Foreign-borne Interest Rate Risk

Rashad Ahmed*

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Abstract

Interest rates on foreign deposits (deposits in the foreign offices of US banks) are more sensitive to US monetary policy than domestic deposit rates. These larger foreign *deposit betas* are a function of (i) the uninsured nature of foreign deposits and (ii) the fact that foreign deposit rates also respond to non-US monetary policy that is correlated with US monetary policy. As a result of large foreign deposit betas, banks become more rate sensitive when the share of foreign deposits is high. At the bank level, this is evidenced by banks with high foreign deposit shares having stronger stock price reactions to US monetary policy. In aggregate, the funding cost sensitivity of the banking sector grows meaningfully larger under high foreign deposit shares.

Keywords: Deposit beta; Eurodollars; Global banks; International spillovers
JEL Classifications: E52, E58, F30, F34, G21

*Office of the Comptroller of the Currency, U.S. Department of the Treasury. E-mail address: rashad.ahmed@occ.treas.gov. The author gratefully acknowledges Iñaki Aldasoro, Luca Guerrieri, Arpit Gupta, Bryan Hardy, Francisco Ilabaca, Anil Jain, Gabriele La Spada, Todd Messer, Camelia Minoiu (Discussant), Win Monroe, Friederike Niepmann, Gabor Pinter (Discussant), Jonathan Pogach, Alexi Savov, Tim Schmidt-Eisenlohr, Andreas Schrimpf, Pinar Uysal, David Zeke, and seminar participants at the BCBS-BIS-CEPR Workshop on Banks' Liquidity in Volatile Macroeconomic and Market Environments, the Federal Reserve Board, the OCC Bank Research Symposium on Depositor Behavior, Bank Liquidity, and Run Risk, and the Reserve Bank of Australia for valuable comments and suggestions. The views expressed in this paper are those of the author and do not necessarily represent the views of the OCC, Department of the Treasury or United States government.

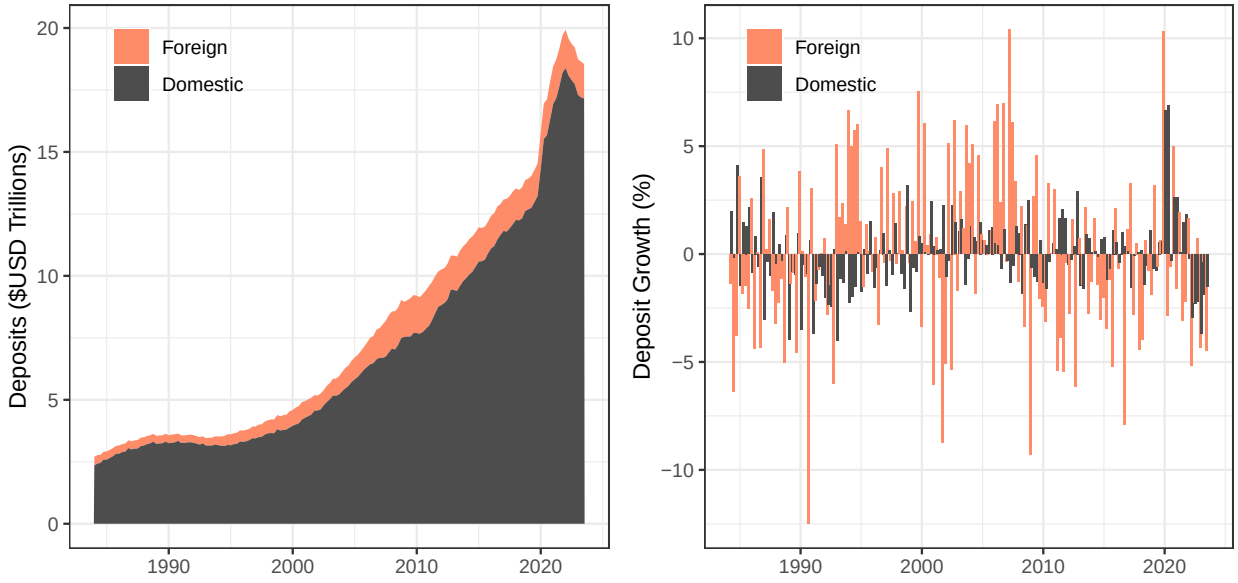
1 Introduction

Deposit liabilities are the largest and cheapest funding source for US commercial banks. Funding cost advantages of deposits are often characterized by low *deposit betas*: low sensitivities of US bank deposit rates to changes in US monetary policy rates [Hannan and Berger, 1991; Neumark and Sharpe, 1992; Drechsler et al., 2021]. Deposit betas are consequential for financial stability because they affect bank funding stability, interest rate risk, and deposit franchise values [Greenwald et al., 2023; Li et al., 2023]. Deposit betas also shape the transmission of monetary policy to deposit costs and bank lending [Bernanke and Blinder, 1992; Drechsler et al., 2017]. Most analyses of deposit betas exclusively consider domestic deposits, given the size of the domestic deposit base. However, US banks that operate globally also issue foreign deposits, i.e., deposits issued in their foreign office branches [Aldasoro et al., 2022; Niepmann, 2023]. While making up a smaller share of aggregate bank deposits, foreign deposits are considerably more volatile (Figure 1). This volatility can impact a bank's funding stability, enable cross-border financial spillovers, and give rise to meaningful differences between foreign and domestic deposit betas [Hale et al., 2020; FDIC, 2024].

In this paper, we estimate the foreign deposit betas of US banks, compare their size *vis a vis* domestic deposit betas, and quantify their macro-financial implications. Our key parameters of interest are the deposit betas of foreign and domestic deposit rates with respect to the Federal Funds Rate (FFR) [Drechsler et al., 2017]. We show that foreign deposit betas are significantly larger than domestic deposit betas at the bank level and in aggregate. While foreign deposits are uninsured and therefore riskier than insured domestic deposits, this only partially accounts for their large deposit betas. Instead, estimates of foreign deposit betas become substantially smaller after controlling for *foreign* monetary policy. This suggests that large foreign deposit betas reflect the additional sensitivity of foreign deposit rates to foreign policy rates (FPR) that are correlated with the FFR.

Large foreign deposit betas can affect financial stability at the bank level and in aggregate. We use the fact that a bank's total deposit beta is the share-weighted average of its foreign

Figure 1: Aggregate Foreign and Domestic Deposits of US Commercial Banks



Note: Quarterly deposit growth rates calculated as de-meaned log-differences of deposit levels. The standard deviations of quarterly domestic and foreign deposit growth are 1.67% and 3.75%, respectively with a correlation coefficient of -0.116 (t=-1.47). Sample period is 1984Q1-2023Q3.

and domestic deposit betas, and thereby increases with the foreign deposit share. As a result, large foreign deposit betas imply that bank funding costs are more sensitive to interest rates when the foreign deposit share is high. At the bank level, we show that the stock returns of banks with higher *ex ante* foreign deposit shares declined by considerably more during the 2021-2022 US interest rate hikes. At the aggregate level, the interest sensitivity of bank sector deposit costs is significantly impacted by foreign deposits. We show via VAR simulations that if the 2023 foreign deposit share of 7.5% was shifted by ±5 percentage points, aggregate deposit cost sensitivity would be impacted by ±$2.47 billion annually per 100 bps change in the FFR.

We begin by presenting some key empirical and institutional details of foreign deposits, leveraging regulatory data from Call Reports with a range of public and non-public datasets. Foreign deposits are issued by a small number of US banks, yet they are subject to disproportionately large fluctuations. While less than 1.5% of US banks issue foreign deposits, the

aggregate foreign deposit share reached as high as 18% in 2008 before declining to 7.5% in 2023. Foreign deposits are primarily composed of uninsured, corporate accounts. Such accounts tend to be more volatile and have larger deposit betas than insured or retail deposits [Brimmer and Dahl, 1975; Comizio and Chiachiere, 2014].[1] Consistent with this, we show that banks issuing more foreign deposits tend to hold more liquid cash instruments and fewer personal loans. The regulatory treatment of foreign deposits is also consistent with their risk profile. Foreign deposits tend to be bucketed with other risky and uninsured deposit types[2], and most global banks self-report large foreign deposit betas in their regulatory filings [Gerlach et al., 2018]. Foreign deposits of US banks are mostly dollar-denominated, and mostly domiciled in countries with strong economic ties to the US and those with lower reserve requirements [Brimmer and Dahl, 1975; Goldberg and Saunders, 1980; He and McCauley, 2012; Claessens and Van Horen, 2021].

Next, we estimate foreign and domestic deposit betas at the aggregate and bank level. Deposit betas are estimated from regressions of deposit rate changes on FFR changes [Drechsler et al., 2017; Messer and Niepmann, 2023]. We show that estimates of contemporaneous and 4-quarter deposit betas are significantly larger for foreign deposit rates. In aggregate, foreign deposit betas are even larger than the betas on domestic time deposits. For every 100 bps change in the FFR, about 54 bps pass through to foreign deposit rates within the same quarter, as opposed to 23 bps to domestic deposit rates. Over a 4-quarter period, foreign deposit betas are on average 63% while domestic deposit betas are 42%. These aggregate estimates are robust to different sample periods and regression specifications, and are comparable to those from Gerlach et al. [2018]. Using bank-level data from Call Reports, we show that total (foreign plus domestic) bank-level deposit betas are significantly increasing in a bank's foreign deposit share. The bank-level estimates suggest that foreign deposit betas are 20-35 percentage points larger than domestic deposit betas, thus aligning closely with

[1] See *FDIC Risk Management Manual of Examination Policies* sections 6.1 and 11.1.

[2] For example, the Liquidity Coverage Ratio (LCR) rule designed to stress test a bank's ability to meet its short-term obligations assigns larger 'runoff rate' assumptions and smaller 'available stable funding' factors to foreign deposits compared to domestic insured deposits.

the aggregate estimates.

