% for the Nakamura-Steinsson shock.)

Results based on monetary policy shocks confirm that an increase in the IOER differential between the U.S. and abroad leads to a surge in foreign banks' reserve holdings. For example, the estimate in column (4) suggests that reserve holdings increase by about 48% in response to a 25-basis-point surprise increase in the interest rate differential (the standard deviation of the fed funds surprise is 9 basis points during our sample period). Similarly, in Panel B, we find that foreign banks operating in the United States increase their holdings of U.S. Treasuries—another important

[19] Nakamura and Steinsson (2017) shocks are obtained from Emi Nakamura's website and are available only until 2014:Q4.

class of reserve assets—if the interest rate differential between the Fed and the central bank in the foreign banks' home country increases. For example, in column (4), we estimate an increase in Treasury holdings of 25% per 25-basis-point surprise increase in the IOER rate differential. Results are quantitatively similar using the Nakamura-Steinsson shocks. Note that due to a lack of homogeneous monetary policy shock measures in a cross-country setting, in columns (4) and (5), we only identify movements in the interest rate differentials from surprise changes in U.S. monetary policy. This is different to our cross-sectional analysis in columns (2) and (3), where variation comes from differences in foreign interest rates within a given quarter, while U.S. conditions are absorbed in the time fixed effects.

In Panels C and D, 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 predictions, 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. Consistent with our model prediction, we also find that partial effects (columns 3) are larger than total effects (columns 2), that is, when we do not control for simulations movement in the spot rate, the reduction in foreign lending in response to an increased interest rate differential is stronger. In column (3), 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%, while the dollar amount of total loans and leases decreases by about 12%.[20] Results based on monetary policy shocks are qualitatively

[20] While we use the interest rate differential based on the IOER rate—the main monetary policy tool since 2008—as the benchmark case, Table II shows that the main results are robust to alternative interest rate differentials based on the overnight interbank rate, which is closely linked to the IOER rate set by the central bank. Results on other short-term rates, such as 3-month rates are similar, but not shown to avoid cluttering.

similar, albeit smaller (in absolute values) in magnitude. For example, in column (4), we find that C&I loans and total loans decrease by 3.75 and 4.13%, respectively. (Recall again that monetary policy shocks are only available for the United States and do not take into account foreign monetary policy shocks.) We should also point out that—while signs of the estimated coefficients are consistent across different specifications—the statistical significance is not stable in all cases.

(Table III here)

In Table III, Panel A, we look at the funding side of the balance sheet. We 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"). To this end, for each bank-parent, we compute the net intragroup borrowing (from foreign offices outside of the U.S.) by adding up the "net due to" positions (borrowing) and subtracting the "net due from" positions (lending). Consistent with the theory of internal capital markets, we find that banks actively reallocate funds to smooth out local shocks, such as a monetary tightening in the United States. The coefficient estimate in column (3), which includes bank and quarter fixed effects as well as the spot rate control, indicates that U.S. branches of global banks that face a 25-basis-points-higher IOER rate differential increase their net borrowing from offices outside of the United States by about USD 2.1 billion. The result presented in column (4)—that is, the specification that instruments the interest rate differential with the surprise change in the federal funds rate target—shows a qualitatively similar estimate. 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.[21]

In Table III, we also look at the volume and cost of FX swaps. The results in column (3) 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 USD 5.5 billion. The results using the federal funds rate surprises confirm this finding (column 4). Results based on the policy news shock are smaller in value and not statistically significant (note the smaller sample). Along with the increase in the swap volume, we also document in Panel C, column (3) an increase in the cost of swapping by 15.8 basis points, as measured by the one-year forward premium, but results are similar if we look at the forward premium at other maturities. Recall that the forward premium is the total "cost" of an FX swap (to facilitate the interpretation we have rescaled the forward premium such that a higher forward premium means the swap becomes more expensive). 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, holdings of foreign reserve assets and intra-group transfers—in a cross-country setting using BIS data.

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[21] The estimated effects for 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.

(Table IV here)

Table IV reports the means and standard deviations of claims by different banking sectors on the official sectors of the six major currency areas. 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 1.17 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 645 billion and USD 250 billion, respectively. The magnitudes of these holdings as well as the size of their variation suggest that holdings of foreign reserve assets are not exclusively a U.S.-dollar phenomenon.

(Table V here)

In Table V, we look at the relationship between interest rate differentials and banks' cross-border claims broken down by currency and sector. In 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 foreign-currency cross-border claims on foreign firms. In line with our previous findings for the United States, 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.[22] This result holds after we control for currency-quarter fixed effects, that is, when we look at the variation of claims in a given foreign-currency *within* the same quarter. Consistent with our theoretical prediction, column (1) shows the total effect of an interest rate change is larger (in absolute values) that the direct (partial) effect shown in column (2), where we

[22] 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, but results are similar if we include them.

control for the spot exchange rate. In 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 1.2% less in foreign-currency claims on foreign firms (total effect in column 1 indicates a reduction of about 2%). The results, based on the overnight rate difference are quantitatively larger.

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 of foreign banks' reserve holdings at the Fed, 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 foreign-currency claims on the foreign official sector, including the central bank and the government. Again, total effects in column (3) are smaller than direct effects in column (4). In column (4), we estimate that a 25-basis-point increase in the IOER rate difference increases the claims on the foreign official sector by about 14.4%. This result—like all results obtained using the BIS data—holds when we exclude U.S. dollar activity from the sample; that is, we are not measuring an effect that is specific to the U.S. dollar. Again, our finding is robust to using alternative interest rate differentials, for example, based on the overnight interbank lending rate.

In columns (5) and (6), we show, consistent with our analysis of the U.S. Call Reports, that global banks reallocate capital to high-interest-rate currencies within their global banking organization. Column (6) shows that a 25-basis-point increase in the IOER rate difference leads to additional internal cross-border capital transfer into foreign currency by 1.9%. Estimates based on the overnight rate differential point to an increase of about 4%. As before, and consistent with our theoretical framework, we find that the direct (partial) effects are larger than total effects.

