The Impact of the Deposit Channel on the International Transmission of Monetary Shocks*

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Abstract

What role do bank deposits play in the international transmission of US monetary policy shocks? Using a panel of US commercial banks, we find that the deposit channel acts on global banks to transmit US monetary policy shocks internationally. Specifically, we document that after a 1 p.p. unexpected increase to the Fed Funds rate, global banks increase deposit spreads on average by 0.2 p.p. and experience a 2.9% decline in deposit growth. As a result, global banks increase growth rates of net transfers from foreign branches by 39.4% to finance lending. Moreover, we find that global banks reduce lending growth by 0.5 p.p. less than domestic banks per percent of deposit outflow. Finally, global banks contract foreign lending growth by 1.3%.

Keywords: International transmission, monetary policy, deposit channel, banking

JEL Codes: E52, E58, F23, F34, F36, G21

As global economies become more integrated, there has been a large discussion both in academic and in policy circles on the outsized role that the Federal Reserve plays on the global stage. The empirical literature has argued that US monetary policy has international repercussions and that shocks to US monetary policy reverberate to other countries. In particular, several papers, including Cetorelli and Goldberg (2012) and Temesvary et al. (2018), argue that global banks (banks operating in multiple countries) actively allocate funds across borders and that much of the international transmission of monetary policy act through the internal markets of global banks. For example, in response to a contractionary US monetary policy shock, Cetorelli

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and Goldberg (2012) show that global banks increase cross-border flows into the US and reduce foreign lending, propagating the US monetary shock internationally.

Interestingly, many existing empirical papers on the international transmission of monetary policy are either agnostic on the channel of monetary policy transmission or lean heavily on the capital or reserve channel of banks, rather than the deposit channel. However, Drechsler et al. (2017) and Wang et al. (2020) recently argue that most of the transmission of US monetary policy domestically can be attributed to the bank deposit channel. In their framework, banks have market power in the deposit market. Hence, when the US Federal Funds rate (FFR) increases, they increase deposit spreads, defined as the spread between the FFR and the deposit rates. It results in households withdrawing bank deposits, and banks contracting lending. Given this evidence of the large role of the bank deposit channel in domestic transmission, and the large role that global banks play in US deposit and loan markets,[1] this paper addresses the open research question of how the deposit channel impacts the international transmission of US monetary policy shocks.

We start by considering the static decision of a global bank which raises deposits and makes lending decisions in two countries, subject to policy rates in the two countries and convex adjustment costs of moving funds across borders. The return rate to lending in each country is increasing in the policy rate and decreasing in the amount lent. As in Drechsler et al. (2017), households view deposits as a composite good, and banks hold market power in the deposit market. Like domestic banks, when the US raises the Federal Funds rates (FFR), the global bank will raise its US deposit spreads. As a result, households will respond by withdrawing their deposits. However, unlike domestic banks, the global banks will also increase cross-border funds into the US, both in response to increased US rates and to the decline in US deposits. This has two effects. First, domestically, this will mitigate the reduction in US lending by global banks, relative to domestic US banks. Second, since foreign funds are being allocated to the US, the bank will reduce its foreign lending, thereby transmitting US monetary policy internationally.

We test the predictions of this framework using a novel dataset that combines quarterly branch-level deposit rates from Ratewatch and bank-level deposits, cross border flows, and foreign lending from US Call reports, for over 5,000 large banks, of which 170 are global banks,

[1] Global banks hold a majority of US deposits and loans.

from 1994 to 2020. First, we empirically estimate the impact of US monetary policy shocks[2] on changes to US bank deposit rates and US bank deposits.[3] We find that in response to a 1 percentage point unexpected increase to the Fed Funds rate, deposit spreads of global banks increase by 20 basis points and global banks' deposit growth decreases by 2.9%, suggesting that the deposit channel is relevant to global banks. We also show that banks with higher sensitivity of spreads to shocks experience higher deposit outflow.

Second, using estimates of US deposits as predicted by monetary shocks through the deposit channel, we evaluate the impact of the deposit channel on lending by global and domestic banks and cross-border flows by global banks. We define cross-border flows as the net transfers from foreign offices to the domestic office, measured by the difference between Call Report items "Net Due to Own Related Offices in Other Countries" and "Net Due from Own Related Offices in Other Countries," which we denote as *NetDue*. As the bank increases cross-border flows into the US, *NetDue* increases. We define a global bank as a bank which has a non-zero *NetDue* between its domestic and foreign branches. Specifically, we begin by regressing changes to bank lending on predicted changes to US deposits[4] at the bank level, controlling for bank and time fixed effects and aggregate macroeconomic variables, including GDP and inflation. As predicted by our mechanism, we find that global banks reduce lending growth by 50 basis points less than domestic banks per percent of deposit outflow.

Next, for our universe of global banks, we regress changes to cross-border flows (*NetDue*) on predicted changes to US deposits and find that cross-border flows into the US increase when deposits decrease. Specifically, a 1% increase in deposit growt corresponds to a decrease in cross-border flows growth of 13.6%. This corresponds to a 39.4% increase in netdue growth rate after 1 p.p. monetary shock. Finally, we show that global banks contract foreign lending growth by 1.3%, transmitting the US monetary shock internationally.

To corroborate that the results are indeed driven by bank market power, as the deposit channel would suggest, we show that our results hold when we explicitly measure bank market power using county-level deposit market Herfindahl-Hirschman index (HHI). We find that branch-level deposit spreads and deposit outflows are more responsive to monetary policy shocks in counties with high deposit HHI (high bank market power). Our results are also robust to

[2]We define US monetary policy shocks using high-frequency changes to 1 month Fed Funds futures around FOMC announcements.

[3]We use weekly Ratewatch data for branch-level deposit rates, FDIC Summary of Deposits for annual branch-level deposits, and quarterly US Call Report data for bank-level deposits.

[4]Predicted by monetary shocks.

using changes to the level of Federal Funds in place of monetary shocks and to size effects.

Our results indicate that the deposit channel and the market power of global banks are important to the transmission of US monetary policy internationally. Specifically, we show that a large portion of the international propagation of US monetary policy shocks can be attributed to the deposit channel. In response to an unexpected increase in US Fed Funds rates, when banks experience more outflow of deposits, they increase cross border flows into the US. It results in greater international transmission of US monetary policy shocks.

We contribute to several strands of financial and economic literature. First, our results shed new light on the transmission of monetary policy. There are three main channels that economists considered before. The first is a reserve channel, where interest rate decisions affect required reserves and hence, lending (Bernanke and Blinder (1988, 1992); Kashyap and Stein (2000)). The second one is a capital channel — interest rate movements tight banks' capital and therefore, affect their decisions (Bolton and Freixas (2000); Brunnermeier and Sannikov (2014); Elenev et al. (2021)). Finally, recent papers argue that shocks are transmitted through banks' deposits because banks have market power in the deposit market (Drechsler et al. (2017, 2021); Wang et al. (2020)). Indeed, Wang et al. (2020) estimate a structural model and prove that the deposit channel accounts for most of the transmission. Rather than considering domestic transmission, this paper quantifies the effect of the deposit channel on international transmission. Moreover, unlike previous papers, we show that shocks are also transmitted through the deposit channel.

We also contribute to the growing literature on the international transmission of monetary and liquidity shocks (Cetorelli and Goldberg (2012); Schnabl (2012); Acharya et al. (2014); Temesvary et al. (2018); Hale et al. (2020)) which claim that global banks play a crucial role in the transmission. While most papers either focus on the reserve channel or do not take a stance on the domestic channel, our paper documents the role of the deposit market on the international transmission of shocks.

Finally, we contribute to the literature on global banking. Multiple theoretical and empirical papers have shown that large global banks are systematically important (Kashyap and Stein (2000); Bolton and Oehmke (2019); Bräuning and Ivashina (2020)), but generally, focus on bank operations across foreign offices rather than the real effects addressed by the literature on domestic banks (Diamond (1984); Holmstrom and Tirole (1997)). In contrast, this paper argues that the market power of global banks and the deposit channel is important to understanding the international transmission of shocks, Moreover, bank market power impacts not just internal bank decision making, but also the magnitude of domestic and foreign lending.

Our results may have useful policy implications. Banks are known to accelerate and even cause panics and crises (Diamond and Dybvig (1983); Goldstein and Pauzner (2005); Gennaioli et al. (2012); He and Krishnamurthy (2013); Gertler and Kiyotaki (2015); Bernanke (2018)). Global banks are usually large and their decisions and financial health have an impact on the entire economy. It is therefore very important to understand global banks' actions and impact on their assets when conducting monetary policy.

The rest of the paper proceeds as follows. Section 1 describes the stylized theoretical models where global banks choose deposits and lending in two countries. Section 2 provides information on our econometric strategy and data. Section 3 contains our main bank-level and branch-level findings. Section 4 provides robustness tests. Section 5 concludes.