Two factors help explain the large size of foreign deposit betas relative to domestic deposit betas. First, we show that large foreign deposit betas can be explained by foreign deposit rates' additional sensitivity to foreign monetary policy rates (FPR). As a result, foreign deposit rates of US banks are subject to a FPR-beta in addition to the FFR-beta. We consider a variety of FPR measures constructed as the bank-weighted, trade-weighted, or GDP-weighted average policy rate across non-US advanced economies. After controlling for the FPR in the deposit rate regressions, 4-quarter foreign deposit FFR-betas fall from 63% to about 50%, while the estimated 4-quarter FPR-beta is 32%. By contrast, placebo tests verify that domestic deposit rates exhibit sensitivity to the FFR but not the FPR. Deposit beta estimates using bank-level data align with these aggregate estimates. We further show that these results are not driven by foreign banking organizations (FBOs) in the sample of US banks, whose parent organizations' funding costs are tied to foreign interest rates. Using non-public FFIEC 009 data, we also show that these results hold for dollar-denominated foreign deposits and not just foreign-currency foreign deposits, as the latter typically have deposit rates mechanically indexed to foreign interest rates.

Second, the uninsured treatment of foreign deposits also partially explains their larger deposit betas.[3] The bank-level data lets us decompose foreign deposit betas into an uninsured deposit beta and a residual beta associated with foreign factors. We identify the uninsured deposit beta by exploiting differences in bank issuance of uninsured versus insured domestic time deposits. Across specifications, we estimate an uninsured deposit beta 'premium' that is between +11 and +14.5 percentage points over insured deposit betas, while estimates of the foreign deposit beta 'premium' range between +14 and +35 percentage points over domestic deposit betas. The uninsured treatment of foreign deposits thus partially accounts for their large deposit betas, but it is not sufficient to rule out alternative explanations, e.g., exposure to foreign monetary policy. These results also hold after controlling for other

[3]Uninsured deposit betas are typically larger than insured deposit betas [Drechsler et al., 2023].

factors that may explain larger deposit betas, such as a bank specialization in time deposits and corporate customers.

We show that these large foreign deposit betas carry important macro-financial consequences at the bank level and in aggregate. Specifically, foreign deposits can raise the interest rate sensitivity of banks by increasing the average deposit beta within a bank and across the bank sector. At the bank level, we adopt an event study approach similar to Aharony et al. [1986] and English et al. [2018] to study how bank stock prices performed over the 2021-22 Federal Reserve monetary tightening cycle. Over the 12 months between September 2021-22 when the Federal Reserve raised the FFR by 500 bps, the stock returns of US banks fell by an additional 4-5% for every 10 percentage points of a bank's foreign deposit share. This effect is robust to controlling for uninsured domestic deposits and bank size. These estimates suggest that investors recognize the interest rate risk inherent to US banks issuing large-beta foreign deposits.

The interest rate risk borne by US banks with foreign deposits does not diminish with aggregation. We show this by projecting bank sector deposit costs following an increase in the FFR under counterfactual foreign deposit share scenarios. First, we extend upon Bernanke and Blinder [1992] and Gerlach et al. [2018] by estimating a macro-finance VAR of key aggregate variables such as the FFR, FPR, foreign and domestic deposit rates, and the foreign deposit share. In a second stage, we apply the impulse response functions (IRFs) generated from the VAR to project forward the 2023 values of the key aggregate variables. We compare the *additional* interest expense following a 100 bps rate hike under counterfactual 2.5% and 12.5% foreign deposit shares, versus a baseline of 7.5% as in 2023. Such ± 5 percentage point shifts in the foreign deposit share can alter bank sector funding sensitivity by $\pm$\$2.47 billion or more annually. The calculations suggest that sector-wide deposit interest expense for 2022 would have been at least 10% higher under a foreign deposit share of 12.5% instead of 7.5%.

Meaningful differences in foreign and domestic deposit betas introduce important trade

offs between monetary policy and financial stability objectives [Stein, 2012; Akinci et al., 2020]. On one hand, large foreign deposit betas strengthen the transmission of US monetary policy to the bank sector when foreign deposit shares are high. On the other hand, high or variable foreign deposit shares, resulting from more aggressive re-pricing of foreign deposits, could potentially raise funding and interest rate risks [Li et al., 2023]. Our results also suggest that foreign deposits present a channel for foreign monetary policy to exert greater influence on US financial conditions by affecting US bank funding costs. Consequently, overlooking the role of foreign deposits in the banking system could result in an incomplete assessment of macro-financial risks.

Related Literature. This paper's contribution lies in the intersection of international finance and deposit markets. While the economics of international banking are generally well-established, few studies focus specifically on the pricing implications of foreign deposit funding. Moreover, several studies estimate deposit betas for domestic deposits of US banks, while this paper presents one of the first systematic analyses of foreign deposit betas.

This paper contributes to the literature on international banking. US banks with foreign deposits are some of the largest banks whose balance sheets figure prominently into the risk-taking capacity of the financial sector [Bruno and Shin, 2015; Cesa-Bianchi et al., 2018]. Financial institutions might desire access to foreign funding markets for a variety of reasons. Early work of Brimmer and Dahl [1975] and Goldberg and Saunders [1980] and more recently Claessens and Van Horen [2021] suggest that banks may expand overseas due to regulatory appeal, growing trade and financial integration, and to cater to increasingly multinational corporations. Additional reasons banks may expand their foreign operations include benefits such as capital efficiency, lower systemic risk, and resilience to domestic shocks. Niepmann [2023] motivates cross-border banking with a theoretical model to show that banks operating across borders improve welfare by making international capital allocation more efficient. Karolyi et al. [2023] shows empirically that cross-border banking is associated with lower

systemic risk. Liu and Pogach [2017] shows that foreign lending by US banks typically compliments domestic lending. While much of the literature focuses on asset-side implications of international banking, our work emphasizes the liability side. Similarly, Anderson et al. [2021] and Aldasoro et al. [2022] show that US wholesale funding is an important source of dollar funding for global banks. Foreign deposits are another important source of funding, though not without their unique risks. Foreign deposits are volatile and have driven systemic bank runs in the past, such as the 1984 run on Continental Illinois [Wall and Peterson, 1990; Hanc, 1998; Carlson and Rose, 2016].[4] We contribute to the literature by presenting new evidence on the macro-financial implications of foreign deposits.

This paper also contributes to the literature on international spillovers via banks by building on Cetorelli and Goldberg [2012c], Cetorelli and Goldberg [2012b], Popov and Udell [2012], Hale et al. [2020] among others. In a closely related paper, Cetorelli and Goldberg [2012a] shows that lending activities of domestic banks with foreign operations are insulated from domestic monetary policy. This is because these banks access foreign funding when domestic financial conditions tighten. Meanwhile, the evidence we present suggests a simultaneous consequence of foreign funding. That is, foreign deposit funding alters monetary policy sensitivity of domestic banks when foreign deposit betas differ from domestic deposit betas. Moreover, while foreign funding serves as a risk diversifier, we show that foreign deposit funding also exposes US banks to foreign monetary policy, thereby enabling cross-border transmission of financial conditions via banks. Berrospide et al. [2017] shows how tighter macro-prudential regulations in foreign countries can boost lending in the US through the US branches of foreign banks. Correa et al. [2022], Spiegel [2022] and Correa et al. [2023] argue that foreign monetary policy and trade shocks can spill over by altering bank *lending* patterns in the US. Our findings complement these studies by emphasizing international spillovers through bank *funding* [Aldasoro et al., 2022].

[4]Continental Illinois was among the top 10 largest US banks at the time. More than half of the bank's deposits were foreign deposits. The bank also held a large foreign loan portfolio that was particularly exposed to Latin America. Credit risk concerns rose during the 1980s Latin American Debt Crisis, which played a role in the bank's eventual failure.

This paper also contributes to the literature on monetary policy transmission through bank deposits. The deposits channel of monetary policy emphasizes the incomplete pass-through of interest rates to deposit rates [Neumark and Sharpe, 1992; Nagel, 2016; Yankov, 2018; Kurlat, 2019; Krishnamurthy and Li, 2023]. As described in Drechsler et al. [2017], the deposits channel suggests that bank market power explains the observation of low deposit betas. In turn, this affects the transmission of monetary policy through bank funding costs and bank lending [Bernanke and Blinder, 1988; Afanasyeva and Güntner, 2020; Li et al., 2023]. Wang et al. [2022] finds that both bank market power and regulatory constraints affect the transmission of monetary policy through banks. Li et al. [2019] finds that changes in the supply of US Treasury securities affects the deposits channel when US Treasuries and bank deposits are substitutes. d'Avernas et al. [2023] documents deposit beta differences between large and small US banks driven by differences in technology, financial services, and customer demographics. Greenwald et al. [2023] shows how deposit betas are inherently dynamic and become larger under higher interest rates, giving rise to deposit convexity. Our contribution also relates to Gerlach et al. [2018] which studies the macroeconomic dynamics of bank funding costs under rising rates. Thus far, the literature has largely focused on the pass-through of monetary policy to domestic deposit rates. We build on this literature by exploring the role of foreign deposits in shaping the deposits channel.

Roadmap. The rest of the paper is structured as follows. Section 2 discusses data used in the analysis, presents trends and statistics on foreign deposit dynamics, and details the institutional and regulatory features of foreign deposits. Sections 3 and 4 reports estimates of foreign and domestic deposit betas using aggregate data and bank-level data, respectively. Section 5 presents bank-level and aggregate analyses on the macroeconomic and financial stability implications of foreign deposits. Section 6 concludes.

2 Foreign Deposit Funding of US Commercial Banks

In this section, we first describe the aggregate and bank-level data used throughout this analysis. We then discuss some empirical characteristics and institutional details of foreign deposits, including aggregate trends and potential drivers, regulatory and legal treatment of foreign deposits, and their distribution across banks and geographies.

2.1 Data

We combine data from a variety of public sources. Aggregate bank data is taken from the FDIC Quarterly Banking Profile and is also derived from the bank-level regulatory Call Reports. In addition to aggregate bank sector data, we collect data on the Fed Funds Rate (FFR), GDP and inflation from FRED. Data on foreign policy rates (FPR) are sourced from the Dallas Fed Database of Global Economic Indicators, FRED, or the OECD, depending on the measure. The FFR and FPR are aggregated to quarterly frequencies by averaging monthly observations within each quarter. All other aggregate data is sampled quarterly, and we consider the 1984Q1-2023Q3 sample period. Aggregate foreign and domestic deposit rates are computed using data on quarterly interest expense on foreign and domestic deposits, respectively and total foreign and interest-bearing domestic deposits, respectively. Specifically, deposit rates are computed as:

$$\text{Deposit Rate (\%)} = \frac{\text{Interest Expense} \times 4}{\text{Deposit Balances}} \times 100. \tag{1}$$

This is done for both domestic office and foreign office deposits and follows a procedure similar to Kang-Landsberg et al. [2023]. To calculate domestic deposit rates, we divide interest paid on domestic deposits by total interest-bearing domestic deposits. To calculate foreign deposit rates, we divide interest paid on foreign deposits by total foreign deposits.[5] Figure 5 plots these deposit rates along with the FFR. The share of foreign deposits is

[5] Almost all foreign deposits are interest-bearing. From 1984-2020, interest-bearing foreign deposits made up least 90% of total foreign deposits at any given time.

computed by dividing foreign deposits by total (foreign and domestic) deposits. Table 1 reports summary statistics for bank sector and macroeconomic aggregates.