Next, we analyze the role of FX swaps in funding assets denominated in foreign currency through synthetic funding. Following McGuire and von Peter (2012), 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. 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.[23]

As columns (7) and (8) 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 result in column (8), where we include the spot exchange rate, indicates that a 25-basis-point increase in the interest rate differential increases the FX swap volume by a sizable amount of about USD 9.7 billion. Total effects are somewhat smaller, in line with our model prediction. In columns (9) and (10), we show that the increase in the demand for FX swaps by banks is accompanied by an increase in the forward premium. Specifically, we find that the one-year forward premium increases by about 18 basis points per 25-basis-point increase in the IOER differential. (Leaving aside the maturity mismatch, this finding shows that CIP roughly holds.) Results are qualitatively similar if we use the forward premium at other maturities. As before, we have rescaled the forward premium for ease of interpretation, such that a higher forward premium

[23] We thank Swapan-Kumar Pradhan from BIS for pointing out to us that data on the currency breakdown of total assets and liabilities exhibit a structural break in 2012:Q2 for some reporting banking sectors and currencies. To account for the level shift, we include in our regressions in columns (7) and (8) banking-sector*currency*post-2012:Q1 fixed effects, thereby allowing for a different intercept before and after 2012:Q2 for each banking-sector-currency pair.

means the swap becomes more expensive. All findings are robust to other measures of interest rate differentials, for example, the overnight rate differential presented in the bottom panel.

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, and reduce their cross-border credit to foreign firms.

(Figure 3 here)

Our key finding that cross-border lending decreases after an increase in the interest rate differential is also illustrated in Figure 3, 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% by 6 percentage points, leading to a contraction of credit in the magnitude of 4%.

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 in a cross-country setting, we next analyze DealScan loan issuance data. Loan-level data allow us to control better for confounding effects of loan demand, which is particularly important given that no homogenous monetary policy shocks series are available in a multi-country setting. Our main identification in this section is based on loan-level data and uses borrower-quarter and bank-quarter fixed effects. In particular, following the standard in the monetary policy transmission literature based on loan-level data (e.g., Jimenez et al. 2012), we exploit within borrower-quarter variation of foreign banks commitments to control for loan demand, and within bank-quarter comparison of loan volumes across different currencies to control for general credit supply by individual banks.

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.

(Table VI here)

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 (5), and the share based on the number of loans in columns (6) to (10). 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. Moreover, we include in all regressions the spot exchange rate between the bank's home currency area and the currency of lending to isolate the partial effect of a change in the interest rate differential.

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 0.74-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 about 2%. The impact on the number of loans, reported in column (6), 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% relative to the average share of 35 percentage points).[24]

In columns (2) and (7), we look at the effect of bank capital on the international monetary policy transmission mechanism through interest rate differentials. 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 (7) 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.[25] 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, as a response to an increase in the IOER rate differential of 25 basis points, a bank with an equity ratio of 2.5 percentage points (one standard deviation) below the sample mean of 5.7% cuts down the share of lending in a given currency by an additional 39% (an additional reduction of 0.31 percentage points on top of the average reduction of 0.81 percentage 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

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[24] 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.

[25] 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.

In columns (3) and (8), we show that the results are not driven by USD-denominated loans. To this end, we include an interaction term between the interest rate differential and a dummy variable that equals one if the lending currency is the U.S. dollar, and zero otherwise. The coefficient on the interest rate differential then measures the effect for all other currencies (excluding the U.S. dollar), while the coefficient on the interaction term measures the differential effect of the U.S. dollar relative to all other currencies. In columns (3) and (8), we find a significant negative coefficient estimate on the interest rate differential. Hence, the mechanism is not confined to the United States but a broader phenomenon across major currency areas, although the economic effects are somewhat stronger for USD-denominated lending as indicated by the negative interaction term in column (3), which is significant at the 10% level.

We are ultimately interested in the monetary spillover to lending of global banks in foreign markets, rather than currencies. In columns (4), (5), (9), and (10), 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 (4), we estimate that a 25-basis-point increase in *IOER difference* is associated with a 0.67-percentage-point decrease in the lending volume share. Relative to the average share of 37.23 percentage points, this is a reduction of about 2%. Column (7) points to a reduction of 1.8% (relative to the average share of 37.23 percentage points), due to an increase in the interest rate differential of 25 basis points.

Finally, in columns (5) and (10), 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 1.5 percentage points per 25-basis-point increase in the interest rate differential (which equals 4.5% when compared with the mean share of 33.21 percentage points).

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

The results presented so far are consistent with the novel 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.[26] 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

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

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. Moreover, 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.

(Table VII here)

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.[27] Again, we look at two margins of credit: the probability of lending (extensive margin)

[27] 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. Of course, this is still not a randomized setting, but, to the degree that there some remaining effects from borrower-lender selection, such borrower-lender matching would need to line up with evolution of interest rates differentials.

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. As before, we focus on estimating the partial effect of an interest rate change and therefore include the spot exchange rate between the borrower and lender county in all specifications.

In Table VII, columns (1) through (4) refer to 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 2.8-basis-point-lower probability of lending (1.2% decline relative to the mean lending probability of 2.5 percent). In columns (2) through (4), 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.[28] 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. 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 addition, we control for

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

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. Borrower-quarter fixed also control for other time-varying firm heterogeneity, such as differential loan demand by firms with currency imbalances on their balance sheets. 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 3.9 basis points (a decline of 1.6% 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 (4), where we include the differences in IP growth and CPI growth between the borrower country and the bank country as additional variables.

In columns (5) through (8), 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 column (5) with the full sample and then restrict the sample to comply with the identification of the fixed effects in columns (6) through (8). 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 and borrower-quarter fixed effects, which represents our benchmark result (column 7). The estimated economic effect in column (7) amounts to a reduction in the lending amount of about 3.6% for a change in the 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 (8), in addition, we control directly for differences in macroeconomic conditions between the borrower and lender country by the differences in IP growth and CPI growth. 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.[29] 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.

(Table VIII here)

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. Moreover, we include time-varying firm characteristics—total assets, return on assets, total debt (relative to assets), as well as property, plant and equipment (relative to assets)—to account for time-varying firm heterogeneity. Compared with the mean loan probability of 3.65%, our coefficient estimate suggests that a one-

[29] 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.

standard-deviation (17.1 percentage points) change in past foreign bank reliance corresponds to a relative change in the probability of a loan of 11%. 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 change. Hence, in this specification, we precisely estimate the spillover of monetary policy shocks to other markets. A one-standard-deviation change in past foreign bank reliance corresponds to a change in the probability of a loan of 12%, 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. Again, all specifications include firm and time fixed effects as well as time-varying firm controls. 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 (18.1 percentage points) corresponds to a relative reduction in the loan amount of granted loans of 4.5%. This result is quantitatively robust if conditioned on periods after a positive IOER rate change that was triggered by a foreign monetary policy change (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. Final Remarks

Multinational banks play a prominent role in economies around the world. Not surprisingly, there is 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 easing (tightening) monetary policy in one country has positive (negative) spillovers on the global lending of multinational banks more broadly. For example, tightening monetary actions by the ECB would lead to a contraction in credit by Eurozone banks in Mexico (Morais, Peydro, and Ruiz 2019), 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 monetary policy 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 this paper, we emphasize that a capital-constrained bank will need to consider the allocation of a fix amount of equity capital to back lending in multiple currencies. This interlinks global bank's lending decisions in different currencies, with the equilibrium lending portfolio composition depending on the opportunity cost of lending in each currency. Because monetary policy affects these opportunity cost by setting the interest rate on reserve assets, local policy rate changes will have international spillover effects to loan supply in other currencies. For example, a domestic policy easing will lead to an increase in domestic lending at the expense of a reduction in foreign credit. Thus, the cross-border spillover effects of monetary policy go in the opposite direction than the channel postulated by the internal markets view.