1 Model

We consider a framework of deposits in each country which follows Drechsler et al. (2017). In each country, households have preferences over final wealth W and liquidity services l, given initial wealth W_0

$$u(W_0) = \max_{W,l} \left(W^{\frac{\rho-1}{\rho}} + \lambda l^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \tag{1}$$

where money, M, and deposits, D, are imperfect substitutes for liquidity services

$$l(M, D) = \left(M^{\frac{\epsilon-1}{\epsilon}} + \delta D^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}} \tag{2}$$

Importantly, in Drechsler et al. (2017) (henceforth, DSS) deposits themselves are composite goods, with deposits by each bank being imperfect substitutes, where

$$D = \left(\frac{1}{N} \sum_{i=1}^{N} D_i^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \tag{3}$$

To understand the behavior of a global bank we consider the static decision of a bank which demands deposits and makes lending decisions in two countries, US and UK, subject to The bank faces policy rates $\{f_{UK}, f_{US}\}$ in each country. Following DSS and Kashyap and Stein (2000), demand for loans in each country is downward sloping, $\ell_{UK_1}, \ell_{US_1} > 0$. The reflects the notion that as the bank increases lending in each country, returns on loans in each country are decreasing, either due to competition for loans or because the bank reduces the quality of loans. The bank pays deposit rates $f_{UK} - s_{UK}$ and $f_{US} - s_{US}$. Recall the spreads, s_{UK} and s_{US}, are the spreads between the policy rate and the rate on deposits. Finally, the bank faces convex adjustment costs to funds which it moves across borders, $\frac{\alpha}{2}T^2$ where

$$T = L_{US} - D_{US} = D_{UK} - L_{UK} \tag{4}$$

is the amount the bank transfers from the UK to the US and $\alpha > 0$. This may reflect currency risk and regulatory costs and suggests that it is increasingly expensive to fund lending in one country through foreign deposits. Note that lending in each country can be expressed as a function of deposits and lending.

$$L_{US} = D_{US} + T \tag{5}$$

$$L_{UK} = D_{UK} - T \tag{6}$$

Thus, given policy rates $\{f_{UK}, f_{US}\}$ and spreads $\{s_{UK}, s_{US}\}$, the bank's problem, can be expressed as a choice of deposits in each country D_{US} and D_{UK}, and transfers between each country, T.

$$\begin{aligned}\Pi = \max_{D_{US}, D_{UK}, T} & \left[f_{UK} - \left(\ell_{UK_0} + \frac{\ell_{UK_1}}{2} L_{UK}\right)\right] L_{UK} - (f_{UK} - s_{UK}) D_{UK} \\ & + \left[f_{US} - \left(\ell_{US_0} + \frac{\ell_{US_1}}{2} L_{US}\right)\right] L_{US} - (f_{US} - s_{US}) D_{US} - \frac{\alpha}{2} T^2\end{aligned} \tag{7}$$

Solving the bank's problem, the bank chooses optimal transfers

$$T = \frac{f_{US} - f_{UK} - (\ell_{US_0} - \ell_{UK_0})}{\ell_{US_1} + \ell_{UK_1} + \alpha} + \frac{\ell_{UK_1}}{\ell_{UK_1} + \ell_{US_1}} D_{UK} - \frac{\ell_{US_1}}{\ell_{UK_1} + \ell_{US_1}} D_{US} \tag{8}$$

We can evaluate how transfers, T, which reflect cashflows from the UK to the US, vary with policy rate f_{US}.

$$\frac{\partial T}{\partial f_{US}} = \frac{1}{\ell_{US_1} + \ell_{UK_1} + \alpha} + \frac{\ell_{UK_1}}{\ell_{UK_1} + \ell_{US_1}} \frac{\partial D_{UK}}{\partial f_{US}} - \frac{\ell_{US_1}}{\ell_{UK_1} + \ell_{US_1}} \frac{\partial D_{US}}{\partial f_{US}} \tag{9}$$

As f_{US} increases, the first term, reflects the increase in return from lending in the US. Since

$\ell_{US_1}, \ell_{UK_1}, \alpha > 0$, this term is positive

$$\frac{1}{\ell_{US_1} + \ell_{UK_1} + \alpha} > 0 \tag{10}$$

Recall that in each country, i, as the policy rate f_i increases, deposit spreads increase, $\frac{\partial f_i}{\partial s_i} > 0$, and households withdraw deposits, $\frac{\partial D_i}{\partial s_i} < 0$. The rate with wich households withdraw deposits depends on the bank's market power. Thus deposits in country i are decreasing in the policy rate in the same country, $\frac{\partial D_i}{\partial f_i} < 0$. Therefore

$$\frac{\ell_{US_1}}{\ell_{UK_1} + \ell_{US_1}} \frac{\partial D_{US}}{\partial f_{US}} < 0 \tag{11}$$

If we assume monetary policy is independent $\frac{\partial f_{UK}}{\partial f_{US}} = 0$,[5] then

$$\frac{\partial D_{UK}}{\partial f_{US}} = \frac{\partial D_{UK}}{\partial f_{UK}} \frac{\partial f_{UK}}{\partial f_{US}} = 0 \tag{12}$$

so

$$\frac{\partial T}{\partial f_{US}} = \frac{1}{\ell_{US_1} + \ell_{UK_1} + \alpha} + \frac{\ell_{UK_1}}{\ell_{UK_1} + \ell_{US_1}} \frac{\partial D_{UK}}{\partial f_{US}} > 0 \tag{13}$$

and transfers are always increasing in f_{US}.

If monetary policy is positively correlated, then $\frac{\partial D_{UK}}{\partial f_{US}} < 0$ and transfers T is increasing in the policy rate f_{US} so long as

$$\frac{1}{\ell_{US_1} + \ell_{UK_1} + \alpha} - \frac{\ell_{US_1}}{\ell_{UK_1} + \ell_{US_1}} \frac{\partial D_{US}}{\partial f_{US}} > - \frac{\ell_{UK_1}}{\ell_{UK_1} + \ell_{US_1}} \frac{\partial D_{UK}}{\partial f_{US}} \tag{14}$$

If monetary policy is negatively correlated, then $\frac{\partial D_{UK}}{\partial f_{US}} > 0$ and thus transfers T is always increasing in policy rate f_{US}.

Now we evaluate the impact of the increase in US policy rate f_{US} on US lending and UK lending under this framework. Recall that US lending is the sum of US deposits plus transfers.

$$L_{US} = D_{US} + T \tag{15}$$

Thus as the US policy rate f_{US} increases, recall that US deposits decrease $\frac{\partial D_{US}}{\partial f_{US}} < 0$. If US and

[5]Note that if one focuses on exogenous shocks, rather than levels, policies are independent by definition of the shock.

UK monetary policies are independent then, transfers are increasing, $\frac{\partial T}{\partial f_{US}} > 0$, and transfers act to mitigate the decrease in lending.

Similarly, note that UK lending is equal to UK deposits less transfers.

$$L_{UK} = D_{UK} - T \tag{16}$$

If US and UK monetary policies are independent, then UK deposits are constant, but transfers increase, decreasing UK lending.

2 Empirical strategy and data

The static model has four main predictions in response to a contractionary monetary policy shock:

1. Global banks increase deposit spreads and lose deposits after the contractionary monetary policy shock.
2. Global banks are able to use their foreign funds to finance US lending. We expect to see an increase in net transfers from foreign branches.
3. As a result, global banks do not contract their lending per unit of deposit outflow as much as domestic banks. We expect to see that the deposit channel is weaker for global banks.
4. Global banks cut future foreign lending because they transferred funds that were supposed to finance loans abroad.

We next propose an empirical strategy and data that we use to test predictions.

2.1 Empirical strategy

Our empirical strategy can be divided into two steps. First, we evaluate the relevance of the deposit channel to global banks (i.e. if they increase spreads and lose deposits after the contractionary monetary policy shock). Specifically, for each bank i we run the following time-series regression:

$$y_{it} = \beta_i MS_t + \gamma_i X_{it-1} + u_{it} \tag{17}$$

where y_{it} is either a change in deposit spreads, defined as the Federal Funds rate less the deposit rate, or the log change in deposit amounts (henceforth, deposit growth), MS_t is a monetary shock, and X_{it-1} is a vector of controls that includes the growth rate of assets and macro indicators such as inflation and GDP growth. We lag controls to avoid simultaneity bias.

(17) gives us β_i for each bank i, or each bank's elasticity of deposit spreads and deposit growth to monetary policy shocks. We refer to β_i from the first set of regressions as *spread betas* (or deposit betas) and β_i from the second set of regressions as *flow betas.* Our model predicts that spread betas should be on average positive for both domestic and global banks, while flow betas should be negative.

We also obtain fitted values from the regression of monetary shocks on deposit growth and denote deposit growth as predicted by the deposit channel as $\widehat{DepGrowth}_{it}$. Importantly, we use fitted values of deposits rather than actual deposits because we want to evaluate the impact of monetary policy and the deposit channel, in particular, on lending and net flows. In this way, we abstract from changes to deposits that are unrelated to the deposit channel but that impact lending and net flows. To account for potential error terms, we cluster standard errors in second-stage regressions at the bank level. We also cluster at the time level as a robustness test.

In the second step of our analysis, we test if deposit outflow is due to a contractionary monetary shock leads to a contraction in lending and, for global banks, to an increase in net transfers from foreign branches and consequent cut in foreign lending. To answer the first question we run the following regression:

$$\Delta \log L_{it} = \theta \widehat{DepGrowth}_{it} + \nu Global_{it} \cdot \widehat{DepGrowth}_{it} + \xi X_{it-1} + \alpha_i + \theta_t + \varepsilon_{it} \qquad (18)$$

where the left hand side variable is the log change in lending (henceforth, lending growth), $Global_{it}$ is a dummy that is equal to 1 if the bank i reports to have foreign branches at time t, X_{it-1} is a set of controls, α_i is a bank fixed effect, and θ_t is a quarter fixed effect.

We are interested in 2 coefficients in (18) for which our model has direct predictions. The first is θ, the percentage change in lending growth after 1 p.p. change in deposit growth due to the expansionary monetary shock. Our model predicts that $\theta > 0$, i.e. a deposit outflow leads to a contraction in lending. The second coefficient is ν, which measures how global banks differ from domestic banks in their response to the deposit growth changes. Our model predicts

$\nu < 0$, that is global banks' will contract lending less per percent of deposit outflow. To recall, given the model, global banks' lending should react less to the deposit outflow since they can use foreign funds to finance loans. Thus, we should expect to see an increase in net transfers from foreign branches. To test this, we run the following regression:

$$NetDueGr_{it} = \eta \widehat{DepGrowth}_{it} + \mu Y_{it-1} + \alpha_i + \theta_t + v_{it} \tag{19}$$

where the left hand side variable is the change in log net transfers from foreign branches (henceforth, netdue growth)[6], Y_{it-1} is a set of controls, and α_i is bank fixed effects. Following following Cetorelli and Goldberg (2012) we control for lagged netdue growth, contemporary and lagged GDP growth, inflation, and asset growth. We also control for assets to account for the size.