Table 1: Aggregate Data Summary

Variable	N	Mean	St. Dev.	Min	Pctl(25)	Median	Pctl(75)	Max
Federal Funds Rate	159	3.561	2.953	0.060	0.478	3.213	5.563	11.390
Foreign Deposit Rate	159	3.895	3.395	0.029	0.590	3.202	6.103	11.779
Domestic Deposit Rate	159	3.207	2.629	0.166	0.813	3.023	4.352	11.565
Foreign Deposit Share	159	11.641	2.665	7.520	9.213	11.750	13.154	18.005
Real GDP Growth	159	2.684	2.050	−7.827	1.812	2.782	3.910	11.288
CPI Inflation	159	2.794	1.535	−1.620	1.793	2.643	3.593	8.210
Bank-weighted Foreign Policy Rate	159	3.490	2.898	-0.160	0.625	3.490	5.093	10.048

Note: Sample period is 1984Q1-2023Q3. Variables are reported in percentage points. Real GDP growth and CPI inflation are year-over-year. Foreign deposit share is a percent of total deposits.

Data on US commercial bank-level variables comes from the FFIEC quarterly Call Reports. The quarterly Call Reports data is prepared following Drechsler et al. [2017] and the 1984Q1-2020Q1 period is considered for the bank-level analysis. The main sub-sample is restricted to bank-quarter observations with both positive domestic deposit and foreign deposit balances. Although for robustness, we also consider a sub-sample that tracks the cohort of banks which held foreign deposits in 2020 over the same 1984Q1-2020Q1 period. Bank-level summary statistics are reported in Table 2. One outlier bank-quarter observation is removed from the sample due to very high (total) deposit rates.[6] Deposit rates calculated at the bank level refer to the bank-level total deposit rates based on the sum of a banks interest-bearing domestic deposits and a banks foreign deposits. Foreign deposit shares at the bank level are calculated by dividing a banks foreign deposits by its total deposits. Finally, asset market concentration is calculated as the percent of assets held by a bank divided by aggregate system-wide assets.

We also collect data on foreign office liabilities of US banks by source country from form FFIEC 009a (Federal Reserve form E.16). Under some reasonable assumptions, we infer the geography of aggregate foreign deposits using this dataset. We also use this data to infer the proportion of dollar-denominated and foreign-denominated foreign deposits of US banks.

[6]First Interstate Bancorp reported a 111% deposit rate in 1991Q4.

Table 2: Bank Level Data Summary

Variable	N	Mean	St. Dev.	Min	Pctl(25)	Median	Pctl(75)	Max
Domestic Deposits	17,396	24.479	103.727	0.00001	0.761	3.675	11.113	1,577.444
Interest-bearing Domostic Deposits	17,396	17.324	70.528	0.00001	0.561	2.624	8.127	1,063.057
Foreign Deposits	17,396	6.909	38.372	0.00000	0.036	0.211	1.134	589.762
Assets	17,396	45.053	181.967	0.016	1.317	5.721	20.054	2,690.959
Deposit Rate	17,396	4.562	2.757	0.003	2.511	4.382	6.627	30.282
Foreign Deposit Share	17,396	16.279	21.387	0.00002	1.980	6.885	21.599	99.998
Asset Market Concentration	17,396	0.437	1.302	0.0004	0.021	0.102	0.299	13.626

Note: Sample period is 1984Q1-2020Q1 and consists of bank-quarters reporting positive foreign deposits. Deposit rate is the bank's total deposit rate calculated using the sum of interest paid on foreign deposits and domestic interest-bearing deposits over the sum of foreign deposits and domestic interest-bearing deposits, reported in annualized percentage points. Foreign deposit share is reported as the percent of foreign deposits to total deposits. Asset market concentration is reported as the percent of a bank's total assets to aggregate market-wide assets. Domestic deposits, domestic interest-bearing deposits, foreign deposits, and assets are reported in USD billions.

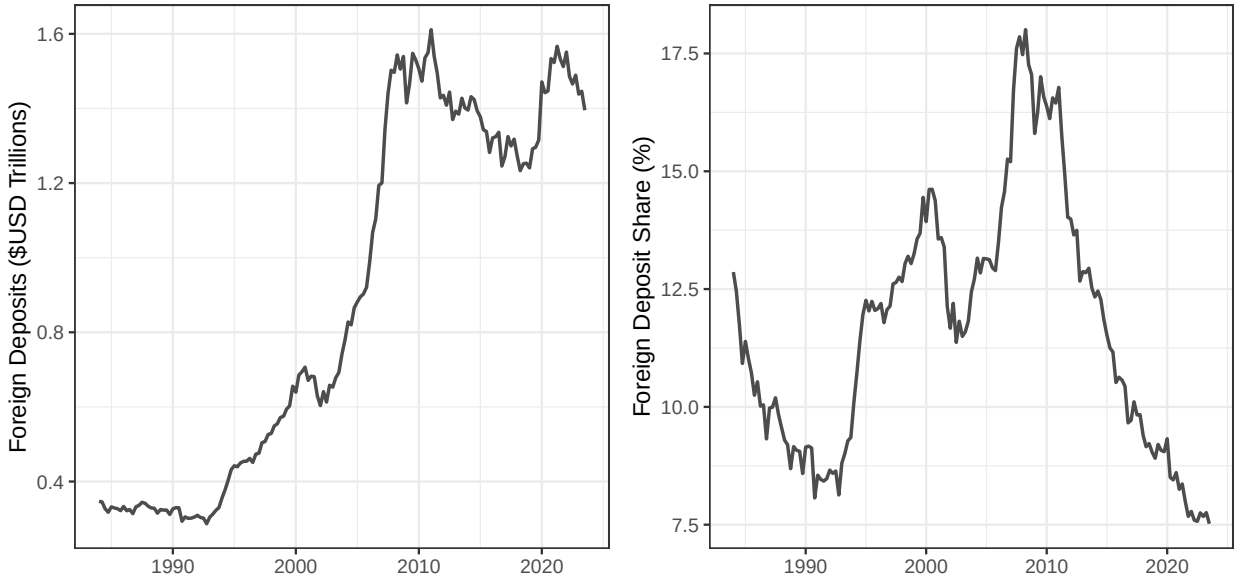
While the aggregated 009a data is public, the bank-level foreign office liabilities via form 009 is non-public supervisory data. We use the bank-level 009 data to infer which banks have high shares of dollar-denominated foreign deposits. We also use to the BIS Locational Banking Statistics (LBS) as an additional source of international exposures of US banks. We rely on the BIS Consolidated Banking Statistics (CBS) data to construct our bank-weighted foreign policy rate.

Lastly, we collect publicly available daily stock prices of foreign deposit-issuing US banks that are listed on US exchanges. This data are used to analyze the real-time response of banks to the 2021-2022 Fed interest rate hikes.

2.2 Aggregate Dynamics and the Distribution of Foreign Deposits

Foreign deposits make up a non-trivial portion of bank sector deposits (and therefore liabilities). In dollar value, foreign deposits rose from roughly $300 billion in the early 1990s and peaked at $1.6 trillion in 2011 (Figure 2). Since 2011, foreign deposits fluctuated between $1.2-1.6 trillion. Both foreign deposit shares and their contribution to total deposit expense varied considerably over time. On average, interest paid on foreign deposits made up 10%

Figure 2: Aggregate Foreign Deposit Level and Foreign Deposit Share of Total Deposits



Note: Quarterly foreign deposit shares calculated as foreign deposits divided by total deposits. Share of interest paid on foreign deposits calculated as interest paid on foreign deposits divided by interest paid on total deposits. Sample period is 1984-2023.

of total bank sector interest expense from 1984-2023.[7] Figure 2 right panel plots the evolution of foreign deposits as a percent of total deposits since 1984. Foreign deposits made up nearly 18% of total deposits in 2008 before the Global Financial Crisis, and has since steadily declined to about 7.5%.

Foreign deposit dynamics differ from domestic deposits in that they are much more volatile than domestic deposits and largely uncorrelated with domestic deposit growth as shown in Figure 1. Because foreign depositors are typically large, sophisticated corporate entities, it is not surprising that foreign deposit volatility is high. Similarly, the volatility of domestic corporate deposits and uninsured domestic deposits are relatively high. However, at the same time, foreign deposit growth is uncorrelated with domestic corporate deposit and uninsured domestic deposit growth (Figure A.1 in the Appendix).[8]

[7]Foreign deposit interest expense contributed roughly 12% to total bank sector interest expense before 2008, reaching upward of 16% at times. See Figure A.2.

[8]Corporate deposits are calculated from the Federal Reserve Flow of Funds data as the sum of nonfinancial corporate business checking and time and savings deposits.

2.3 Potential Sources of Aggregate Foreign Deposit Variation

The pre-2008 rise in foreign deposit share and the secular post-2008 decline are visually striking (Figure 2). What factors drove these trends? Domestic deposits continued to steadily rise since 2008 while foreign deposits peaked in 2011 and have fluctuated between $1.2-1.6 trillion since. Domestic deposits grew even faster since 2019 increasing by roughly $6 trillion in three years. Mechanically, this drove the foreign deposit share lower in the post-pandemic period. Much of this domestic deposit growth resulted from the combination of domestic fiscal and unconventional monetary policy during the pandemic.