We test our prediction in the context of changes in the IOER rate in six major currency areas between 2000 and 2016. 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 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.

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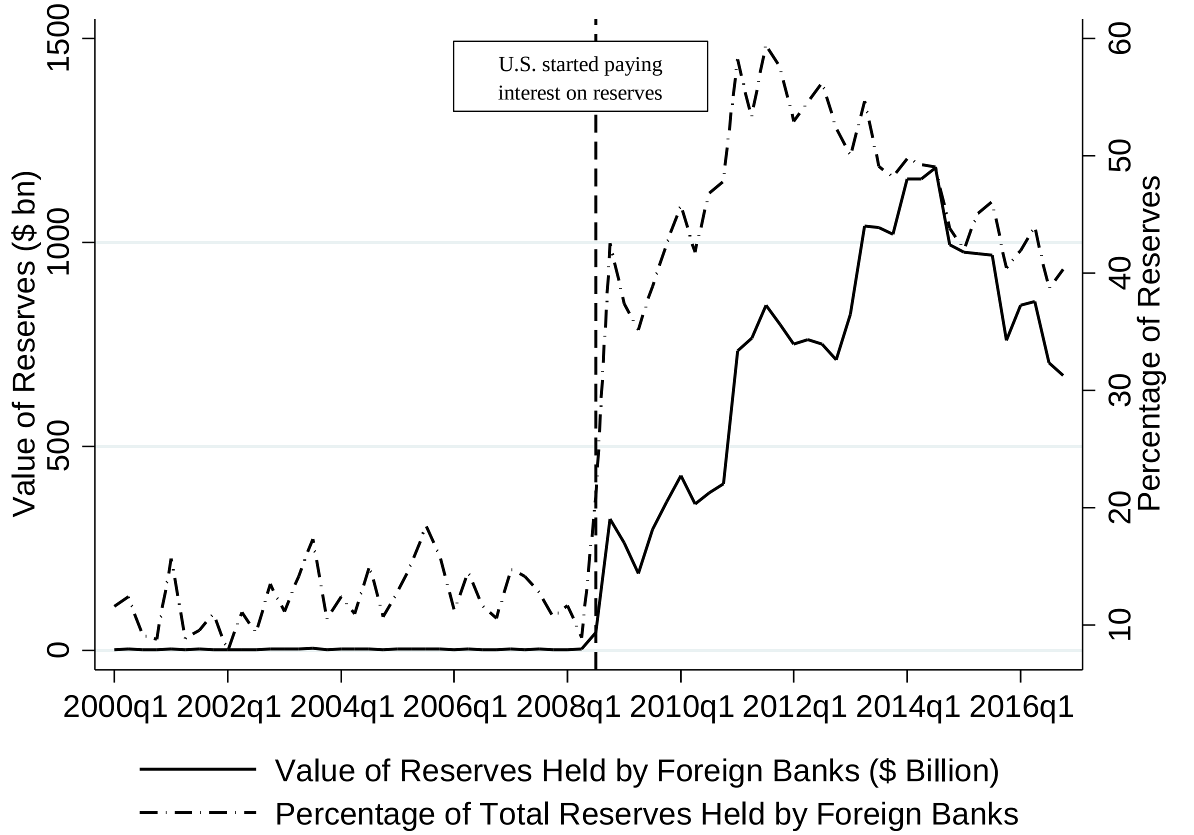

Figure 1. Foreign Banks' Reserve Holdings at The Federal Reserve. The solid line shows the deposits (in billions of USD) held by foreign banks at U.S. Federal Reserve Banks for the period from 2000:Q1 to 2016:Q4. The dashed line (secondary axis) shows the foreign holdings as a percentage of total reserves. The vertical dashed line indicates 2008:Q4, when the Federal Reserve started paying interest on reserves held against deposits.