Next, η measures the sensitivity of netdue growth to deposit growth. Our model predicts that $\eta < 0$, i.e. banks increase netdue growth after the deposit outflow. We test this empirically. Moreover, we want to show that netdue growth changes due to the deposit channel lead to lending growth changes. We will address this in detail in Section 3.

Finally, to show the international transmission of monetary shocks, we test if deposit outflow leads to a contraction in future foreign lending.[7] Specifically, we estimate the following equation:

$$\Delta \log ForL_{it} = \iota \widehat{DepGrowth}_{it-1} + \mu Z_{it-1} + \alpha_i + \theta_t + m_{it} \tag{20}$$

where $\Delta \log ForL_{it}$ is a log change in foreign lending, and Z_{it-1} is a vector of controls. We expect $\iota > 0$ meaning that global banks contract foreign lending when they suffer deposit outflow.

2.2 Data

Our data cover the universe of 12,126 banks[8] from 1994 to 2018. 170 banks report to have foreign branches — we define them as *global*. We keep only banks with assets in the 5th quantile

[6] Note that net transfers can be negative. That's why, we first take logs of the absolute value, then add sign, and only after that compute changes.

[7] We do not find significant contemporaneous effect. It means that shocks are transmitted with one quarter lag.

[8] Even uninsured banks file Call Reports. Also, any depository financial institution that files Call Reports is included. Those are mainly but not only commercial banks. We will use the term 'bank' throughout the paper.

to drop small banks and finance companies. Our final sample contains 5,403 subsidiary banks. In robustness tests, we show that our results hold in the full sample as well. We next describe the data sources and variables that we use.

1. *Bank-level quarterly data.* We use Consolidated Reports of Condition and Income (US Call Reports), which are maintained by the St. Louis Federal Reserve bank, to get quarterly bank-level balance sheet data.[9] Sample contains 24,039 banks.[10] Notice that those are not bank-holding companies that we will refer to as BHC. One BHC may have multiple subsidiaries which we call banks. The opposite is also true — one subsidiary can be owned by multiple holding companies. To be clear, we will analyze banks. Call Reports assign a unique identifier to the banks — RSSD ID.

2. *Foreign flows.* We get net due to and from foreign offices from Call Reports RCON series. RCON 2941 is net due to own foreign offices, Edge and Agreement subsidiaries, and IBFs and RCON 2163 is net due from own foreign offices, Edge and Agreement subsidiaries, and IBFs. The difference is what we call *NetDue*. Its positive value means that the bank *borrowed* funds from the foreign branches. Only banks that have foreign branches file RCON 2941 and RCON 2163. Hence, we define a bank i to be global at time t if its $NetDue_{it}$ is non-zero.[11] We merge RCON series with bank-level data using RSSD ID.

3. *Foreign lending.* Foreign lending data comes from Call Reports RCFN series. Specifically, RCFN 2327 corresponds to loans originated by foreign offices of banks that report in the United States. We observe foreign lending only from 2001 to 2010. This is the main limitation of the data.

4. *Monetary policy surprises.* We use tick-by-tick CME Globex Fed Fund futures data to construct monetary policy surprises. They are defined as changed in futures 15 minutes before and 45 minutes after the FOMC meeting.[12] FOMC meetings take place 8 times per year. We convert the data into quarterly observations to make them compatible with

[9] We thank Philipp Schnabl for posting and regularly updating parts of the US Call Reports.

[10] Throughout the analysis, we show results for banks in the 5th size quantile, i.e. we keep only relatively large banks. All our results hold in the full sample. We also try 90th and 95th percentiles as a threshold and show that our results hold.

[11] An alternative would be to define global banks as banks with non-missing figures for RCON series, hence including zero. We do not do it for two reasons. First, zero in the report can mean either that the bank has foreign branches and does not transfer funds, or that the bank does not have foreign branches. Second, even if the bank has foreign branches but does not transfer funds to or from them, that bank does not really operate globally. That's why we exclude such banks from our sample.

[12] We thank Pascal Paul for making his data from Paul (2020) available.

the rest of the sources. We will refer to these surprises as monetary *shocks* as opposed to *levels*. Monetary shocks are the unexpected part of monetary policy changes. These shocks have been used in multiple papers including Bernanke and Kuttner (2005), Gertler and Karadi (2015), Gorodnichenko and Weber (2016), and Paul (2020). We also collect other shocks that have been extensively used in the literature, i.e. actual changes in FFR from FRED, Romer and Romer (2017) and Gertler and Karadi (2015) shocks from Valerie Ramey's website.

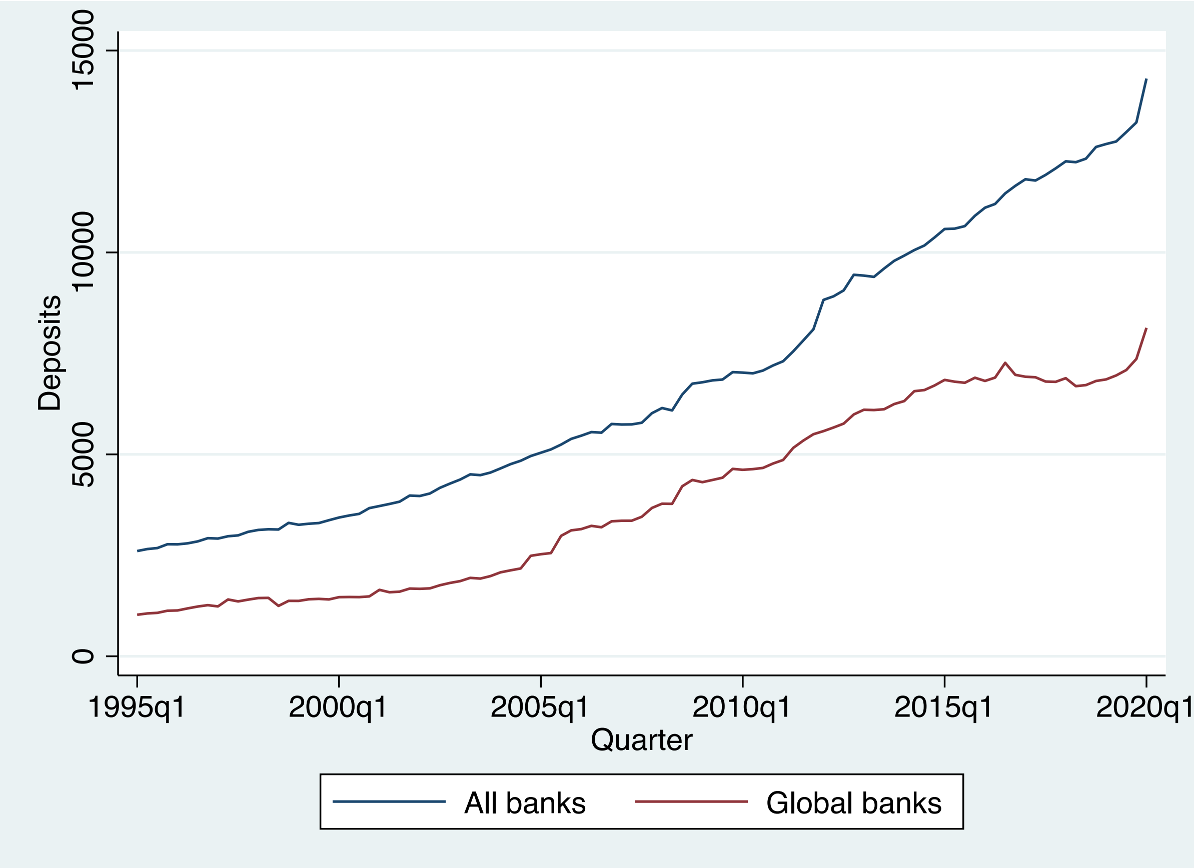
5. *Branch-level deposits*. We collect annual branch-level data on banks' deposits and assets from the FDIC Summary of Deposits. Each bank has many branches. Households and firms usually open deposit accounts within a branch — that is why it is possible to observe deposits not only for parent banks but also for branches. This will let us control for county unobservables and exploit branch-level analysis. We merge SoD with Call Reports using a table that links FDIC certificate numbers with RSSD ID. The table is provided by the New York Federal Reserve bank.

6. *Branch-level deposit rates*. Weekly deposit rates by branches are available in S&P Global RateWatch. They cover almost all global banks in our sample and more than 50% of the entire sample. The data report deposit rates on new accounts. We follow Drechsler et al. (2017) and restrict our sample to 12-month certificates of deposit with an account size of \$10,000 or more, and money market deposit accounts with an account size of \$25,000.[13] We aggregate data on the quarterly level to make it compatible with the rest of the data. We merge RateWatch data with SoD using RSSD ID and branch identifier.

7. *County and country variables*. We collect data on counties — employment, wages, and population from US Census. We need these to compute the Herfindahl-Hirschman index for each county. We identify counties using fips. We can then merge county data with branch-level data using zip-fips crosswalk. Country data come from BIS, OECD, FRED, and the World Bank. We collect annual real and potential GDP, quarterly CPI inflation, FFR, GDP growth, and employment rates.

[13]The products represent time and saving deposits, respectively.

Figure 1: Deposits of the Banks



Note: This figure plots total deposits for US banks. Blue line corresponds to aggregate total deposits of all banks and red line — to global banks. Deposits are measured in billion of dollars.