A factor contributing to the earlier rise of foreign deposit shares may have been banks seeking to circumvent US regulatory costs and specifically the different reserve requirements on foreign deposits.[9] Goldberg and Saunders [1980] and Claessens and Van Horen [2021] point to capital controls in the US as one determinant of US bank internationalization, along with growing US international trade. Moving forward but prior to 2008, reserve requirements were binding for US banks, but deposits issued in other jurisdictions were subject to local reserve requirements. Therefore, this incentivized US banks to issue foreign deposits in jurisdictions with lower reserve requirements. In addition, holding reserves on the balance sheet was particularly costly because the Fed did not pay interest on reserves before 2008. As shown later in Figure 4, it is likely that a large majority of these deposits are held in the UK, and some in other countries such as Hong Kong and the Cayman Islands, jurisdictions without explicit reserve requirements. The 2008 inflection point in the foreign deposit share aligns with the period after which reserve requirements were no longer binding in the US, the Fed began paying interest on reserve balances, and system-wide reserve levels were no longer scarce due to unconventional monetary policies.[10] Trade integration seems to be a part of the story too. The pre-2008 rise and 2011 peak observed in foreign deposits align with the rapid growth and twin peaks of US global trade measured as a percent of GDP

[9] Regulatory arbitrage is considered one important motivation behind the formation of the eurodollar market [He and McCauley, 2012].

[10] See Figure A.3 in the Appendix.

observed in 2008 and 2011.

In addition, the 2011 peak in foreign deposits of $1.6 trillion somewhat aligns with the resolution over the debate on the uninsured treatment of foreign deposits of US banks, which was finalized in 2013. The rule clarified that foreign depositors are excluded from 'depositor preference' and therefore subordinate to domestic insured and uninsured depositors. If foreign countries perceived this hierarchy as unfair, they may choose to seize the assets of foreign branches of failed US banks [Marino and Bennett, 1999]. These risks may have also contributed to the deceleration of foreign deposit growth.[11]

Another possible set of factors behind early foreign deposit growth were high foreign interest rates – a common feature of eurodollar deposits [He and McCauley, 2012]. Figure 6 shows that from the late 1980s to 1995, foreign monetary policy rates were higher than the FFR. At the same time, foreign deposit rates were substantially higher than domestic deposit rates (and the FFR). Therefore these high foreign dollar deposit rates were possibly driven by the need for US banks to compete not only with domestic deposit rates tied to the FFR but also foreign local-currency deposit rates tied to foreign monetary policy, as we will subsequently show. These high foreign deposit rates in turn coincided with the growth surge in foreign deposit share from 1990-2000 (Figure 2).

2.4 Regulatory Treatment of Foreign Deposits

The differential regulatory and legal treatment of foreign deposits is consistent with their relatively high volatility and risk. Foreign deposits are often cited as being a more volatile deposit type. For example, see the discussion on foreign deposits within the *FDIC Risk Management Manual of Examination Policies* (sections 6.1 and 11.1). Foreign deposits are also explicitly treated as less stable from a regulatory standpoint. In addition, FFIEC includes foreign deposits in its category of *volatile liabilities*, which include foreign deposits, Federal Funds, uninsured domestic time deposits, and trading liabilities.

[11] In Europe, foreign branches of the home country bank are covered by the home country insurance, contrary to the US.

Under the Liquidity Coverage Ratio (LCR) rule requiring banks to hold high quality liquid assets (HQLA) sufficient to withstand a 30-day stress period, foreign deposits are treated as uninsured deposits and assigned an assumed runoff rate of 10% to 25% compared to a runoff assumption of 3% assigned to standard domestic retail deposits.[12] In a similar vein, the Available Stable Funding (ASF) weights assigned to foreign deposits in calculating Net Stable Funding Ratio (NSFR) tend to be smaller, implying that they are less stable forms of deposit funding. Depending on the type of foreign deposit, ASF weights on foreign deposits range between 90% and 50% compared to 95% to 90% ASF weights assigned to most domestic deposit types.[13]

Some large banks with assets exceeding $100 billion self-report expected deposit betas across different deposit segments in confidential FR Y-14 regulatory filings. Gerlach et al. [2018] presents summary statistics on these self-reported deposit betas. Again consistent with the volatility and risk of foreign deposits, Banks report foreign deposit betas that are larger than domestic deposit betas. For example, self-reported median deposit betas on foreign deposits ranged from 50% to 70%, while the median across domestic deposit types ranged from 23% to 52%.

Finally, foreign deposits are uninsured. The only exception lies in foreign deposits that are transferrable and able to be withdrawn at a domestic branch of the bank, but such cases are rare.[14] In 2013, the FDIC issued the Final Rule establishing that foreign branch deposits do not fall under 'depositor preference'. Therefore, foreign depositors are not treated equally to domestic uninsured deposits amidst a bank failure.[15] Domestic uninsured depositors are subject to 'depositor preference' and are therefore treated senior to general creditors.

[12] See '*Liquidity Coverage Ratio: Liquidity Risk Measurement Standards," 79 Fed. Reg. 61440 (October 10, 2014)*' section 3.

[13] See Miller et al. [2022].

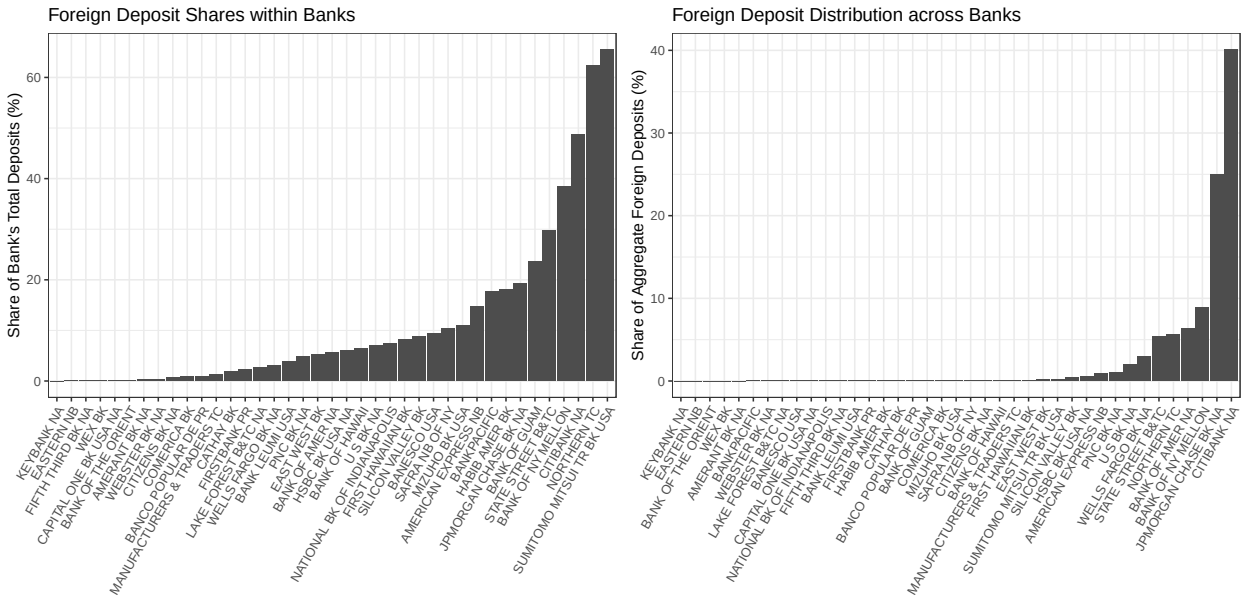
[14] These are referred to 'dual' deposits.

[15] Legal debates over the treatment and insurance of US bank foreign office deposits grew out of a need to address inherent political risks. The history of state actors appropriating foreign deposits include cases from the Russian Revolution, the Vietnam War, and the Cuban Revolution [Comizio and Chiachiere, 2014]. In 2013, the FDIC approved a final rule clarifying that foreign deposits are not subject to 'depositor preference' and are not insured by the FDIC.

Foreign depositors are not subject to 'depositor preference' and are subordinate to domestic uninsured depositors. Thus, if a US bank were to fail, its foreign depositors would share in the distribution of the bank's liquidated assets as general creditors after the claims of insured and uninsured domestic depositors have been satisfied.[16] The 2023 failure of Silicon Valley Bank exemplified this, as uninsured domestic deposits were *de facto* insured via a government guarantee, but foreign deposits were not.[17] Such uninsured treatment of foreign deposits can contribute to their volatility.

2.5 The Distribution of Foreign Deposits within the US Banking System

Figure 3: Foreign Deposits: Shares within Banks and Distribution across Banks, Q1 2020



Note: left-panel reports foreign deposit shares calculated as foreign deposits divided by total deposits at the bank level. Right-panel reports the percent of aggregate foreign deposits held by each bank in 2020.

It's quite clear that foreign deposits account for a non-trival share of total deposits in the US banking system. However, foreign deposits are unevenly distributed and tend to be highly

[16] See '*Final Rule on Definition of Insured Deposit*', FDIC, September 5, 2013.

[17] See June 19, 2023 Reuters article, "SVB's Asian customers who lost deposits remain on the hook for loans".

concentrated among just a few banks. In fact, since 1984, the proportion of banks holding foreign deposits ranged between 0.5% to 1.5% of all banks. As of 2020, a total of 39 banks held foreign and domestic deposits, out of 5,098 RSSD IDs, or about 0.76% of banks. Figure 3 reports banks holding foreign deposits as of 2020. Two critical dimensions of concentration emerge. First, the left-panel reports within-bank foreign deposit shares (a bank's foreign deposits as a % of its total deposits). Even conditional on holding foreign deposits, some banks are more reliant on foreign deposit funding than others, such as Citibank, Northern Trust, and Sumitomo Mitsubishi, all of which had foreign deposit shares exceeding 40% as of 2020. Closer inspection reveals that several of the banks holding foreign deposits are connected to foreign or international financial institutions, which may explain their relatively high foreign deposit shares.[18]

Similar to the observation of concentrated domestic deposit markets, the right-panel of Figure 3 reveals that the foreign deposit market is also highly concentrated among a few, mega-sized banks and these banks also tend to issue the majority of aggregate *domestic* deposits (e.g., BNY Mellon, JP Morgan Chase, Citibank). As of 2020, half of all domestic deposits outstanding were issued by the small fraction of banks that also issue foreign deposits.

2.6 Asset Portfolios of Banks with Foreign Deposits

Call Reports data does not break down deposits by counterparty type. However, we can test whether the asset portfolios of banks issuing foreign deposits are different. This analysis allows us to present some empirical evidence consistent with (i) the relatively high volatility and interest rate sensitivity of foreign deposits and (ii) the tendency for foreign depositors to be corporate entities rather than retail customers.