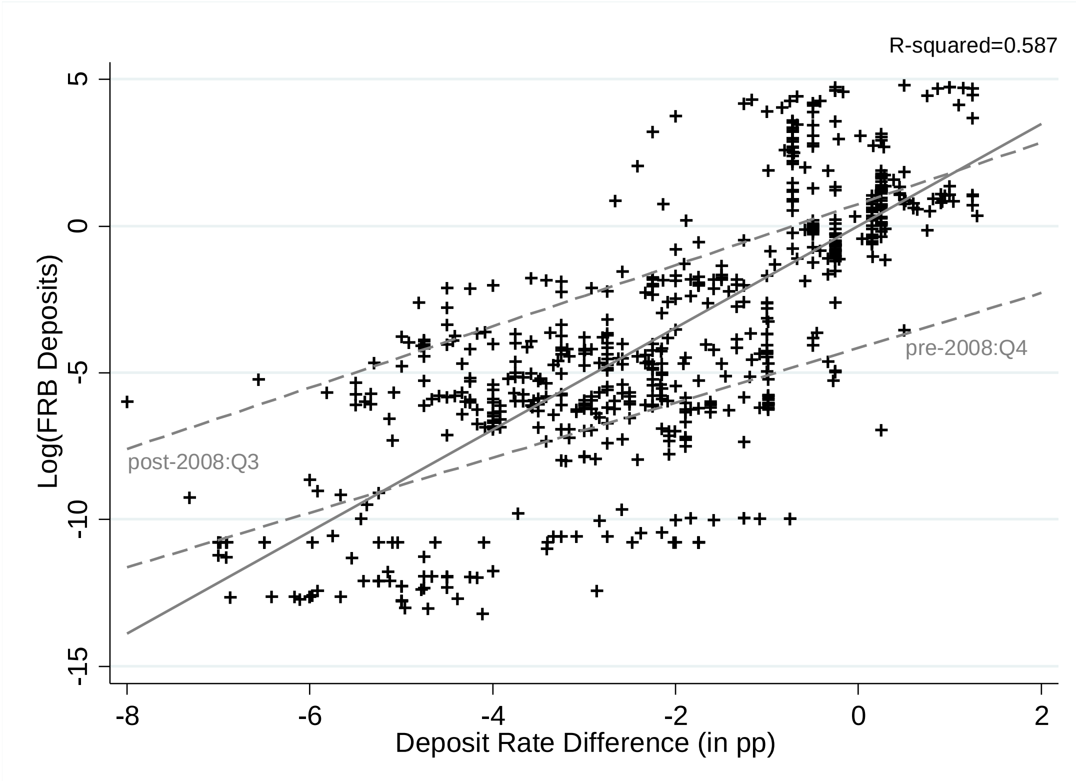

Figure 2. IOER Differential and Foreign Banks' Reserve Holdings at the Federal Reserve. *Log(FRB Deposits)* is the (logarithm of) a foreign bank's deposits held at the Federal Reserve. *Deposit Rate Difference* is the difference in the interest paid on reserves in the U.S. and the foreign bank's home country. *Log(FRB Deposits)* are adjusted for currency-area fixed effects. That is, we first estimate the regression *Log(FRB Deposits)=α+β Deposit Rate Difference + Currency Area FE + residual*, and then plot (*Log(FRB Deposits)-Estimated Currency Area FE*) against the deposit rate difference. The sample covers reserve holdings by foreign banks from 16 currency areas from 2000:Q1 to 2016:Q4.

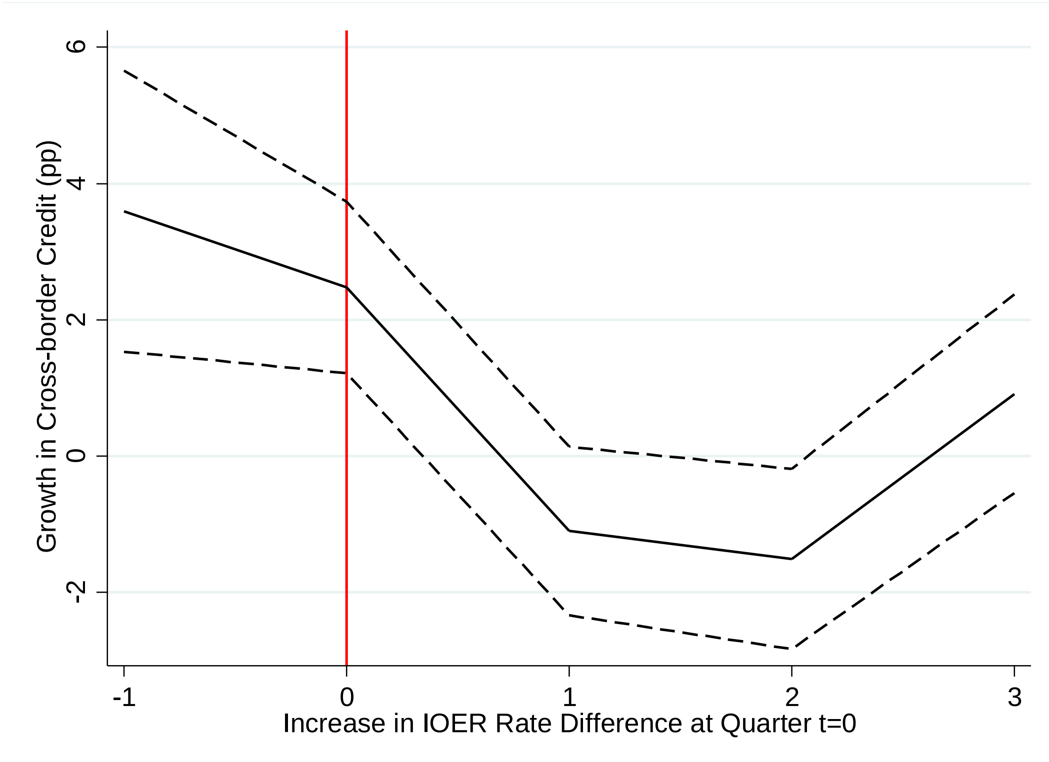

Figure 3. Cross-Border Credit after Increase in IOER Rate Difference. *Growth in Cross-border Credit* is defined as the percentage change in cross-border claims on private, nonbank entities (firms). The sample covers the period from 2000:Q1 to 2016:Q4 and includes banks and nonbank firms from the United States, the Eurozone, the United Kingdom, Japan, Switzerland, and Canada. The solid line is the mean of the conditional distribution of *Growth in Cross-border Credit* (conditional on the time after an IOER rate differential increase), and the dashed lines refer to the conditional interquartile range.

Table I
Changes in Interest Rate Paid on Excess Reserves, 2000–2016

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
06/04/02	0.00	2.25	2.25	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

Date	US	EA	CA	GB	CH	JP
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
06/07/06	0.00	1.50	4.00	4.25	0.00	0.00
06/15/06	0.00	1.75	4.00	3.50	0.00	0.00
07/05/06	0.00	1.75	4.00	4.25	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
09/06/06	0.00	2.00	4.00	4.50	0.00	0.00
10/11/06	0.00	2.25	4.00	3.75	0.00	0.00
11/08/06	0.00	2.25	4.00	4.50	0.00	0.00
11/09/06	0.00	2.25	4.00	4.00	0.00	0.00
12/06/06	0.00	2.25	4.00	4.75	0.00	0.00
12/13/06	0.00	2.50	4.00	4.00	0.00	0.00
01/10/07	0.00	2.50	4.00	4.75	0.00	0.00
01/11/07	0.00	2.50	4.00	4.25	0.00	0.00
02/07/07	0.00	2.50	4.00	5.00	0.00	0.00
03/14/07	0.00	2.75	4.00	4.25	0.00	0.00
04/04/07	0.00	2.75	4.00	5.00	0.00	0.00
05/10/07	0.00	2.75	4.00	4.50	0.00	0.00
06/06/07	0.00	2.75	4.00	5.25	0.00	0.00
06/13/07	0.00	3.00	4.00	4.50	0.00	0.00
07/04/07	0.00	3.00	4.00	5.25	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
08/01/07	0.00	3.00	4.25	5.50	0.00	0.00
12/05/07	0.00	3.00	4.00	5.50	0.00	0.00
01/22/08	0.00	3.00	3.75	4.50	0.00	0.00
02/06/08	0.00	3.00	3.75	5.25	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
03/05/08	0.00	3.00	3.25	5.00	0.00	0.00