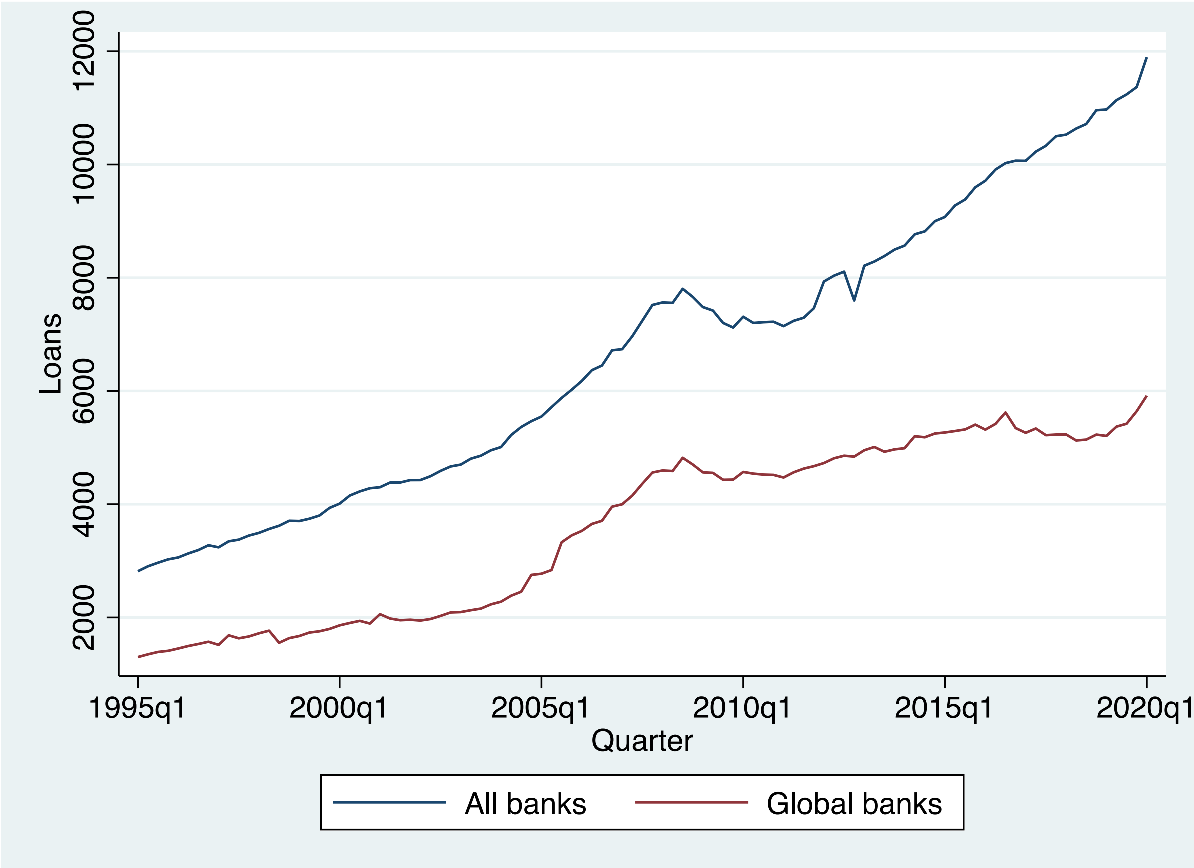
2.3 Summary statistics

Table 1 contains summary statistics of our data. Panel A represents bank characteristics. We define commercial banks as *subsidiary* banks that file Call Reports. Their main identifier is RSSD ID. We also observe their holding companies (their identifier is RSSD HCR), but we will focus on subsidiary banks in this paper unless mentioned otherwise. Our sample of banks has 685,839 bank×quarter observations. The time period is from the first quarter of 1994 to the last quarter of 2017. Only 5,185 of these observations are global banks. For our regressions with international data, we restrict the sample and keep only observations from 2001 to 2011 to have reliable data on netdue and foreign loans.

We can see that global banks have on average more assets, deposits, and loans.[14] If the bank can afford to have foreign branches, that bank is likely to be large. This fact poses potential

[14]See Figures 1 and 2.

Figure 2: Total Loans of the US Banks

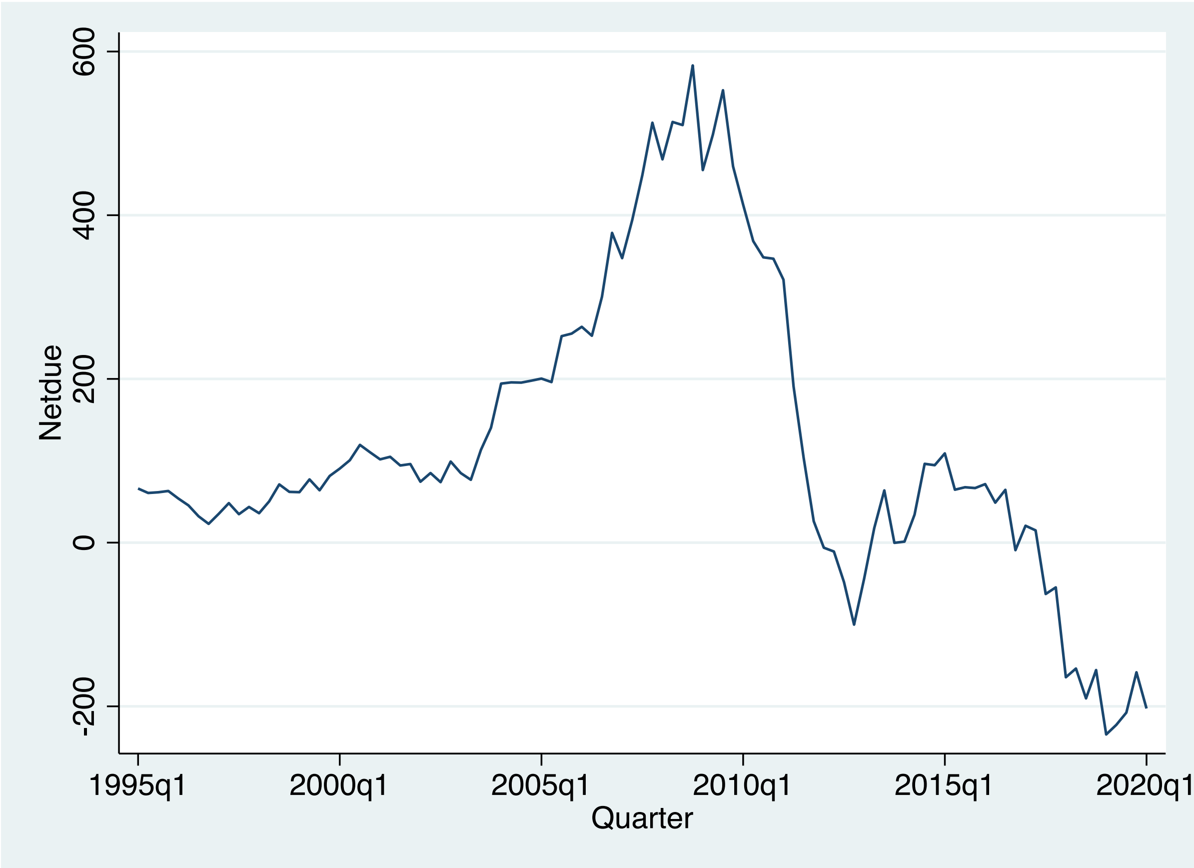


Note: This figure plots total loans net of unearned income for US banks. Blue line corresponds to aggregate total loans net of unearned income of all banks and red line — to global banks. Loans are measured in billion of dollars.

identification concerns to our empirical strategy. That is why we control for asset growth in all our regressions. Moreover, in the robustness tests, we show that our results are robust to the inclusion of the level of assets. Hence, we are able to control for the size and make sure that our results are not driven by the simple fact that global banks are large. Another way of coping with the problem is to analyze changes rather than levels. We see from Table 1 that log changes are not significantly different across groups.

As a main measure of lending, we use loans net of unearned income for two reasons. First, we want to separate effects on lending from potential effects on unearned income that are possible if interest rates are rising. The second reason is data-driven — banks stopped reporting total loans after 2010. From 2011 banks only have to report loans net of unearned income and breakdown of loans by categories — commercial and industrial loans (C&I), personal loans, and real estate loans. Global banks dominate all three markets. Figure 2 plots US lending by

Figure 3: Net Trasfers from Foreign Branches of the US Banks



Note: This figure plots total net transfers from foreign branches for US banks. Deposits are measured in billion of dollars. We use the Call Report items "Net Due to Own Related Offices in Other Countries" and "Net Due from Own Related Offices in Other Countries". Their difference reflects the net claims from foreign offices on the domestic office and denoted by *NetDue*. NetDue is measured in billions of dollars.

all banks and global banks. It is clear that global banks dominate the market.

The table also shows net transfers from foreign branches. Aggregated figures are plotted in Figure 3. As mentioned above, net transfers can be negative in rare circumstances.[15] That is why, we first take logs from the absolute value of netdue, then add sign, and only after that take the differences. The measure is comparable to other log changes. Hence, we call it *Netdue Growth* in the paper. Of course, only global banks report netdue. Banks report non-zero netdue only if they have foreign branches. We then define the bank to be global at time t if it reports non-zero netdue at time t. Panel A also shows foreign loans. Those are loans that are originated by banks' foreign offices. By definition, only global banks report foreign loans.