If banks recognize that foreign deposits have a meaningfully different risk profile from other deposit types, then banks with a large portion of their liabilities in foreign deposits may

[18] See, for example, Bank of the Orient, Banco Popular, Bank Leumi, HSBC, Banesco, Safra Bank, Mizuho, Habib America, Bank of Guam, Sumitomo Mitsubishi.

exhibit different asset portfolio compositions from those with little or no foreign deposits on the balance sheet. Foreign deposit balances are volatile and foreign deposit rates are subject to larger deposit betas. It then follows that issuing foreign deposits raises liquidity risk and shortens the duration of bank liabilities.[19] We therefore take our sub-sample of foreign deposit issuing banks and examine if their asset composition changes with their foreign deposit share by estimating the following fixed effects panel regression:

$$FDS_{it} = \alpha_i + d_t + \sum_{a \in A} \beta_a Assets^a_{it} + \epsilon_{it}, \tag{2}$$

where FDS_{it} is the foreign deposit share of bank i in quarter t measured as its foreign deposits divided by its total deposits, α_i and d_t are bank and time period fixed effects, and $Assets^a_{it}$ are specific asset positions of the bank each measured as a percent of the banks total assets. The asset categories (a) we consider are: reserves and balances due from other banks (i.e., 'cash'), securities, net fed funds and repo assets, foreign office loans, real estate (RE) loans, commercial and industrial (CI) loans, and personal loans.

Table 3: Bank Asset Portfolios and Foreign Deposit Shares

Asset	Coefficient (β_a)	Std. Error
Reserves and Balances Due	0.321***	(0.085)
Securities	0.001	(0.071)
Net Fed Funds and Repo	0.018	(0.071)
Foreign Loans	0.185*	(0.109)
RE Loans	-0.106	(0.067)
CI Loans	0.102	(0.075)
Personal Loans	-0.176**	(0.071)

Note: Standard errors are clustered at the bank level. Estimation period is 1984Q1-2020Q1. '*', '**', '***' correspond to 10%, 5%, 1% significance, respectively. Sample of all bank-quarter observations with positive domestic deposits with and without foreign deposits. Foreign deposit share is measured as the bank's foreign deposits as a percent of the bank's total deposits. All asset categories are measured as a percent of the bank's total assets. Estimates correspond to Equation 2 and includes both bank and time period fixed effects. Total sample size is 15,386 observations.

Table 3 reports the results. Banks with larger foreign deposit shares hold significantly

[19] We study the duration and balance sheet consequences of foreign deposits in a concurrent paper.

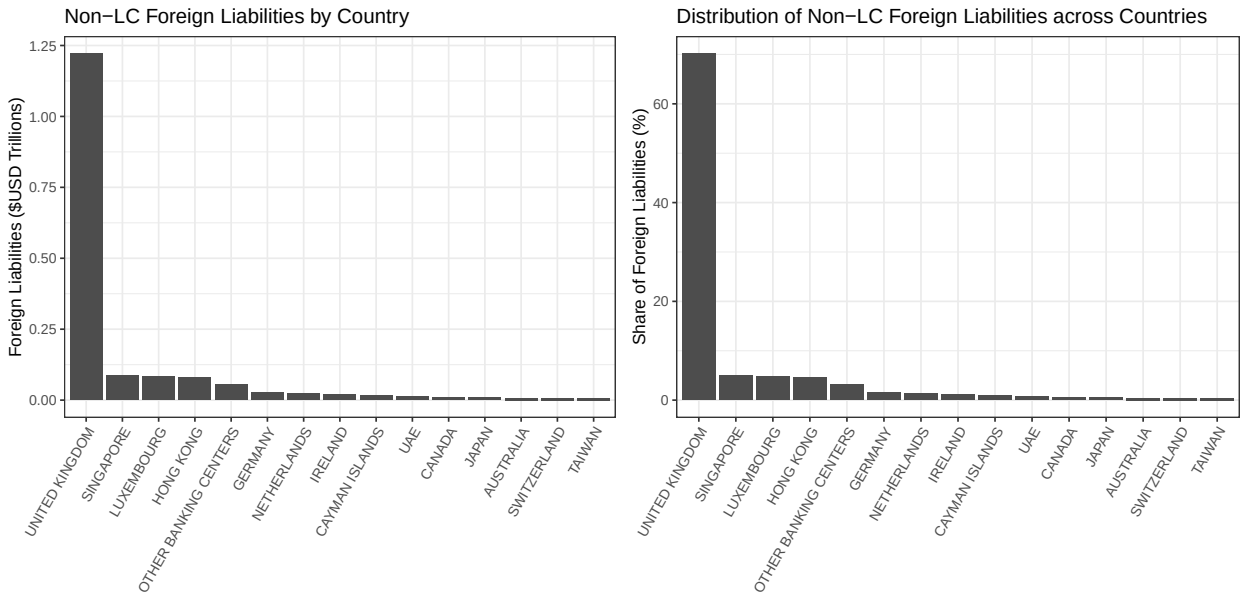
more cash assets. On average, a 10 percentage point increase in the foreign deposit share is associated with a 3.21 percentage point increase in cash assets held as a percent of total assets. This supports the view that banks recognize foreign deposit liabilities as a relatively volatile funding source. Perhaps unsurprisingly, banks with larger foreign deposit shares also hold larger positions of foreign loans. Banks with larger foreign deposit shares hold significantly fewer personal loans but more CI loans, although the coefficient on the latter is estimated imprecisely. Holding fewer personal loans suggests that foreign depositors are composed of mostly corporate entities. Along with holding more cash assets that are priced to overnight rates, banks with larger foreign deposit shares effectively swap out fixed rate loan positions (RE loans and personal loans) for variable rate loans (foreign and CI loans). This suggests that banks with larger foreign deposit shares hold a substantially shorter duration asset portfolio.

2.7 The Geography of Foreign Deposits

Public data is not available breaking down foreign deposits by source country, which is reported in non-public form FFIEC 009. However, form FFIEC 009a and Federal Reserve E.16 does publish less granular local and non-local currency (LC) foreign office liabilities by source country. To get a rough idea for where these foreign deposits might be located geographically, we assume that non-local currency foreign office liabilities are in some reasonable capacity referring to USD-denominated foreign office deposits.[20] Figure 4 reports such non-LC foreign liabilities for several countries in 2023Q3. Total non-LC foreign liabilities of US commercial banks were about $1.74 trillion in 2023Q3 (compared to $1.4 trillion of foreign deposits). Non-LC foreign liabilities are highly concentrated across source countries with over 70% issued in the UK. Global financial centers outside the US show a distinct affinity to house non-LC foreign liabilities, with more than 87% of non-LC foreign liabilities held in the UK, Singapore, Luxembourg, Hong Kong, and 'Other Banking Centers'. This high

[20] In aggregate, the majority of foreign deposits are denominated in non-local currency, but there is substantial variation in the curernncy denomination of foreign deposits at the bank level.

Figure 4: Non-Local Currency Foreign Liabilities of US Banks by Source Country, Q3 2023



Note: left-panel reports non-LC foreign office liabilities of US commercial banks (in USD trillions). Right-panel reports each country's share of total non-LC foreign liabilities which were approximately $1.74 trillion in 2023Q3. Data is from form FFIEC 009a.

concentration toward financial centers offers support toward the view that foreign deposits are highly mobile and held by relatively sophisticated depositors. In turn, foreign depositors may be more 'flighty' and sensitive to deposit rates. Moreover, the high concentration of foreign office liabilities in the UK and Hong Kong is consistent with their attractiveness as foreign deposit centers, given that there is no reserve requirement.

As a secondary source of geographical data, one might refer to the BIS Locational Banking Statistics. Again, the data is limited since it does not identify deposits exclusively. However, it does provide a geographical distribution of the cross-border liabilities of the US. As of Q3 2023, US cross-border liabilities were most concentrated in the UK, Cayman Islands, Japan, Canada, France, and Germany (in descending order), which is qualitatively consistent with the FFIEC 009a data. We later use the non-public FFIEC 009 data to analyze foreign deposits across currency denominations.

3 Aggregate Foreign and Domestic Deposit Betas

Foreign deposits are more volatile than domestic deposits, are uninsured, and composed of sophisticated corporate depositors. Therefore *a priori* one would expect more competitive pricing of foreign deposits that domestic deposits on average. In this section, we present aggregate level evidence of differential deposit betas on foreign and domestic deposit rates that is consistent with these observations. We also explore potential factors behind the differences in foreign and domestic deposit betas.

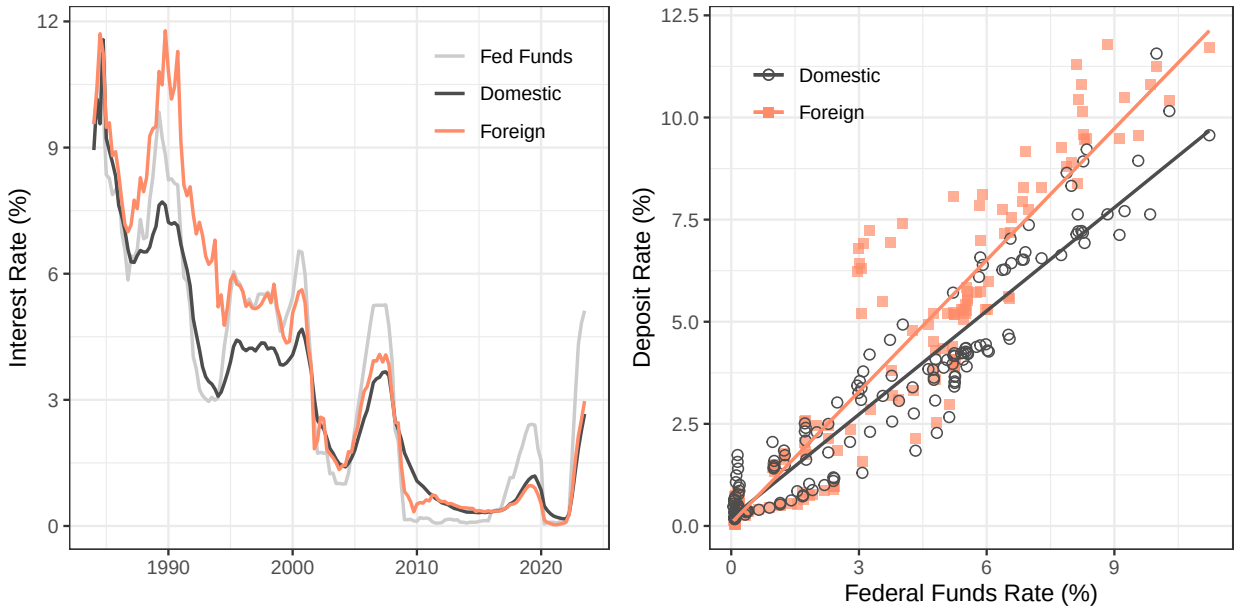
3.1 Foreign and Domestic Deposit Betas to US Monetary Policy

The left-panel of Figure 5 reports the time-series of aggregate domestic and foreign deposit rates along with the FFR. Aggregate deposit rates are calculated as described in Section 2. Foreign deposit rates were, on average, substantially higher than domestic deposit rates prior to 2000, possibly driven by a similar spread observed between non-US advanced economy and US policy rates over the same period (Figure 6). Visually inspecting Figure 5 also shows that foreign deposit rates tend to co-move tightly with domestic deposit rates especially after 2000 and both appear to adjust to monetary policy slowly. It is noticeable that when the FFR peaks, the foreign deposit rate tends to peak slightly higher than the domestic deposit rate, and when the FFR reaches cycle lows, the foreign deposit rate tends to end lower than the domestic deposit rate. These patterns are suggestive of larger deposit betas on foreign deposit rates through the sample period, including the post-2000 period.