Date	US	EA	CA	GB	CH	JP
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
05/07/08	0.00	3.00	2.75	4.75	0.00	0.00
07/09/08	0.00	3.25	2.75	4.75	0.00	0.00
07/10/08	0.00	3.25	2.75	4.00	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
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
01/21/15	0.25	-0.20	0.50	0.50	0.00	0.10
01/22/15	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
02/16/16	0.50	-0.30	0.25	0.50	-0.75	-0.10
03/16/16	0.50	-0.40	0.25	0.50	-0.75	-0.10
08/04/16	0.50	-0.40	0.25	0.25	-0.75	-0.10
12/15/16	0.75	-0.40	0.25	0.25	-0.75	-0.10

Table II
Reserve Assets and Bank Lending by Foreign Banks in the United States

	(1)	(2)	(3)	(4) IV: Fed Funds	(5) IV: Policy News	(1)	(2)	(3)	(4) IV: Fed Funds	(5) IV: Policy News
	Panel A – Dependent Variable: Log(Reserves)					Panel B – Dependent Variable: Log(Treasuries)				
IOER Difference (pp)	1.230***	0.584	0.757**	1.909***	2.083***	1.029**	0.382	0.187	1.001***	0.698***
	(5.02)	(1.68)	(2.46)	(4.85)	(3.12)	(2.58)	(0.88)	(0.50)	(3.77)	(2.84)
R-sq.	0.753	0.787	0.789	0.751	0.766	0.796	0.814	0.818	0.796	0.854
ON Rate Difference (pp)	0.976***	0.425	0.597*	1.574***	1.758***	0.812**	0.281	0.091	0.805***	0.584***
	(4.10)	(1.11)	(1.72)	(4.67)	(2.85)	(2.49)	(0.63)	(0.23)	(3.93)	(2.86)
R-sq.	0.750	0.787	0.789	0.748	0.761	0.793	0.813	0.817	0.793	0.853
Observations	1,923	1,923	1,923	1,923	1,318	847	847	847	847	561
	Panel C – Dependent Variable: Log(C&I Loans)					Panel D – Dependent Variable: Log(Total Loans)				
IOER Difference (pp)	-0.065	-0.418**	-0.392**	-0.152*	-0.169*	-0.124	-0.462**	-0.411**	-0.165*	-0.207
	(-0.51)	(-2.26)	(-2.15)	(-1.80)	(-1.79)	(-1.20)	(-2.66)	(-2.65)	(-1.88)	(-1.70)
R-sq.	0.905	0.909	0.910	0.906	0.942	0.927	0.931	0.932	0.929	0.937
ON Rate Difference (pp)	-0.066	-0.435**	-0.415**	-0.124*	-0.142*	-0.108	-0.454***	-0.408***	-0.134*	-0.174
	(-0.63)	(-2.42)	(-2.24)	(-1.81)	(-1.77)	(-1.29)	(-3.04)	(-2.91)	(-1.89)	(-1.65)
R-sq.	0.905	0.910	0.910	0.906	0.942	0.927	0.932	0.932	0.929	0.937
Observations	1,836	1,836	1,836	1,836	1,270	1,892	1,892	1,892	1,892	1,309
Fixed Effects:										
Bank (D_i)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter (D_t)	--	Yes	Yes	N/A	N/A	--	Yes	Yes	N/A	N/A
FX Spot Rate	--	--	Yes	Yes	Yes	--	--	Yes	Yes	Yes

The dependent variables are selected balance sheet positions of foreign branches and subsidiaries in the United States, consolidated at the bank-parent level. *Reserves* is the amount of reserves held at the Federal Reserve Banks. *Treasuries* is the amount of U.S. Treasury debt securities. *C&I Loans* are commercial and industrial loans. *Loans and Leases* refers to total loans and leases. The independent variables of interest are difference (in percentage points) between the rate in the U.S. (r^{US}) and the equivalent rate of the country where the bank is headquartered (r^d). *IOER* is the interest on excess reserves. *ON Rate* is the overnight interbank lending rate. As an example, specification (3), Panel A corresponds to:

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

where D_i are bank fixed effects, and D_t are quarter fixed effects. *FX Spot Rate* is the spot exchange rate between the United States and the country where the bank is headquartered. Columns (4) and (5) show the results when the federal funds rate is instrumented with different monetary policy shocks; see text for details. Robust *t*-statistics are in parentheses. Standard errors are two-way clustered at the bank and quarter level. ***, **, and * indicates statistical significance at the 1%, 5% and 10% level, respectively.

Table III
Internal Capital Reallocation by Foreign Banks in the U.S. and the Dollar FX Swap Market

	(1)	(2)	(3)	(4) IV: Fed Funds	(5) IV: Policy News
	A. Dependent Variable: Net Internal Borrowing				
IOER Difference (pp)	5.049***	9.204***	8.531***	3.201*	4.695
	(3.67)	(3.60)	(3.91)	(1.77)	(1.45)
R-sq.	0.623	0.657	0.658	0.623	0.543
ON Rate Difference (pp)	3.991***	8.493***	7.856***	2.578*	3.898
	(3.39)	(3.47)	(3.53)	(1.77)	(1.37)
R-sq.	0.621	0.657	0.658	0.621	0.540
Observations	1,990	1,990	1,990	1,990	1,360
	B. Dependent Variable: USD FX Swaps				
IOER Difference (pp)	22.924***	21.626***	21.882***	23.784*	2.833
	(5.75)	(5.52)	(6.28)	(1.90)	(0.17)
R-sq.	0.778	0.894	0.894	0.779	0.707
ON Rate Difference (pp)	23.815***	25.386***	25.788***	21.400*	0.878
	(5.68)	(5.33)	(5.98)	(1.92)	(0.06)
R-sq.	0.783	0.899	0.899	0.784	0.703
Observations	85	85	85	85	50
	C. Dependent Variable: USD Forward Premium				
IOER Difference (pp)	0.633**	0.638***	0.634***	0.353**	-0.208
	(2.16)	(6.11)	(6.36)	(2.13)	(-0.91)
R-sq.	0.661	0.904	0.905	0.633	0.478
ON Rate Difference (pp)	0.638**	0.728***	0.726***	0.310**	-0.185
	(2.32)	(8.04)	(8.22)	(2.09)	(-0.91)
R-sq.	0.683	0.937	0.937	0.638	0.474
Observations	85	85	85	85	50
Fixed Effects:					
Bank/Currency (D_i)	Yes	Yes	Yes	Yes	Yes
Quarter/Month (D_t)	--	Yes	Yes	N/A	N/A
FX Spot Rate	--	--	Yes	Yes	Yes