Finally, Panel A shows deposit spreads. Banks do not report their deposit rates because

[15]The United States remains the most important player in the financial markets. Most funds still flow *into* the US rather than *out*.

each branch can have its own deposit rate. However, banks report interest expenses. We thus define deposit rate in basis points as follows:

$$DepRate_{it} = 100 \cdot \frac{IntExp_{it}}{IntBearDep_{it}} \tag{21}$$

where $IntExp_{it}$ is interest expenses and $IntBearDep_{it}$ is the amount of interest-bearing deposits. Most deposits are interest-bearing. They only exclude checking accounts. All interest paid by banks is included in interest expenses. We can also use total deposits as a denominator and/or interest expenses on domestic deposits as a numerator. In the robustness tests, we show that results are not sensitive to the denominator and numerator in (21). We multiply the ratio by 100 to interpret rates in percentage points. To convert rates into spreads, we simply subtract $DepRate_{it}$ from the respective Fed Funds rate.

Panels B and C represent branch-level data. We focus on two deposit products — CDs and MMs. In the main branch-level analysis we leave only CDs as they are more sensitive to interest rate movements. When analyzing deposit amounts, we use FDIC data rather than Ratewatch because of the much broader sample size.

Branch-level data have two main advantages. First, we can observe deposit rates, so we do not have to use a potentially noisy measure given by (21). Second, we know branch addresses. That allows us to compute county HHIs and identify an exact effect of market power. We are unable to do it in our main bank-level analysis. HHI is computed as a squared share of deposits in the county. We then divide the number by 1000. The average HHI in our sample is 0.19. It means that the deposit market is **not** perfectly competitive.[16] This is the crucial feature of our analysis — the deposit channel would not work in a perfectly competitive market. The imperfect competition allows branches to increase spreads without losing an entire clientele. Also, HHI for global banks is close to HHI for domestic banks, meaning that their markets are not significantly different.

2.4 Measure of monetary shock

We use monetary surprises as our main measure of monetary shock. In Section 3 we also check if our results hold with actual changes in FFR. We choose surprises as our main measure

[16] The US Department of Justice considers a market with an HHI of less than 0.15 to be a competitive market, an HHI of 0.15 to 0.25 to be a moderately concentrated market, and an HHI of 0.25 or greater to be a highly concentrated market.

Table 1: Summary Statistics

	All		Global		Domestic	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Panel A: Bank characteristics (Call Reports)						
Total assets (mill. \$)	826	18,549	73,019	239,307	460	5,420
Total deposits (mill. \$)	375	16,126	40,696	137,319	165	12,433
Interest expenses (mill. \$)	4.14	70.08	214.42	695.62	2.65	34.46
Total loans (mill. \$)	289	5,245	24,628	72,315	184	1,630
Loans net of unearned income (mill. \$)	420	8,626	37,626	111,923	232	2077
C&I loans (mill. \$)	83	1,368	6,404	17,647	57	647
Foreign loans (mill. \$)	50	2,797	50	2,797	—	—
Net transfers from abroad (mill. \$)	1,885	8,591	1,885	8,591	—	—
Log deposit growth ($\times 10^3$)	16.5	57.4	20	86.6	16.5	57.1
Log loan growth ($\times 10^3$)	20.6	50.7	21.2	58.2	20.6	50.6
Log foreign loan growth ($\times 10^3$)	9.7	460.4	9.7	460.4	—	—
Change in log netdue ($\times 10^3$)	17	489	17	489	—	—
Deposit spread (b.p.)	2.19	1.98	1.89	2.12	2.19	1.98
Observations (bank×quarter)	685,839		5,185		680,654	
Panel B: Branch characteristics (Ratewatch)						
Deposits (mill. \$)	379	6,010	2,206	18,1246	177	1,695
CD deposit rate (b.p.)	1.58	1.40	1.24	1.42	1.65	1.40
MM deposit rate (b.p.)	0.78	0.87	0.58	0.83	0.82	0.87
CD deposit spread (b.p.)	−0.28	0.92	0.06	0.81	−0.32	0.92
MM deposit spread (b.p.)	0.66	1.43	0.91	1.46	0.64	1.43
Branches	304	911	2,339	1,606	59	251
Observations (branch×quarter)	669,659		68,931		600,728	
Panel C: Branch characteristics (FDIC)						
Deposits (mill. \$)	81	1,438	121	2,126	56	713
Branch-HHI	0.19	0.12	0.17	0.10	0.20	0.12
Observations (branch×year)	2,431,461		872,908		1,558,553	

Note: This table provides descriptive statistics for banks and branches in our sample. All panels provide a breakdown into global and domestic banks. Global banks are banks that report to have foreign branches. Panel A contains statistics of bank-quarter level variables. It includes balance sheet variables and log growth (change) for deposits, loans, and netdue. Bank-level deposit spreads are computed as interest expenses divided by interest-bearing deposits. Panel B representes statistics on deposits, deposit rates, and deposit spreads for branches. It contains both CD (time) deposit rates and spreads and MM (saving) deposit rates and spreads. Panel C provides statistics on deposits of branches as reported to FDIC. Panel C also depicts Herfindahl-Hirschman indices for respective counties.

for exogeneity reasons. FFR changes are driven by observable and unobservable factors that might be related to banking. That is one of the most important macroeconomic identification concerns (Nakamura and Steinsson (2018)). We successfully overcome the problem by using truly unexpected changes — deviations in 1-month FF futures around FOMC meetings. They include only the part of the change that was not priced by the market.

To interpret our main results as a reaction to unexpected FFR changes, we instrument changes in FFR with monetary surprises. Specifically, we run the following regression:

$$\Delta FF_t = \delta Surprise_t + \xi X_t + \varepsilon_t \tag{22}$$

where MS_t is a monetary surprise and X_t is a vector of controls that includes GDP growth, inflation, and lagged values of FFR changes. We thus separate the unexpected component of changes to FFR. Predicted values from (22) are used as our measure of monetary shock. One unit of the measure can be interpreted as an unexpected 1 percentage point increase to FFR.

3 Results

We first show our main bank-level results. Specifically, we estimate equation (17) for spreads and deposits. Recall that if the deposit channel is relevant to global banks, they will react to the contractionary monetary shocks by increasing spreads and thereby losing deposits. We then run (18) and (19) to show that global banks do not contract lending as much as domestic banks and that they transfer funds from abroad. One of the model predictions is that global banks can afford not to cut lending because they can use foreign funds. We use 2SLS to quantify the prediction. Finally, we estimate (20) to show that global banks contract foreign lending. We also turn to the branch-level analysis to refute the endogeneity concern — the fact that banks can shift their spreads for other reasons, not necessarily because they have market power. This is important for our lending results because global banks and domestic banks might target different markets. The branch-level analysis allows us to compare banks with similar market powers. We address other concerns in Section 4.

3.1 *Bank-level results*

3.1.1 *Deposit growth and deposit spreads*

We estimate equation (17) for each bank in our sample using OLS. We do not need to use VAR to mitigate reverse causality concerns here for two reasons. First, our measure of monetary policy shock is completely exogenous, hence, our LHS variables cannot impact shocks. Second, we lag controls. Omitted variable bias is unlikely to be a problem here too because, by our assumption, nothing impacts MS_t, including any unobservables that at the same time affect deposits.

Table 2 provides means and medians of estimates separately for domestic, global, and all banks. We follow Drechsler et al. (2017) and denote bank sensitivities of deposit growth to monetary shock as *flow betas* and sensitivity of deposit spreads as *spread betas.* Column 3 suggests that deposit growth declines for all banks, including global. 1 p.p. contractionary shock leads to a 3% decline in deposit growth for an average global bank and a 2.4% decline for a median global bank. Column 4 suggests that deposit spreads increase by 19.8 b.p. for the average global bank and by 20.2 b.p. for the median global bank following a 1 p.p. contractionary shock.

Average domestic bank increases its deposit spread by 20.9 b.p. Spread betas are nearly the same for two groups of banks. Hence on average global banks and domestic banks are not significantly different from each other in their decision to increase spreads. It suggests that global banks have identical sources of market power as domestic banks. We explore that statement more in Subsection 3.3.

Flow betas differ across samples. Although global banks' deposits are more sensitive to monetary shocks, we do not think that it is related to market power. First, results on deposit spreads suggest that banks' responses are nearly the same. Banks increase spreads because they have market power, and global banks increase spreads by the same amount as domestic banks. Second, global banks initially have a higher mean deposit growth rate. Finally, this can be related to the size — global banks are generally larger and grow faster. Using the branch-level analysis that we do in Section 3.3 we compare global and domestic banks with the same market power.

We also find that banks with higher spread betas (i.e. with more market power) lose more

Table 2: Sensitivity of Deposit Spreads and Deposit Amounts to Monetary Shocks

$$y_{it} = \beta_i MS_t + \gamma_i X_{it-1} + u_{it}$$

Subset	Statistics	Flow beta	Spread beta
Domestic	Mean	-0.005^{***}	0.209^{***}
	Median	-0.002	0.209
Global	Mean	-0.030^{***}	0.198^{***}
	Median	-0.024	0.202
All	Mean	-0.006^{***}	0.208^{***}
	Median	-0.003	0.209

Note: This table provides mean and median flow and spread beta for domestic banks, global banks, and all banks in our sample as measured by equation (17). Column 3 depicts flow betas, i.e. estimates of (17) with log deposit growth as a LHS variable. Column 4 represents spread betas, i.e. estimates of (17) with changes in spreads as a LHS variable. Outliers are dropped at 1% level. We also conduct t-tests for means. *** above the estimate mean that we reject the hypothesis that the mean is zero at 1% level of confidence.

deposits. We run the following regression:

$$\Delta \log D_{it} = \alpha SpreadBeta_i \cdot MS_t + \gamma X_{it-1} + u_{it} \tag{23}$$

where $SpreadBeta_i$ is a spread beta for bank i. Our estimate for α is equal to -0.032 and it is significant at a 1% level of confidence for both domestic and global banks.[17] That is, banks with more market power lose more deposits, suggesting our deposit results are not driven by the deposit demand. We elaborate on this more in Section 3.3 where we account for branch-level market power using county-level HHI.