The right-panel charts the scatterplot of FFR levels against domestic and foreign deposit rate levels, respectively. Although limited inference can be reliably drawn from this scatterplot, the steeper slope of foreign deposit rates provides cursory evidence of higher deposit betas for foreign deposits. Note that Figure A.4 of the Appendix shows that these patterns hold when comparing aggregate foreign and domestic deposit rates from the sub-sample of US banks that hold both domestic and foreign deposits (i.e., excluding domestic-only banks

from the calculations).

Figure 5: Aggregate Foreign and Domestic Deposit Rates of US Commercial Banks



Note: Quarterly foreign (domestic) deposit rates calculated as annualized interest paid on foreign (domestic interest-bearing) deposits divided by total foreign (domestic interest-bearing) deposits. Sample period is 1984-2023.

Visual inspection suggests that aggregate foreign deposit betas may be larger than domestic deposit betas. Formally, deposit betas for domestic and foreign deposit rates can be estimated using a dynamic regression specification that builds on Messer and Niepmann [2023]:

$$\Delta DR_{kt} = \alpha_k + \sum_{l=0}^{L} \beta_{kl} \Delta FFR_{t-l} + \Phi_k [FFR_{t-1} - \overline{DR}_{t-1}] + \mathbf{\Gamma}_k \mathbf{X}_t + \epsilon_{kt}, \tag{3}$$

where ΔDR_{kt} is the quarterly change in the deposit rate of segment $k \in \{\text{domestic}, \text{foreign}\}$ and ΔFFR_{t-l} is the quarterly change in the FFR lagged l quarters. The specification is estimated with $L = 3$ lags allowing the deposit rate a total of four quarters to adjust to FFR changes. Deposit betas are defined as the pass-through coefficient of the FFR to deposit rates. Short-run deposit betas are given by β_{k0} while long-run, or 4-quarter deposit betas are given by the sum of coefficients $\sum_{l=0}^{3} \beta_{kl}$. The error-correction term $[FFR_{t-1} - \overline{DR}_{t-1}]$

measures the deposit rate gap, defined as the difference between the FFR and the total deposit rate $\overline{DR}_t$. The total deposit rate, $\overline{DR}_t$, is calculated as the sum of interest paid on domestic and foreign deposits divided by the sum of foreign and interest-bearing domestic deposits. Intuitively, the coefficient on the deposit rate gap captures the non-linearity of deposit rates increasingly moving to close the deposit rate gap as the distance between the FFR and deposit rate widens. In other words, the error-correction term characterizes convexity in deposit betas [Greenwald et al., 2023] or cointegration between FFR and deposit rates.[21] The vector $\mathbf{X}_t$ controls for year–over-year growth in real GDP and year-over-year CPI inflation to account for macroeconomic conditions impacting deposit demand.

Table 4: Federal Funds Rate Pass-through to Foreign and Domestic Deposit Rates

	Foreign	Domestic	F-D Difference
ΔFFR_t	0.539***	0.232***	0.307**
	(0.124)	(0.037)	(0.119)
$\sum_{l=0}^{3} \Delta FFR_{t-l}$	0.63***	0.418***	0.212*
	(0.121)	(0.046)	(0.116)
$[FFR_{t-1} - \overline{DR}_{t-1}]$	0.082*	0.119***	-0.037
	(0.044)	(0.036)	(0.041)
Adjusted R^2	0.413	0.773	0.069
Observations	155	155	155

Note: Standard errors are adjusted for autocorrelation and heteroscedasticity. Estimation period is 1984Q1-2023Q3. '*','**','***' correspond to 10%, 5%, 1% significance, respectively. Estimates correspond to Equation 3.

Table 4 reports estimates for aggregate US domestic and foreign deposit betas. Both short-run and long-run deposit betas are significantly larger for foreign deposit betas. Domestic deposits exhibit weaker contemporaneous adjustment to changes in the FFR within the same quarter (23 bps per 100 bps change in the FFR, or a contemporaneous beta of 23%) and over a course of 4 quarters (41.8 bps per each 100 bps change in the FFR).[22] Meanwhile,

[21] In practice, both proprietary and vendor-based deposit rate models typically allow for error-correction in deposit rates. The goal of this term is to allow deposit rates to increase at a faster rate and decrease at a slower rate when the prevailing deposit rate gap is wide and positive.

[22] A 1 basis point (bps) change in an interest rate refers to a 0.01 percentage point change in the interest

foreign deposits exhibit much stronger contemporaneous adjustment to changes in the FFR (53.9 bps change per 100 bps change in the FFR within the same quarter). Over a course of 4 quarters, 63 bps per each 100 bps change in the FFR passes through to foreign deposit rates. These estimates are similar to those in Gerlach et al. [2018] which estimates foreign and domestic deposit betas of 67% and 42% over a shorter sample period and using a different methodology. The confidential Y-14 data shows that banks self-reporting foreign deposit betas for time and non-time deposits are nearly the same [Gerlach et al., 2018], suggesting that this result is unlikely to be driven by foreign time deposits. Column 3 of Table 4 shows that these differences in deposit betas are economically and statistically significant.

The coefficients on the error-correction terms are significant and positive for both foreign and domestic deposit rates, though larger for domestic deposits. These estimates are consistent with deposit rates adjusting faster to an increase in the FFR as the deposit rate gap grows larger and more positive, a behavior we directly observed during the most recent series of US monetary policy rate hikes beginning in 2021 [Kang-Landsberg et al., 2023].

Additional results are reported in the Appendix. Table A.1 reports additional domestic deposit beta estimates after splitting domestic deposit rates into three segments using Call Reports data: deposit rates on domestic transaction, savings, and time deposits. As expected, betas tend to be smaller for transaction deposits and larger for time deposits. 1-quarter betas range from 7.6% to 28.4% while 4-quarter betas on domestic transaction, savings, and time deposits are 10.2%, 32.1%, and 50.8%, respectively. Both 1-quarter and 4-quarter foreign deposit betas of 53.9% and 63% are notably larger than the deposit betas across the domestic segments, even domestic time deposits.[23]

Table A.2 modifies the regression specification in (3) to allow for asymmetric pass-through of the FFR to deposit rates. Deposit betas are roughly twice as large when the FFR decreases than when the FFR increases at 1-quarter and 4-quarter horizons. Foreign deposit betas,

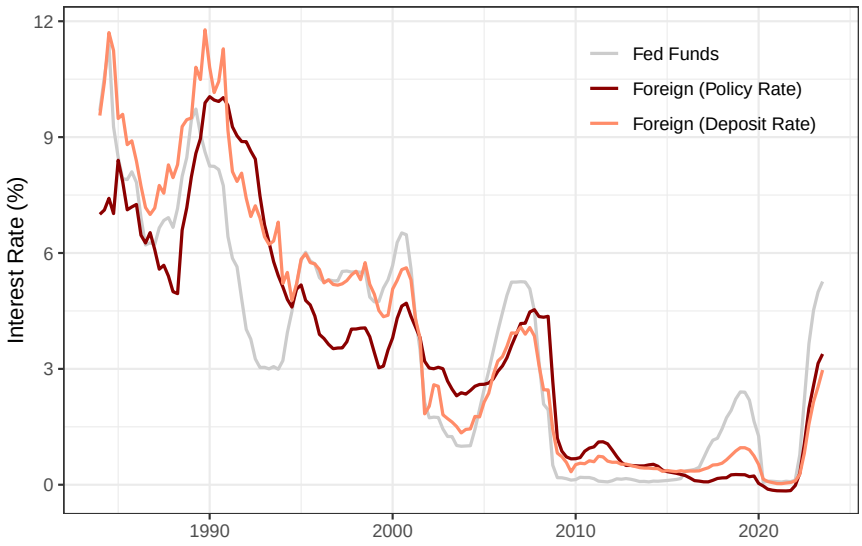
rate.

[23]Interest expense on time deposits implied from Call Reports is a weighted average of expense on newly issued time deposits and existing time deposits. As a result, the estimated time deposit betas from Call Reports data may be smaller than betas estimated on time deposit rates observed in the market.

however, remain larger than domestic deposit betas under both an increasing or decreasing FFR. The differences in deposit beta remain in a similar range regardless of the directional move in the FFR. That is, downside deposit betas are 25 percentage points larger for foreign deposit rates than domestic deposit rates while upside deposit betas are 30.6 percentage points larger for foreign deposit rates. Table A.3 reports estimates from the benchmark regression, but over the period 2000Q1-2023Q3. The estimates are very similar to the estimates over the full sample period, suggesting that the differences in deposit betas between foreign and domestic deposits do not rise exclusively from the earlier period of observably high foreign deposit rate levels.

3.2 Explaining Large Foreign Deposit Betas: The Role of Foreign Monetary Policy

Figure 6: Aggregate Foreign Deposit Rates of US Commercial Banks and US and Foreign Advanced Economy Policy Rates



Note: Quarterly foreign deposit rates calculated as annualized interest paid on foreign deposits divided by total foreign deposits. Foreign policy rate is the bank-weighted average of non-US advanced economy policy rates. Sample period is 1984-2023.