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 bank-parent level. *Net Internal Borrowing* (in USD billion) is defined as internal borrowing ("net due to") minus internal lending ("net due from"). *USD FX Swaps* (in USD billion) refers to the amount of FX swaps from each foreign currency into USD. *USD Forward Premium* (in percentage points) is the forward premium for a one-year swap, that is, the total "cost" of an FX swap. The independent variables of interest are difference (in percentage points) between the rate in the U.S. (r^{US}) and the equivalent rate of the country where the bank is headquartered (r^d). *IOER* is the interest on excess reserves. *ON Rate* is the overnight interbank lending rate. *FX Spot Rate* is the spot exchange rate between the United States and the foreign country/currency. Empirical specifications in Panel A are similar to those presented in Table II. In Panel B and C, due to the nature of the data, D_i refers to currency fixed effects, and D_t to month fixed effects. Robust t-statistics are in parentheses. Standard errors are two-way clustered at the bank and quarter level (Panel A) or clustered at month level (Panel B and C). ***, **, and * indicates statistical significance at the 1%, 5% and 10% level, respectively.

Table IV
Banks' Claims on Foreign Official Sector

Banks from:	Claims on the Official Sector of :					
	US	EA	GB	JP	CH	CA
US	--	139.52	53.57	77.66	13.39	14.38
		(51.36)	(32.70)	(37.45)	(12.72)	(6.81)
EA	241.06	--	75.93	120.04	34.33	26.46
	(140.53)		(36.63)	(45.72)	(21.43)	(12.29)
GB	194.92	170.52	--	45.03	20.89	15.46
	(99.01)	(71.20)		(20.19)	(20.51)	(6.51)
JP	404.74	225.85	38.28	--	0.76	16.76
	(137.24)	(29.61)	(9.32)		(0.19)	(2.58)
CH	174.50	84.75	38.62	N/A	--	3.74
	(68.11)	(27.98)	(16.89)			(1.43)
CA	154.04	24.34	13.41	6.93	0.27	--
	(72.22)	(14.20)	(7.21)	(5.63)	(0.42)	

The table reports the mean and standard deviation (in parentheses) of claims by different banking sectors on official sectors of the six major currency areas. Claims are expressed in billions of 2016:Q4 U.S. dollars. The sample period runs from 2005:Q1 through 2016:Q4. The data are compiled from BIS Consolidated Banking Statistics.

Table V
Cross-Border Claims and FX Swap Volumes by Banking Sector

Dependent Variable:	FX Claims on Firms		FX Claims on Official Sector		FX Intragroup Claims		FX Swapping Volume		FX Forward Premium	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
IOER Difference (pp)	-0.073***	-0.046**	0.536***	0.578***	0.048	0.076**	38.145***	38.836***	0.740***	0.720***
	(-3.27)	(-1.98)	(5.81)	(6.31)	(1.57)	(2.35)	(4.46)	(4.19)	(37.20)	(27.72)
R-sq.	0.934	0.939	0.820	0.825	0.898	0.900	0.987	0.987	0.952	0.954
ON Rate Difference (pp)	-0.132***	-0.102***	0.453***	0.488***	0.116***	0.171***	32.626***	34.011***	0.850***	0.841***
	(-4.02)	(-3.13)	(5.06)	(5.63)	(3.09)	(4.93)	(3.56)	(3.23)	(61.34)	(57.06)
R-sq.	0.935	0.940	0.816	0.821	0.899	0.901	0.986	0.986	0.981	0.982
Fixed Effects										
Banking Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Currency*Quarter	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FX Spot Rate	--	Yes	--	Yes	--	Yes	--	Yes	--	Yes
Observations	1,361	1,361	1,036	1,036	1,276	1,276	1,017	1,017	1,017	1,017

FX Claims on Firms, *FX Claims on Official Sector,* and *FX Intragroup Claims* refer to cross-border claims denominated in foreign currency *f* by a banking sector headquartered in currency area *d* on either private nonbank entities, foreign official sector (including central bank deposits and government debt holdings), and related offices, respectively. *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*. *FX Forward Premium* is the one-year forward premium in percentage points. All data are quarterly. There are two specifications for each dependent variables. For example, specification (2) corresponds to:

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

where D_d are fixed effects for the currency area of the banking sector, and $D_f \times D_t$ are currency interacted with quarter fixed effects. *FX Spot Rate* is the spot exchange rate between the foreign investment currency and the banking-sector currency. Columns (7) and (8) include Banking-Sector*Currency*Post-2012q1 fixed effects (unreported) to account for a structural break (level shift) in some data series in 2012:Q2. The change in the number of observations is due to data availability. Robust *t*-statistics are in parentheses. Standard errors are clustered at the quarter*currency level. ***, **, and * indicates statistical significance at the 1%, 5% and 10% level, respectively.

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	
					Drop in r^d					Drop in r^d
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
IOER Difference (pp)	-2.968***	-3.225***	-0.727**	-2.663***	-6.128***	-2.421***	-2.597***	-1.090***	-1.920***	-1.941*
	(-6.41)	(-5.07)	(-2.39)	(-5.91)	(-4.54)	(-6.07)	(-4.63)	(-3.39)	(-4.88)	(-1.70)
IOER Difference × Equity	--	0.505***	--	--	--	--	0.578***	--	--	--
		(3.24)					(4.03)			
Equity (% of Assets)	--	-0.859*	--	--	--	--	-0.110	--	--	--
		(-2.07)					(-0.26)			
IOER Difference × Dollar Lending	--	--	-1.483*	--	--	--	--	-1.195	--	--
			(-1.75)					(-1.49)		
Dollar Lending	--	--	23.594***	--	--	--	--	21.550***	--	--
			(10.68)					(10.30)		
Fixed Effects:										
Bank (D_i)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter (D_t)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FX Spot Rate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,695	5,661	10,695	8,915	1,755	10,695	5,661	10,695	8,915	1,755
R-squared	0.666	0.599	0.734	0.747	0.511	0.666	0.599	0.753	0.747	0.511

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:

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

where D_i and D_t are bank and quarter fixed effects. *Equity* is a bank's equity over total assets (in percent) measured as of the preceding quarter. *Dollar Lending* is a dummy variable that equals one for dollar lending, and zero otherwise. *FX Spot Rate* is the spot exchange rate between the foreign lending currency and the lender-country currency. In addition, columns (1) through (5) include the dollar exchange rate (unreported) given that all loan volumes are expressed in U.S. dollars. The sample used in columns (5) and (10) 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. The independent variables in columns (2) and (7) are demeaned. Robust t-statistics are in parentheses. Standard errors are two-way clustered at the bank and quarter*currency level. ***, **, and * indicates statistical significance at the 1%, 5% and 10% level, respectively.