Overall, our results on deposit spreads and deposit growth suggest that contractionary monetary shock induces monopolistic banks to increase deposit spreads, and hence, they suffer an outflow of deposits. That holds for both domestic and global banks. In contrast, in perfectly competitive markets, banks would not change their spreads in response to monetary policy, and deposits would not change. We interpret deposit flows predicted by equation (17) as a *deposit growth predicted by the deposit channel*:

$$\widehat{DepGrowth}_{it} = \hat{\beta}_i MS_t + \hat{\gamma}_i X_{it} \tag{24}$$

We use these fitted values in further analysis to separate the effect of monetary policy on deposits from other supply and demand-side movements.

[17] We do not display a table with results here to save space.

3.1.2 Domestic lending, net transfers, and foreign lending

By our hypothesis, global banks respond to the deposit outflow by transferring funds from their foreign branches allowing them to reduce lending less. To test these hypotheses we estimate (18) and (19) using OLS with fixed effects. As before, we lag controls to avoid reverse causality concerns. Additionally, our independent variable is only a predicted part of deposit growth, and hence, should not be affected by the LHS variable.

We first estimate (18) for a total lending net of unearned income and separately for the three largest loan categories — C&I, personal, and real estate. Columns 1-2 of Table 3 presents results of the regression estimation. The first column represents total lending. Significant positive coefficient at $\widehat{DepGrowth}$ implies that an increase in deposit growth as predicted by the deposit channel leads to an increase in lending growth. Recall that contractionary monetary policy cause deposits to *flow out*. Lending growth, thus, declines. The coefficients at the $Global \cdot \widehat{DepGrowth}$ are negative and significant. It means that global banks contract lending growth **less** after the contractionary monetary shock. Results are in line with our predictions.

Recall that 1 p.p. shock leads to a 2.9% decrease in deposit growth of an average global bank. It implies that global banks contract lending growth by 0.3%. Domestic banks contract lending by 0.1%. It may seem that global banks actually contract lending growth less but two things should be noticed. First, global banks initially have a higher loan growth rate (it exceeds the loan growth rate of domestic banks by 0.1 p.p.). Second, global banks lose much more deposits. Hence, *per percent of deposit outflow* global banks contract lending less.

It is worth noting that global banks and domestic banks target different markets, so our samples are self-selected. We can't use domestic banks as a counterfactual for global banks. We mitigate these concerns partly by limiting our sample and leaving only relatively large banks. We also control for size and bank fixed effects. Nonetheless, we still may be missing important features of international banks. That's why domestic lending results alone cannot be sufficient enough proof that global banks reduce lending exposure to monetary shocks using their foreign funds. For a complete picture, we need to show that banks indeed increase transfers from foreign branches.

We thus estimate regression (19). Columns 3-4 of Table 3 present results. The coefficient is negative and significant, suggesting that outflow of deposits leads to an increase in net transfers

Table 3: Bank-level Results on Lending, Net Transfers, and Foreign Lending

$$\Delta \log L_{it} = \theta \widehat{DepGrowth}_{it} + \nu Global_{it} \cdot \widehat{DepGrowth}_{it} + \xi X_{it-1} + \alpha_i + \theta_t + \varepsilon_{it}$$
$$NetDueGr_{it} = \eta \widehat{DepGrowth}_{it} + \mu Y_{it-1} + \alpha_i + \theta_t + v_{it}$$
$$\Delta \log ForL_{it} = \iota \widehat{DepGrowth}_{it-1} + \mu Z_{it-1} + \alpha_i + \theta_t + m_{it}$$

	Dependent variable:					
	Loans		Netdue		Foreign loans	
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{DepGrowth}$	0.225***	0.239***	−13.640***	−12.128**	0.462**	0.381**
	(0.010)	(0.010)	(5.202)	(5.033)	(0.177)	(0.186)
$Global \cdot \widehat{DepGrowth}$	−0.117***	−0.105***				
	(0.031)	(0.032)				
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	No	Yes	No	Yes	No
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	203,926	203,926	1,319	1,319	1,107	1,107
R^2	0.218	0.161	0.222	0.210	0.196	0.196

Note: This table provides results of estimation of equations (18), (19), and (20). The first two columns correspond to lending net of unearned income. Columns 3 and 4 show results of netdue regression. Columns 5 and 6 correspond to a foreign lending regression. Independent variables are log deposit growth predicted by the deposit channel and an interaction of that variable with the indicator which is equal to 1 for global banks. There is only one independent variable in the netdue and foreign lending regressions because all banks in those regressions are global. Standard errors are clustered at the holding company level and displayed in the parentheses. Bank and time fixed effects are included. *,** , and *** correspond to 10-, 5-, and 1% significance level, respectively.

from foreign branches. 1% decline in deposit growth leads to 13.6% increase in netdue growth. This is both statistically and economically significant. It suggests that after 1 p.p. monetary shock, global banks will increase a growth rate of netdue by 39.4%. Given that netdue rises at 1.4% each quarter, banks practically increase their existing netdue by 40%. It implies nearly \$180 billion flowing into the US.[18]

Finally, we estimate (20). Columns 5-6 of Table 3 show results. Banks contract foreign lending if they lost deposits in the previous quarter due to monetary shock. Specifically, 1 p.p. shock leads to a 1.3% decline in foreign lending growth. Hence, US monetary shocks are transmitted internationally through the deposit channel. Our results are robust to the inclusion of time fixed effects as well as to macro controls.

[18]Total netdue is \$270bn averaged across quarters.

3.2 Alternative explanations

In the previous subsection, we presented evidence that the deposit channel impacts the international transmission of monetary shocks. Specifically, we have shown that 1 p.p. contractionary shock can lead to a 25.4% increase in the growth rate of net transfers from foreign offices. For the average bank, it is equivalent to an additional $1 billion in net transfers. Provided that we have 170 global banks in the sample, total transfers can add up to $180 billion transfer.

Nevertheless, there are several concerns. First, our results are based on the fact that deposits flow out because banks have market power. We provide evidence that deposit spreads move, and they can only move in an imperfectly competitive market. However, deposits can flow out because of changes in lending. In other words, deposit flows might be demand-driven rather than supply-driven. If banks lend less, they do not need as many deposits. This is a lending channel of monetary policy as opposed to the deposit channel (Bernanke and Blinder (1992)). We exploit our branch-level data to refute this concern in the next subsection.

Second, we focus on shocks rather than levels of monetary policy rate for exogeneity reasons. However, some deposit channel papers specifically use levels and discuss the transmission of the *policy*.[19] We address this concern in Section 4 by repeating our analysis with monetary policy levels rather than shocks. We expect to find little statistical difference.

Finally, our lending results suggest that global banks shrink lending growth less than other banks. The average global bank contracts lending growth by 50 b.p. less per percent of deposit outflow. They effectively offset 50 b.p. by transferring funds from foreign offices. The assumption here is that lending changes are supply-driven. An alternative explanation is that demand drives results. We believe it to be unlikely because county fixed effects in branch-level analysis account for new lending opportunities. An alternative way to prove that our findings are not demand-driven is to focus on *newly originated* loans within counties. Community reinvestment act (CRA) provides the data on small business lending. The data have many limitations in comparison to Call Reports. Even though CRA can help us to refute demand vs. supply concerns, it will likely bring up other serious issues.

[19]For details see Drechsler et al. (2017, 2019).

3.3 Branch-level lending results

One of the concerns outlined above is that our lending results might be driven by lending channel rather than deposit channel. We address this concern by conducting branch-level analysis. We first quantify the effects of monetary shocks on deposits and spreads interacted with market power. In other words, we compare banks with high and low market power. We then predict deposits and test if global banks are different than domestic banks in lending behavior.

We run the following panel regression to find out if branches change spreads and lose deposits:

$$y_{it} = \beta MS_t \cdot BranchHHI_c + \gamma Global_{it} \cdot MS_t \cdot BranchHHI_c + \alpha_i + \theta_c + \zeta_{st} + u_{icst} \tag{25}$$

where y_{it} is either a change in deposit spread or log deposit growth of branch i at time t[20], $BranchHHI_c$ is a HHI index of county c where branch i is located, $Global_{it}$ is an indicator which is equal to 1 if branch i is a branch of the global bank at time t, α_i is branch FE, θ_c is county FE, and ζ_{st} is state-time FE.[21] By our hypothesis, γ should be statistically indifferent from zero.

Table 4 provides estimates. The first column suggests that the coefficient at an interaction between shock and market power is negative. It implies that banks with more market power lose more deposits. This finding is in line with Drechsler et al. (2017) — deposits flow out because of the supply, not demand. If it was demand, banks with market power would never want to deliberately lose deposits. The second coefficient is negative and significant. It implies that branches of global banks lose more deposits. We got the same result in bank-level analysis. Branch-level regression allows us to pin down an exact difference between two groups. Global banks lose twice as many deposits as domestic banks.

Column 2 shows that banks with more market power increase CD spreads more following a contractionary monetary policy shock. Global banks are not significantly different. Finally, column 3 implies that MM spreads do not change with monetary surprises. This can be related to the fact that MM spreads are very low. Their movements are usually explained by fundamental changes in the FF rate, not by surprises. The most important fact is that global

[20] Regressions with deposit flows are annual because we use FDIC data.

[21] We follow Drechsler et al. (2017) in choosing fixed effects. Our results are robust to inclusion of bank-time FEs as well.