In the previous subsection we show that foreign deposit betas to the FFR are significantly

larger than domestic deposit betas. Qualitatively, this may rise from the need to price foreign deposits more competitively because they are riskier than domestic deposits. We now present evidence of the particular source of this risk, which is quite unique to foreign deposits. Specifically, unlike domestic deposits, foreign deposits may be foreign-denominated and thus their deposit rates explicitly indexed to foreign interest rates. But even dollar-denominated foreign deposits of US banks may be exposed to foreign interest rates. This is because US banks' foreign offices compete with non-US banks for foreign depositors, and, non-US banks set their deposit rates according to non-US monetary policy. Figure 6 plots foreign policy rates alongside foreign deposit rates of US banks. It is visually apparent that foreign deposit rates are correlated with both the FFR and foreign monetary policy rates. We proceed to test this hypothesis more rigorously on aggregate deposit rates by extending (3) to the following specification:

$$\Delta DR_{kt} = \alpha_k + \sum_{l=0}^{L} \beta_{kl} \Delta FFR_{t-l} + \sum_{l=0}^{L} \Psi_{kl} \Delta FPR_{t-l} + \Phi_k [FFR_{t-1} - \overline{DR}_{t-1}] + \mathbf{\Gamma}_k \mathbf{X}_t + \epsilon_{kt}, \quad (4)$$

where ΔFPR_{t-l} is the foreign monetary policy rate (FPR). Our baseline measure of the FPR uses the BIS CBS database to construct a bank-weighted average FPR using short-term interest rates of Germany (for the EU jurisdiction), Australia, Canada, Switzerland, UK, and Japan. These foreign interest rates are weighted based on US banks' total claims on counterparties within each of the respective jurisdictions on a guarantor basis.[24] In addition to the bank-weighted FPR, we also consider trade-weighted and GDP-weighted FPRs. These two FPRs are measured using the non-US advanced economy policy rates published by the Dallas Fed Global Economic Indicators Database [Grossman et al., 2013].[25]

[24]Because this CBS data begins populating in 2005, we extend backward the 2005 weights to construct the bank-weighted FPR since 1984. Moreover, we rely on US banks' total claims instead of their liabilities because the former is publicly available via the database while the latter is not.

[25]The trade and GDP-weighted FPRs are constructed as the trade-weighted and PPP-GDP-weighted average policy rates of 18 non-US advanced economies, respectively. When policy rates are not available, short-term market interest rates, lending/deposit rates, or money market rates are used. Trade weights are based on the US trade share with each country.

Specification (4) extends (3) to a 2-factor framework allowing for two distinct deposit betas: the standard FFR-beta (β_{kl}) and a FPR-beta (Ψ_{kl}). Economically large estimates of Ψ_{kl} would indicate that deposit rates of US banks respond to FPR changes. We proceed to estimate (4) for foreign deposit rates. While it is unlikely that domestic deposit rates respond to foreign monetary policy, we still estimate (4) for domestic deposit rates as a placebo test.

Table 5: Federal Funds Rate Pass-through to Foreign and Domestic Deposit Rates after Controlling for Bank-weighted Foreign Monetary Policy

	Foreign	Domestic	F-D Difference
ΔFFR_t	0.507***	0.305***	0.203
	(0.132)	(0.044)	(0.125)
$\sum_{l=0}^{3} \Delta FFR_{t-l}$	0.526***	0.520***	0.005
	(0.131)	(0.036)	(0.117)
$[FFR_{t-1} - \overline{DR}_{t-1}]$	0.060	0.113***	-0.054
	(0.044)	(0.031)	(0.033)
ΔFPR_t	0.135	-0.214	0.349***
	(0.147)	(0.082)	(0.104)
$\sum_{l=0}^{3} \Delta FPR_{t-l}$	0.326*	-0.120	0.445***
	(0.196)	(0.083)	(0.159)
Adjusted R^2	0.445	0.817	0.203
Observations	155	155	155

Note: Standard errors are adjusted for autocorrelation and heteroscedasticity. Estimation period is 1984Q1-2023Q3. '*','**','***' correspond to 10%, 5%, 1% significance, respectively. Estimates correspond to Equation 4.

Table 5 reports the results using the bank-weighted FPR. Perhaps unsurprisingly, domestic deposit rates only have a significant FFR-beta. However, foreign deposit rates are significantly associated with the FPR and the FFR. A 100 bps change in the FPR is associated with a 13.5 basis point change in foreign deposit rates in the short-run and a statistically significant 32.6 basis point change over a four-quarter period. After including the FPR in the foreign deposit rate regression, the 1-quarter FFR-beta shrinks slightly from 0.539 to 0.507 while the 4-quarter FFR-beta shrinks substantially from 0.63 to 0.526. The FFR-betas

between foreign and domestic deposit rates are no longer significantly different from each other. However, the short-run FFR-beta on the foreign deposit rate remains meaningfully larger than the short-run FFR-beta on the domestic deposit rate (50.7% vs. 30.5%). Statistically, the FPR-beta on the foreign deposit rate accounts for much of the difference in FFR-betas between foreign and domestic deposit rates shown earlier in Table 4. This stems from the high correlation between changes in foreign and US policy rates, which is equal to 0.46, and implies the presence of omitted variable bias in foreign deposit rate regressions that exclude the FPR. The FFR and FPR therefore tend to change in tandem, resulting in foreign deposit rates that are more interest rate sensitive than domestic deposit rates. Tables A.4 and A.5 reports similar and somewhat stronger results using the trade-weighted and GDP-weighted FPR, respectively.

4 Bank-level Deposit Betas

In the previous section we showed that deposit beta differences exist in the aggregate time-series of domestic and foreign deposit rates. In this section we now present evidence of similar differences, but at the bank-level.

4.1 Foreign Deposit Shares and Bank-level Deposit Betas

While the aggregate data indeed suggest that foreign deposit betas are significantly larger than domestic deposit betas, similar patterns at the bank-level would verify that the phenomenon holds in the cross-section of banks. To test these hypotheses, we start by using quarterly data from Call Reports to estimate panel regressions for total (domestic plus foreign) deposit betas at the bank level. We consider the sub-sample of bank-quarter observations with positive foreign deposits.[26] The following fixed-effects panel regressions, similar to

[26]Banks without foreign deposits are excluded from the main analysis to avoid selection bias.

Drechsler et al. [2017], are estimated using levels and changes of deposit rates, respectively:

$$DR_{it} = \alpha_i + \beta_0 FFR_t + \beta_1[FFR_t \times FDS_{i,t-1}] + \beta_2[FFR_t \times AMC_{i,t-1}] + \epsilon_{it}, \quad (5)$$

$$\Delta DR_{i,[t-4,t]} = \alpha_i + \beta_0 \Delta FFR_{[t-4,t]} + \beta_1[\Delta FFR_{[t-4,t]} \times FDS_{i,t-4}] + \beta_2[\Delta FFR_{[t-4,t]} \times AMC_{i,t-4}] + \epsilon_{i,[t-4,t]}. \quad (6)$$

Specifically, the first equation regresses the deposit rate level of bank i on the level of the FFR while the second equation regresses the 4-quarter change in the deposit rate of bank i on 4-quarter changes in the FFR. Bank-specific deposit rates are calculated by dividing the sum of interest paid on domestic and foreign deposits by the sum of interest-bearing domestic deposits and foreign deposits. The coefficient α_i captures bank-level fixed effects that absorb persistent within-bank unobservables such as size, culture, or business model factors. The FFR is interacted with the lagged foreign deposit share (FDS_{it}) of bank i and the FFR is also interacted with a measure of asset market concentration (AMC_{it}) of bank i. Foreign deposit share at the bank level is measured as the foreign deposits of bank i divided by its total deposits within each quarter. To measure asset market concentration of bank i, bank i assets are divided by aggregate system-wide assets within each quarter.

The coefficient on β_0 is expected to be positive but less than one, implying imperfect pass-through of monetary policy to bank deposit rates. The coefficient on β_1 is expected to be positive, since banks with larger foreign deposit shares would have larger (total) deposit betas if foreign deposit betas are larger than domestic deposit betas. Finally the coefficient on β_2 is expected to be negative, consistent with banks with more market share exerting their market power to enjoy smaller deposit betas [Drechsler et al., 2017].

Table 6 reports the results from the bank-level regressions. Banks on average have positive and significant (total) deposit betas but the betas are less than 1, implying incomplete pass-through of the FFR to deposit rates. Deposit betas, however, are significantly increasing

Table 6: Bank-level Regressions of Deposit Rates on the Federal Funds Rate

	Dependent variable:					
	Bank Deposit Rate (Level)			Bank Deposit Rate (4Q Change)		
	(1)	(2)	(3)	(4)	(5)	(6)
FFR_t	0.811***	0.779***	0.784***			
	(0.010)	(0.010)	(0.010)			
$FFR_t \times$ Foreign Deposit Share$_{i,t-1}$		0.164***	0.190***			
		(0.040)	(0.045)			
$FFR_t \times$ Asset Market Concentration$_{i,t-1}$			−4.305***			
			(1.089)			
$\Delta FFR_{t-4,t}$				0.574***	0.516***	0.522***
				(0.011)	(0.012)	(0.012)
$\Delta FFR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$					0.326***	0.349***
					(0.051)	(0.045)
$\Delta FFR_{t-4,t} \times$ Asset Market Concentration$_{i,t-4}$						−2.574***
						(0.682)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,396	16,867	16,867	15,672	15,672	15,672
Adjusted R^2	0.754	0.763	0.766	0.360	0.366	0.366

Note: Standard errors are clustered at the bank level. Estimation period is 1984Q1-2020Q1. '*', '**', '***' correspond to 10%, 5%, 1% significance, respectively. Sample of all bank-quarter observations with positive foreign deposits. Foreign deposit share (bank's foreign deposits as a percent of the bank's total deposits) and asset market concentration (bank's total assets as a percent of market-wide assets) lie between 0 and 1 and their standard deviations are 0.213 and 0.013, respectively. Estimates correspond to Equations 5 and 6.

in a banks share of foreign deposits, and decreasing in a banks asset concentration. For two hypothetical banks, one holding entirely foreign deposits and the other holding only domestic deposits, these estimates imply bank-level deposit betas to be 20-35 percentage points larger for the bank funded with foreign deposits. These bank-level estimates are in line with the aggregate deposit beta estimates reported in Table 4 that find aggregate foreign deposit betas to be roughly 20-30 percentage points larger than aggregate domestic deposit betas.