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)
IOER Difference (pp)	-0.114***	-0.110***	-0.156*	-0.164*	-0.005**	-0.010**	-0.142*	-0.147*
	(-5.82)	(-5.38)	(-1.77)	(-1.82)	(-1.97)	(-2.20)	(-1.69)	(-1.73)
Fixed Effects:								
Bank (D_i)	Yes	Yes	--	--	Yes	Yes	--	--
Quarter (D_t)	Yes	Yes	--	--	Yes	Yes	--	--
Borrower (D_j)	Yes	Yes	--	--	Yes	Yes	--	--
Bank × Quarter (D_{it})	--	--	Yes	Yes	--	--	Yes	Yes
Borrower × Quarter (D_{jt})	--	--	Yes	Yes	--	--	Yes	Yes
FX Spot Rate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro Controls	--	--	--	Yes	--	--	--	Yes
Observations	3,052,180	2,675,968	2,675,968	2,675,968	70,486	58,000	58,000	58,000
R-squared	0.010	0.010	0.601	0.601	0.753	0.784	0.977	0.977

The dependent variable in columns (1) though (4) 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 (5) 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 (4) and (8) include the tightest set of controls; specification (4) corresponds to:

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

where D_{it} are bank × quarter fixed effects, and D_{jt} are borrower × quarter fixed effects. *FX Spot Rate Control* is the spot exchange rate between the foreign-loan currency and the lender-country currency. *Macro Controls* are the difference between the industrial production growth and CPI growth of the loan-currency area (*f*) and the lender currency area (*d*). In addition, all regressions with volumes as the dependent variable include the dollar exchange rate (unreported) given that all loan volumes are expressed in U.S. dollars. Standard errors are two-way clustered at the borrower*lender and quarter*currency level. ***, **, and * indicates statistical significance at the 1%, 5% and 10% level, respectively.

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	-0.023***	-0.022***	-0.026***	-0.251***	-0.339***	-0.304***
	(-4.32)	(-2.75)	(-3.13)	(-2.71)	(-3.12)	(-2.73)
Fixed Effects:						
Firm (D_j)	Yes	Yes	Yes	Yes	Yes	Yes
Quarter (D_t)	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	217,173	178,658	169,011	10,772	9,554	9,326
R-squared	0.056	0.061	0.062	0.145	0.152	0.149

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:

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

where D_j are firm fixed effects, and D_t are quarter fixed effects. *Time-Varying Firm Controls* include log total assets, return on assets, total debt over assets, and property, plant and equipment over assets. In addition, all regressions with volumes as the dependent variable include the dollar exchange rate given that all loan volumes are expressed in U.S. dollars. Standard errors are two-way clustered at the firm and quarter*currency level. ***, **, and * indicates statistical significance at the 1%, 5% and 10% level, respectively.

INTERNET APPENDIX

FOR MONETARY POLICY AND GLOBAL BANKING*

* Bräuning, Falk and Victoria Ivashina, Internet Appendix to "Monetary Policy and Global Banking," Journal of Finance

A.I – Additional Theoretical Predictions

A. Unhedged FX exposure

The discussion in the main text focused on the case where the bank hedges the entire foreign exchange exposure. However, depending on the parameters, the bank may choose to leave part of the currency exposure unhedged, which introduces additional capital charges on foreign investments. From the complementary slackness condition, we know that if $U > 0$ then $\gamma = 0$ and so equation (7) is reduced to $E[X_1] - \omega X_0 + \mu = 0$ or—combining equations (1), (2) and (6) and using log approximation—$E[X_1 - X_0]/X_0 + \Delta r = \omega$. Thus, it is optimal to leave part of the FX exposure unhedged if the interest rate differential plus the expected percentage change in the spot rate equals the Lagrange multiplier on the capital constraint, ω, which can be interpreted as the shadow cost of capital.[30]

We can for the possibility that banks are not fully hedged and show the partial derivatives in the case $U > 0$. This is consistent with the evidence that banks may carry some direct or indirect (e.g., Berthou, Horny, and Mesonnier, 2018) FX exposure. From equation (20), we find that, similar to the case if *U=0,* the hedged currency exposure increases in the interest rate differential:

$$\frac{\partial S}{\partial \Delta r} > 0.$$

Moreover, because of the complementary slackness condition, we know that $\gamma = 0$ if $U > 0$. Substituting out μ and ω in equation (7) and using log approximation, we obtain:

$$\frac{\partial L^d}{\partial \Delta r} = \frac{1}{g''} < 0.$$

[30] In fact, from equation (7), we can see that the bank will hedge the entire FX exposure if $E[X_1 - X_0]/X_0 + \Delta r < \omega$; that is, if the shadow cost of capital is high enough to exceed the interest rate differential plus the expected change in the spot rate. Moreover, equation (7) shows that, while in equilibrium covered interest parity holds, uncovered interest parity does not hold due to positive shadow cost of capital, suggesting another reason for the forward premium puzzle and carry-trade anomaly (e.g., Lustig et al. 2011 and Hassan and Mano 2014).

Combining equations (1)–(4):

$$\frac{\partial L^f}{\partial \Delta r} = \frac{h'}{h''}(1 + \frac{1}{g'}) \ < 0.$$

That is, in the case of unhedged exposure, both domestic and foreign lending decrease in the interest rate differential. This happens because, from the capital constraint, we obtain that the bank leaves more currency exposure unhedged position if the interest rate differential increases,

$$\frac{\partial U}{\partial \Delta r} = -\left(\frac{\partial L^f}{\partial \Delta r} + \frac{1}{X^0}\frac{\partial L^d}{\partial \Delta r}\right) > 0,$$

which needs to be backed by additional capital and is not available for lending any more.