Table 4: Branch-level Results on Deposits

$$y_{it} = \beta MS_t \cdot BranchHHI_c + \gamma Global_{it} \cdot MS_t \cdot BranchHHI_c + \alpha_i + \theta_c + \eta_{bt} + \zeta_{st} + u_{it}$$

	Dependent variable:		
	Deposits	CD Spreads	MM spreads
	(1)	(2)	(3)
$MS \cdot BranchHHI$	-0.018^{***}	0.199^{**}	0.177
	(0.005)	(0.092)	(0.139)
$Global \cdot MS \cdot BranchHHI$	-0.019^{***}	0.204	-0.390
	(0.008)	(0.220)	(0.279)
Fixed effects	Yes	Yes	Yes
Observations	1,307,583	89,711	72,682
R^2	0.315	0.834	0.880

Note: This table provides branch-level regression results for equation (25). First column runs regression with log deposit growth as a LHS variable. Second column runs regression with time deposit spreads, and third column — with saving deposit spreads. Fixed effects are branch, county, and statetime. Standard errors in parentheses are clustered at the county level. *,** , and *** correspond to 10-, 5-, and 1% significance level, respectively.

banks are not different from domestic banks.

We next aggregate predicted deposit flows from regression (25) up to the bank level to analyze lending and netdue. We use deposit shares of branches as weights. Notice that, unlike the previous section, predicted deposit growth in this section cannot be explained by lending. All lending opportunities are included in county and state fixed effects. Market segmentations are captured by the HHI index, and deposits move because banks have market power. The branch-level analysis makes it possible to directly account for the market power. That is why all following results can be interpreted as pure deposit channel findings, not lending channel ones.

We repeat the analysis of Section 3.1 here with predicted deposits from branch-level regressions. We denote them by $Dep\widehat{Growth}Br$. Notice that R^2 of deposit regressions are high enough, so we fit the data well. We ask if global banks contract lending less than domestic banks. We estimate the following regression:

$$\Delta \log L_{it} = \theta Dep\widehat{Growth}Br_{it} + \nu Global_{it} \cdot Dep\widehat{Growth}Br_{it} + \xi X_{it-1} + \alpha_i + \theta_t + \varepsilon_{it} \qquad (26)$$

where α_i are bank FE.[22]

[22] We use bank FE rather than HC FE here because aggregation was specifically at the bank level.

Then, we estimate netdue and foreign lending regressions. Specifically, we run the following regression for netdue:

$$NetDueGr_{it} = \eta Dep\widehat{Growth}Br_{it} + \mu Y_{it-1} + \alpha_i + \theta_t + v_{it} \tag{27}$$

and for foreign lending:

$$\Delta \log ForL_{it} = \iota Dep\widehat{Growth}Br_{it-1} + \mu Z_{it-1} + \alpha_i + \theta_t + m_{it} \tag{28}$$

Controls in regressions above are the same as in bank-level regressions. We include bank balance sheet variables (e.g. asset growth) and macro variables. The only difference between these regressions and bank-level ones is an explanatory variable. In the current section, the explanatory variable is entirely driven by monetary shock **and** market power. All estimates thus should be interpreted as a sensitivity to the deposit channel.

Table 5 presents results. Coefficients at the $Dep\widehat{Growth}Br$ in the regressions are positive and significant. It means that deposit outflow caused by the contractionary monetary shock leads to a contraction in lending growth. Moreover, coefficients at the interaction term are negative and significant. Hence, global banks offset lending risk.[23]

Column 3 of Table 5 shows that banks with higher market power increase the growth rate of net transfers more. The results are in favor of the deposit channel. We don't find a significant coefficient in the regressions without time fixed effects. The potential reason is that the sample is too small, and time effects become crucial. That is another reason for using bank-level analysis as a benchmark. We also don't find any significant effect on foreign lending, although signs are as expected. One possible reason is that we observe only annual data. Bank-level analysis suggested that in a year all effect on foreign loans is gone. Thus, it is impossible to pin down foreign lending results in a branch-level setting.

Results above mitigate potential identification concerns and show that the deposit channel is weaker for global banks. Magnitudes in Table 5 are smaller than in bank-level regressions. That is because here we focus on just one source of market power — HHI, i.e. deposit shares in the county. Another reason has to do with interpretation. We don't ask if global banks are different from domestic banks. We rather ask if global banks with high market power are

[23] In these regressions it even appears that global banks offset all of the risks.

Table 5: Results on Lending, Net Transfers, and Foreign Lending: Aggregated from Branches

$$\Delta \log L_{it} = \theta \widehat{DepGrowthBr}_{it} + \nu Global_{it} \cdot \widehat{DepGrowth}_{it} + \xi X_{it-1} + \alpha_i + \varepsilon_{iht}$$
$$NetDueGr_{it} = \eta \widehat{DepGrowthBr}_{it} + \mu Y_{it-1} + \alpha_i + \theta_t + v_{it}$$
$$\Delta \log ForL_{it} = \iota \widehat{DepGrowthBr}_{it-1} + \mu Z_{it-1} + \alpha_i + \theta_t + m_{it}$$

	Dependent variable:					
	Loans		Netdue		Foreign loans	
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{DepGrowthBr}$	0.010***	0.010***	−0.736**	−0.288	0.084	0.006
	(0.001)	(0.001)	(0.321)	(0.256)	(0.100)	(0.021)
$Global \cdot \widehat{DepGrowthBr}$	−0.020***	−0.021***				
	(0.004)	(0.004)				
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	No	Yes	No	Yes	No
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	141,112	141,112	332	157	206	96
R^2	0.349	0.349	0.394	0.674	0.372	0.859

Note: This table provides results of estimation of equations (26)-(28). Columns 1-2 show domestic lending restuls. Columns 3-4 correspond to netdue regressions. Finally, columns 5-6 show foreign lending results. Independent variables are log deposit growth predicted by the branch-level deposit channel and an interaction of that variable with the indicator which is equal to 1 for global banks. There are no interaction terms in netdue and foreign lending regressions, because all banks in those regressions are global. Bank and time fixed effects are included. Standard errors in parentheses are clustered at bank level. *,** , and *** correspond to 10-, 5-, and 1% significance level, respectively.

different from global banks with low market power. Of course, banks and especially global banks can have other sources of market power including marketing, state law, or government. That is why our main results are bank-level. Branch-level analysis in this section proves that our lending results hold even in the very constrained case with just one source of the market power but at the same time these results are purely driven by the deposit channel.

Overall, findings in this section shed new light on the transmission of US monetary shocks abroad. We show that global banks transfer up to $180 billion following 1 p.p. contractionary monetary shock. By doing that, global banks effectively offset lending risk — they do not have to contract lending growth rates so much as domestic banks per percent of deposit outflow. This is strong evidence that the deposit channel impacts the international transmission of monetary shocks.

4 Robustness

We have already shown that our results are robust to the level of aggregation, exclusion of certain fixed effects, and macro variables. In this section, we check if our results are robust to the measure of monetary policy shock and to the full sample. We have evidence that our results are robust to standard errors, various sets of controls and fixed effects, exclusion of random sets of banks or quarters, denominator and numerator in (21), size threshold, and measure of lending, but we leave it all beyond the text of the paper.

4.1 Changes in FF level

Most deposit channel papers focus on FF levels rather than shocks (Drechsler et al. (2017); Wang et al. (2020)). We are interested in the transmission of shocks, but in this section, we show that our results hold for Fed Fund rate changes too. We only show bank-level results here, however, the branch-level analysis produces analogous findings. We repeat the analysis of Section 3.1. Specifically, we define ΔFF_t as a change in Fed Funds rate (henceforth, FFR) from period $t-1$ to t.[24] We first compute spread and flow betas — we estimate the following regression for each bank i:

$$y_{it} = \beta_i \Delta FF_t + \gamma_i X_{it-1} + u_{it} \tag{29}$$

where y_{it} is either a change in deposit spreads or log deposit growth. We include the same controls here as in regressions with monetary surprises.

Table 6 presents results. After a 1 p.p. change in FFR, banks increase spreads and lose deposits. The average bank increases spreads by 0.29 b.p., the average global bank — by 0.26 b.p., and the average domestic bank — by 0.29 b.p. The average bank's growth of deposits decreases by 0.4%, for the average global bank — by 1.2%, and for the average domestic bank — for 0.4%. Medians are fairly close to means.

The results above suggest two important implications. First, our first step results are robust to whether we use FF changes or monetary surprises. Second, deposit channel works for global banks not only in transmitting shocks but also in transmitting policy itself. Magnitudes in regressions with FFR are generally close but still smaller than ones in main regressions. This can be explained by the fact that FFR changes themselves are predictable.

[24] We have data on FFR up to 2020 in contrast to surprises that we have only up to 2018.

Table 6: Sensitivity of Deposit Spreads and Deposit Amounts to FF Changes

$$y_{it} = \beta_i \Delta FF_t + \gamma_i X_{it-1} + u_{it}$$

Subset	Statistics	Flow beta	Spread beta
Domestic	Mean	-0.004^{***}	0.287^{***}
	Median	-0.003	0.281
Global	Mean	-0.012^{***}	0.260^{***}
	Median	-0.008	0.258
All	Mean	-0.004^{***}	0.286^{***}
	Median	-0.003	0.281

Note: This table provides statistics of estimates of equation (29). The first irst statistic is a mean, and the second one is a median. First row provides estimates for domestic banks, second — for global banks, and third — for all banks in our sample. Column 3 depicts flow betas, i.e. estimates of (29) with log deposit growth as a LHS variable. Column 4 represents spread betas, i.e. estimates of (29) with changes in spreads as a LHS variable. Outliers are dropped at 1% level. We also conduct t-tests for means. *** above the estimate mean that we reject the hypothesis that the mean is zero at 1% level of confidence.

We use deposit regressions to fit predicted deposit growth as we did before. We denote the variable by $Dep\widehat{Growth}FFR$. We first estimate the following regression to test if our lending results are robust to the measure of monetary shock:

$$\Delta \log L_{it} = \theta Dep\widehat{Growth}FFR_{it} + \nu Global_{it} \cdot Dep\widehat{Growth}FFR_{it} + \xi X_{it-1} + \alpha_i + \theta_t + \varepsilon_{it} \quad (30)$$

where α_i is a bank FE.

Next, we show that netdue results are also robust to the measure of monetary shock. We estimate the following regression:

$$NetDueGr_{it} = \eta Dep\widehat{Growth}FFR_{it} + \mu Y_{it-1} + \alpha_i + \theta_t + v_{it} \quad (31)$$

Finally, we test if foreign lending results are robust to the expectedness of the shock:

$$\Delta \log ForL_{it} = \iota Dep\widehat{Growth}FFR_{it-1} + \mu Z_{it-1} + \alpha_i + \theta_t + m_{it} \quad (32)$$

Table 7 presents main findings. Both global and domestic banks contract lending growth after an increase in FFR. This is in line with our main findings. However, we don't find significant evidence that global banks contract lending less.[25] This is because changes in FFR are predictable and banks adjust domestic lending accordingly. However, the same logic doesn't apply to foreign flows. Columns 3-4 present results on netdue. Global banks increase net

[25] Coefficients are significant in the full sample.

Table 7: Bank-level Results on Lending, Net Transfers, and Foreign Lending with FFR

$$\Delta \log L_{it} = \theta \widehat{DepGrowthFFR}_{it} + \nu Global_{it} \cdot \widehat{DepGrowth}_{it} + \xi X_{it-1} + \alpha_i + \theta_t + \varepsilon_{it}$$
$$NetDueGr_{it} = \eta \widehat{DepGrowthFFR}_{it} + \mu Y_{it-1} + \alpha_i + \theta_t + v_{it}$$
$$\Delta \log ForL_{it} = \iota \widehat{DepGrowthFFR}_{it-1} + \mu Z_{it-1} + \alpha_i + \theta_t + m_{it}$$

	Dependent variable:					
	Loans		Netdue		Foreign loans	
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{DepGrowthFFR}$	0.212***	0.225***	−13.671**	−11.364*	0.524***	0.518***
	(0.009)	(0.010)	(5.965)	(5.803)	(0.148)	(0.171)
$Global \cdot \widehat{DepGrowthFFR}$	−0.045	−0.057				
	(0.037)	(0.037)				
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	No	Yes	No	Yes	No
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	239,745	239,745	1,275	1,275	1,106	1,106
R^2	0.200	0.147	0.227	0.215	0.238	0.211

Note: This table provides results of estimation of equations (30), (31), and (32). The first two columns correspond to lending net of unearned income. Columns 3 and 4 show results of netdue regression. Columns 5 and 6 correspond to a foreign lending regression. Independent variables are log deposit growth predicted by the deposit channel and an interaction of that variable with the indicator which is equal to 1 for global banks. There is only one independent variable in the netdue and foreign lending regressions because all banks in those regressions are global. Standard errors are clustered at the holding company level and displayed in the parentheses. Bank and time fixed effects are included. *,**, and *** correspond to 10-, 5-, and 1% significance level, respectively.

transfers after an increase in the FF rate. Magnitudes are very close to ones in Table 3. Finally, we show that global banks contract foreign lending. Magnitudes again are similar to the main results.

Hence, global banks react to changes in FFR by increasing net transfers and contracting foreign lending. We don't find evidence that they contract domestic lending less than local banks. The reason is that changes to FFR are induced by market decisions and anticipated. We can't observe counterfactuals and see how global banks would behave if they didn't have foreign offices. That is one reason why we concentrate on monetary shocks and not levels.[26]

4.2 Full sample

There is evidence in the literature that large and small banks differently transmit monetary policy (Kashyap and Stein (2000)). Large banks are believed to use their balance sheet to

[26]See Nakamura and Steinsson (2018) for more on identification issues with FFR.

Table 8: Sensitivity of Deposit Spreads and Deposit Amounts to Monetary Shocks: Full Sample

$$y_{it} = \beta_i MS_t + \gamma_i X_{it-1} + u_{it}$$

Subset	Statistics	Flow beta	Spread beta
Domestic	Mean	-0.009^{***}	0.199^{***}
	Median	-0.007	0.205
Global	Mean	-0.030^{***}	0.195^{***}
	Median	-0.024	0.196
All	Mean	-0.009^{***}	0.199^{***}
	Median	-0.007	0.205

Note: This table provides mean and median flow and spread beta for domestic banks, global banks, and all banks in the full sample as measured by equation (17). Column 3 depicts flow betas, i.e. estimates of (17) with log deposit growth as a LHS variable. Column 4 represents spread betas, i.e. estimates of (17) with changes in spreads as a LHS variable. Outliers are dropped at 1% level. We also conduct t-tests for means. *** above the estimate mean that we reject the hypothesis that the mean is zero at 1% level of confidence.

smooth the transmission. In our case, it would mean that large banks will be more resistant to lending cuts. It is a concern because most global banks are indeed large. In this section, we show that our results are not driven by size.

In all previous regressions, we focused on relatively large banks, i.e. we dropped banks beyond the fifth size quantile. In this section, we repeat the analysis but we keep all banks. First, we report deposits and spread betas. Table 8 report results. The main patterns of our analysis remain the same. Specifically, global banks increase spreads and lose deposits. As in the benchmark sample, global banks lose more deposits than domestic banks.

We then repeat analysis for lending, net transfers, and foreign lending. Table 9 presents results. The main coefficients are robust to the sample. We don't find any statistical or economic difference in findings. We also repeat analysis with FFR in the full sample and find that results are robust. In addition, we try 70- and 90% cutoff for size and find no statistical difference.[27] Overall, we conclude that our main findings are robust to the samples and are not driven by the fact that global banks are large.

5 Conclusion

In this paper, we contribute to the understanding of how bank deposits and market power impact the international transmission of monetary policy. Given the large academic and political interest in understanding how US monetary policy is transmitted internationally, we consider

[27] We do not show these results to save space.

Table 9: Bank-level Results on Lending, Net Transfers, and Foreign Lending: Full Sample

$$\Delta \log L_{it} = \theta \widehat{DepGrowth}_{it} + \nu Global_{it} \cdot \widehat{DepGrowth}_{it} + \xi X_{it-1} + \alpha_i + \theta_t + \varepsilon_{it}$$
$$NetDueGr_{it} = \eta \widehat{DepGrowth}_{it} + \mu Y_{it-1} + \alpha_i + \theta_t + v_{it}$$
$$\Delta \log ForL_{it} = \iota \widehat{DepGrowth}_{it-1} + \mu Z_{it-1} + \alpha_i + \theta_t + m_{it}$$

	Dependent variable:					
	Loans		Netdue		Foreign loans	
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{DepGrowth}$	0.298***	0.305***	−13.247***	−11.782**	0.477***	0.398**
	(0.005)	(0.006)	(5.032)	(4.870)	(0.169)	(0.178)
$Global \cdot \widehat{DepGrowth}$	−0.149***	−0.160***				
	(0.031)	(0.031)				
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	No	Yes	No	Yes	No
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	631,882	631,882	1,343	1,343	1,142	1,142
R^2	0.209	0.163	0.221	0.209	0.224	0.195

Note: This table provides results of estimation of equations (18), (19), and (20) in the full sample. The first two columns correspond to lending net of unearned income. Columns 3 and 4 show results of netdue regression. Columns 5 and 6 correspond to a foreign lending regression. Independent variables are log deposit growth predicted by the deposit channel and an interaction of that variable with the indicator which is equal to 1 for global banks. There is only one independent variable in the netdue and foreign lending regressions because all banks in those regressions are global. Standard errors are clustered at the holding company level and displayed in the parentheses. Bank and time fixed effects are included. *,** , and *** correspond to 10-, 5-, and 1% significance level, respectively.

the question of whether the deposit channel, which recent literature has argued is a major channel for the transmission of monetary policy domestically, has implications to the internal decision by the global banks to allocate resources across borders, and to the transmission of monetary policy. To understand the bank decision, we suggest a static model of a global bank which operates in two countries and has market power in the deposit market. We show that under this framework, when the policy rate in one country increases, like domestic banks, global banks increase their deposit spreads. The increase in spreads is commensurate to their market power in the deposit market, with high market power banks optimally choosing a spread which results in a larger outflow of deposits. However, unlike domestic banks, global banks optimally choose to transfer funds from foreign branches, thereby reducing domestic lending less than domestic banks but also reducing foreign lending.

We then evaluate the predictions of this framework empirically. We confirm that the deposit channel holds for both domestic and global banks and both expected and unexpected movements in the Fed Funds rate. Moreover, the decreases in deposits as predicted by unexpected changes to the Fed Funds Rate, reduce lending for both domestic and global banks, but as predicted, global banks reduce lending less per percent of deposit outflow. This predicted decline in deposits also increases net flows by global banks into the US. Finally, we show that global banks contract foreign lending.

The results of this paper suggest that understanding bank market power is critical in quantifying the transmission of US monetary policy, both domestically and abroad. Relative to a closed economy, an increase in bank market power further dampens the impact of US monetary policy domestically and amplifies the transmission internationally. This paper raises a few clarifying questions. First, we show that global banks fund domestic operations through foreign flows, and this impact US lending. A quantitative understanding of the impact on foreign lending and foreign business activity, including investment and trade, is important in understanding the full impact of the deposit channel on foreign lending and the portion of the international transmission of US monetary policy that can be attributed to the deposit channel. Next, a clear evaluation of the relative impact of the deposit channel and the reserve channel in the international transmission of monetary and liquidity shocks would provide policymakers with a better understanding of how monetary policy is transmitted and which parties are most impacted. Finally, this framework abstracts from concerns of currency and capital controls, both of which may be relevant to bank decision-making, especially since foreign lending funded through domestic deposits introduces the risk of currency mismatch in addition to duration mismatch. We leave these questions for future research.

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