Assuming for tractability that the functional forms of h and g are given by logarithmic functions, we can show that the contraction in foreign lending is larger than the contraction in domestic lending, that is

$$\partial(L^f/((L^f + L^d))/\partial \Delta r < 0.$$

The intuition is that, regardless of the optimal hedging position, the source of differential pressure on foreign currency lending when interest rate differential changes comes from resulting changes in the relative opportunity cost of lending, and changes in the shadow cost of capital and expected exchange rate movements.

Using equation (9), we also obtain that the bank allocates more funds into foreign reserve assets when the interest rate differential widens:

$$\frac{\partial R^f}{\partial \Delta r} = \frac{1}{(1 + r^f)}\left[\frac{\partial U}{\partial \Delta r} + \frac{\partial S}{\partial \Delta r} - h'(L^f)\frac{\partial L^f}{\partial \Delta r}\right] > 0.$$

From the balance sheet constraint, we obtain for domestic reserve holdings:

$$\frac{\partial R^d}{\partial \Delta r} = -\left(\frac{\partial L^d}{\partial \Delta r} + X_0\frac{\partial R^f}{\partial \Delta r} + X_0\frac{\partial L^f}{\partial \Delta r}\right) < 0,$$

if foreign reserves increase by more than overall lending decreases, $X_0\frac{\partial R^f}{\partial \Delta r} > -\frac{\partial L^d}{\partial \Delta r} - X_0\frac{\partial L^f}{\partial \Delta r}$.

B. Swap market counterparty

In deriving equation (20), we assumed that the foreign investor is fully equity funded; this would be consistent with the counterparty being a pension fund, insurance company or a mutual fund. We could allow the investor to take on leverage. Similarly, we could allow the investor's return functions to depend on interest rates directly. In both cases, the supply curve will then also shift if the interest rate differential changes, and the impact on the swap market equilibrium (equations (20)) could be different. However, we can derive conditions for supply functions under which our predictions continue to hold.

Let the supply function of the counterparty be given by $X^{Fwd} = f^s(S, \Delta r)$, while the perfectly elastic demand function by the bank is given by $X^{Fwd} = f^d(\Delta r)$. Using implicit differentiation of the market clearing condition, one can show that $\frac{\partial \hat{S}}{\partial \Delta r} = \frac{f^d_{\Delta r} - f^s_{\Delta r}}{f^s_S}$, where $f_x = \frac{\partial f}{\partial x}$. Suppose the counterparty's supply curve has a downward slope, $f^s_S < 0$ which could be because of decreasing returns to scale in investments abroad or a quadratic swap position cost. Then $\frac{\partial \hat{S}}{\partial \Delta r} > 0$ continues to hold if $f^s_{\Delta r} > f^d_{\Delta r}$. Simply put, we require the bank's demand curve to shift downward by more than the counterparty's supply curve if the interest rate differential increases. This assumption would be consistent with banks' role as arbitrageurs using interest rates on reserves and an imperfect monetary policy pass-through to the interest rates used by the bank's counterparty.

C. No capital requirement on FX exposure

Consider the same setup as in the main text, but now there is no capital charge for unhedged foreign currency exposures ($\alpha' = 0$), and the bank is fully unhedged ($S = 0$). Instead of using the forward market, the bank converts all foreign-currency cash flows to domestic currency at time t_1 using the spot market. The formal maximization problem becomes:

$$\max \; (1 + r^d)R^d + g(L^d) + UE[X_1] - d(D^d),$$

s.t.

$$K - \alpha(L^d - X_0 L^f) \geq 0,$$

$$U - (1 + r^f)R^f - h(L^f) = 0,$$

$$D^d + K - R^d - L^d - X_0 R^f - X_0 L^f = 0,$$

$$D^d \geq 0, L^d \geq 0, L^f \geq 0, R^d \geq 0, R^f \geq 0, U \geq 0.$$

The first-order conditions (1) through (5), as well as the balance sheet constraint, equation (10) are unaffected by these changes. FOC (6) becomes irrelevant, and equations (7) through (9) now become:

$$\partial \mathcal{L}/\partial U = E[X_1] + \mu = 0 \quad (7')$$

$$\partial \mathcal{L}/\partial \omega = K - \alpha(L^d - X_0 L^f) = 0 \quad (8')$$

$$\partial \mathcal{L}/\partial \mu = U - (1 + r^f)R^f - h(L^f) = 0 \quad (9')$$

Since (3) and (4) are unaffected, as before we get:

$$g'(L^d) = -\frac{\mu}{X_0} h'(L^f)$$

Using equation (7'), we can substitute μ to get our key equation (15) that links lending in the two currencies to the interest rate differential:

$$g'(L^d) = \frac{E[X_1]}{X_0} h'(L^f) = \frac{1 + r^d}{1 + r^f} h'(L^f),$$

where the second equality follows from (1), (2), and (7'). As before, using log approximations, the capital constraint, and implicit differentiation, we obtain the same results on the lending predictions, that is, equations (18) and (19).

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 from 2000:Q1 though 2015:Q2.[31]

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%. Finally, on December 17, 2015, the Fed increased the IOER rate to 0.5%.

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

31 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 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 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% to battle sluggish growth and encourage bank lending. Subsequently, the ECB further reduced the deposit rate twice, to its current level of -0.4%.

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% 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% when BoJ established the "temporary rules regarding funds-supplying operation against pooled collateral." On January 29, 2016, in a surprise move, the BoJ decided to adopt a negative deposit facility rate of -0.1%.

Switzerland—The Swiss National Bank (SNB) used 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% on the portion of the sight deposit account balance that exceeds a certain threshold. With the announcement of a negative interest rate, the target range for the Libor extended to its usual width of 1 percentage point. On January 15, 2015, the SNB lowered the interest rate on sight deposits to -0.75% and moved the target range downwards to between -1.25% and -0.25%.

Canada—Currently, the Bank of Canada (BoC) has no reserve requirement. However, it operates under a similar framework around Canada's Large Value Payment System, through which the BoC can pay a deposit rate on the excess cash left in the payment system. The Bank of Canada conducts its monetary policy by targeting the overnight interest rate through its operating band.

The top of the band, the Bank Rate, is always 0.25 percentage points above the overnight rate target. This is the rate at which the BoC will lend money overnight to the financial institutions in the Large Value Payment systems. On the other hand, the bottom of the operating band is the interest rate on the overnight deposits at the BoC. Thus, the operating bands are 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%, 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% and also lowered the deposit rate to zero. With this change, the deposit rate became largely irrelevant for reserve-scheme participants.

Table A.III
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

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 only the list of foreign banks in 2015 is available.