The effects of foreign deposit share on deposit betas are similar yet somewhat stronger than that of asset concentration. The standard deviation of bank-level foreign deposit share of total deposits is 21.3 percentage points and the standard deviation of bank-level assets as a percent of aggregate assets is 1.3 percentage points. So based on columns 1 and 6, a 1-standard deviation increase in foreign deposit share raises a bank's deposit beta by 4-7.4 percentage points while a 1-standard deviation increase in asset market concentration lowers a bank's deposit beta by 3.3-5.5 percentage points.

4.2 Bank-level Deposit Betas and Foreign Monetary Policy

Tables 4 and 5 reported in the aggregate data that the larger FFR-betas on foreign deposit rates result from foreign deposit rates exhibiting a second deposit beta, the FPR-beta. In this subsection, we similarly extend the bank level regressions reported in Table 6 by allowing for both FPR-betas and FFR-betas. Specifically, we add to the bank-level panel regressions the interaction of the bank-weighted FPR with foreign deposit shares (e.g., $FPR_t \times$ Foreign Deposit Share$_{i,t-1}$). We add the corresponding variables to both the level and change regression specifications (5) and (6).

Table 7 reports the results. Both in the level and change regressions, the interaction of the FPR with foreign deposit shares enters significant and positive. This indicates that larger foreign deposit shares increase the sensitivity of a bank's deposit rate to the FPR. Comparing Table 6 to Table 7, the coefficients on the interaction of $FFR_t \times$ Foreign Deposit Share$_{i,t-1}$

Table 7: Bank-level Regressions of Deposit Rates on the Federal Funds Rate and Bank-weighted Foreign Policy Rates

	Dependent variable:	
	Bank Deposit Rate (Level)	Bank Deposit Rate (4Q Change)
	(1)	(2)
FFR_t	0.793^{***}	
	(0.011)	
$FFR_t \times$ Foreign Deposit Share$_{i,t-1}$	-0.051	
	(0.054)	
$FFR_t \times$ Asset Market Concentration$_{i,t-1}$	-3.820^{***}	
	(1.058)	
$FPR_t \times$ Foreign Deposit Share$_{i,t-1}$	0.286^{***}	
	(0.075)	
$\Delta FFR_{t-4,t}$		0.522^{***}
		(0.012)
$\Delta FFR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$		0.245^{***}
		(0.048)
$\Delta FFR_{t-4,t} \times$ Asset Market Concentration$_{i,t-4}$		-2.653^{***}
		(0.687)
$\Delta FPR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$		0.303^{***}
		(0.066)
Bank FE	Yes	Yes
Observations	16,867	15,672
Adjusted R^2	0.770	0.371

Note: Standard errors are clustered at the bank level. Estimation period is 1984Q1-2020Q1. '*', '**', '***' correspond to 10%, 5%, 1% significance, respectively. Sample of all bank-quarter observations with positive foreign deposits. Foreign deposit share (bank's foreign deposits as a percent of the bank's total deposits) and asset market concentration (bank's total assets as a percent of market-wide assets) lie between 0 and 1 and their standard deviations are 0.213 and 0.013, respectively. Foreign policy rate is the bank-weighted average of non-US advanced economy policy rates, weighted by US banks' total claims in each non-US jurisdiction. Estimates correspond to Equations 5 and 6 augmented with the interaction of the foreign policy rate with foreign deposit share.

or $\Delta FFR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$ shrink substantially after including the interaction of $FPR_t \times$ Foreign Deposit Share$_{i,t-1}$ or $\Delta FPR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$ in the regressions. The evidence in the cross-section of banks is therefore consistent with what we report in the aggregate analysis. That is, banks with larger foreign deposit shares have larger bank-level deposit FFR-betas, and this results from their greater exposure to foreign policy rates characterized by significant FPR-betas. Table A.6 reports similar results using the trade-weighted FPR.

To get an economically meaningful sense of these bank-level estimates, again consider two hypothetically equivalent banks, but one that is 100% funded with domestic deposits and the other fully funded with foreign deposits. Based on Table 7 after conditioning on $FPR_t \times$ Foreign Deposit Share$_{i,t-1}$, a bank fully funded with foreign deposits is expected to have a FPR-beta between 28.6% and 30.3% while a bank funded with domestic deposits has a FPR-beta of 0%. The FFR-beta for a bank funded with foreign deposits, however, lies between -0.05 percentage points lower and +24.5 percentage points larger than the FFR-beta of a bank fully funded with domestic deposits. As a result, moving from Table 6 to 7 suggests that the bank-level FFR-betas that were 20-35 percentage points larger for foreign deposits are now roughly 0-25 percentage points larger after controlling for FPR-betas. This is consistent with the aggregate results.

4.2.1 Non-FBO Banks

We re-estimate the bank-level panel regressions on a subsample keeping only US banks that are not foreign-banking organizations (FBOs).[27] This may be an important robustness check as FBOs have parent banks domiciled in foreign jurisdictions, which could then explain why US bank deposit rates are exposed to foreign interest rates. Table A.7 reports the results, which show that the main estimates are not driven by FBOs, as the non-FBO subsample of US banks also exhibit deposit betas that are significantly increasing with foreign deposit

[27]Some FBO banks that are filtered out of the sample include MUFG, Deutsche Bank, HSBC, TD Bank, Santander Bank, Bank of the West.

shares.

4.2.2 Foreign Deposit Currency Denomination

The currency denomination of foreign deposits may also drive the results. As discussed previously, if these foreign deposits are foreign-denominated, then their deposit rates would be tied mechnanically to foreign interest rates. While the aggregate data suggest that the majority of foreign deposits are dollar-denominated, the share of dollar-denominated and foreign-denominated foreign deposits may vary widely from bank to bank. To infer which banks have high shares of dollar-denominated foreign deposits, we rely on non-public FFIEC 009 data wherein banks report the quantity of local currency and non-local currency foreign office liabilities.[28] As before, we assume that non-local currency foreign office liabilities are dollar-denominated foreign deposits. We then identify banks that on average, reported dollar-denominated foreign deposits of at least 70%, respectively. This gives us a distinct sub-sample of banks with mostly dollar-denominated foreign deposits.

Table A.8 reports results for dollar-denominated foreign deposits. The main results hold for this subset: FFR-betas increase with foreign deposit shares, but this effect attenuates after introducing the FPR variable in the regressions. FPR-betas increase significantly with foreign deposits shares for banks with mostly dollar-denominated foreign deposits. These estimates suggest that our baseline results are not driven by foreign currency denominated foreign deposits, which are mechanically exposed to foreign interest rates. Rather, the exposure to foreign interest rates can explain large FFR-betas on foreign deposits for both dollar and non-dollar foreign deposits.

4.3 Deposit Betas and the Uninsured Deposit Premium

While we show that foreign monetary policy plays a key role in explaining the large FFR-betas on foreign deposits, another explanation is that foreign deposits are uninsured. Like

[28] Banks began reporting this data in the mid 2000s.

foreign deposits rates, uninsured domestic deposit rates are typically priced more competitively than insured domestic deposit rates. This is because uninsured domestic depositors tend to be more price-sensitive, giving rise to uninsured deposit betas that are larger than insured deposit betas [Drechsler et al., 2023]. Therefore, it remains an open question whether larger foreign deposit betas simply reflect the riskier nature of uninsured deposits over insured deposits. Conceptually, we can decompose the foreign deposit beta premium into two components: the pure uninsured deposit premium plus the pure foreign deposit premium that remains unexplained by the uninsured premium:

$$\Delta\beta^{foreign}_{uninsured} = [\beta^{domestic}_{uninsured} - \beta^{domestic}_{insured}] + [\beta^{foreign}_{uninsured} - \beta^{domestic}_{uninsured}]. \tag{7}$$

It is possible that larger foreign deposit betas simply reflect their uninsured nature, or that $[\beta^{foreign}_{uninsured} - \beta^{domestic}_{uninsured}] = 0$. Alternatively, it may be the case that the uninsured premium does not entirely account for the gap in deposit betas between foreign and domestic deposits, or that $0 < [\beta^{foreign}_{uninsured} - \beta^{domestic}_{uninsured}] \leq \Delta\beta^{foreign}_{uninsured}$.

Because we do not observe deposit rates on uninsured and insured domestic deposits, decomposing the foreign deposit beta is a non-trival task. We aim to recover the uninsured domestic deposit beta by using available bank level data on estimated uninsured and insured domestic time deposits. Following Drechsler et al. [2017] and Drechsler et al. [2021], uninsured domestic time deposits are measured as a banks domestic time deposits exceeding $100,000 until from 1984-2009 and exceeding than $250,000 after that. This approach assumes that any difference in bank deposit betas under entirely uninsured domestic time deposits and entirely insured domestic time deposits is a consistent estimate of the uninsured deposit beta premium, and this premium is the same across banks. We augment (5) and (6) bank-level panel regressions with the share of uninsured domestic time deposits (as a

percent of total domestic time deposits) interacted with the FFR:

$$DR_{it} = \alpha_i + \beta_0 FFR_t + \beta_1[FFR_t \times FDS_{i,t-1}] + \beta_2[FFR_t \times AMC_{i,t-1}] + \beta_3[FFR_t \times Uninsured_{i,t-1}] + \epsilon_{it}, \quad (8)$$

$$\Delta DR_{i,[t-4,t]} = \alpha_i + \beta_0 \Delta FFR_{[t-4,t]} + \beta_1[\Delta FFR_{[t-4,t]} \times FDS_{i,t-4}] + \beta_2[\Delta FFR_{[t-4,t]} \times AMC_{i,t-4}] + \beta_3[\Delta FFR_{[t-4,t]} \times Uninsured_{i,t-4}] + \epsilon_{i,[t-4,t]}. \quad (9)$$

From (8) and (9), estimates of β_3 will provide a range for the uninsured beta premium, $[\beta^{domestic}_{uninsured} - \beta^{domestic}_{insured}]$, that we can compare to β_1 which yields an estimate of the total foreign deposit beta premium inclusive of the uninsured beta premium: $\Delta\beta^{foreign}_{uninsured}$. Any difference between the two can be attributed to beta premium specific to foreign deposits that is unexplained by their uninsured treatment, $[\beta^{foreign}_{uninsured} - \beta^{domestic}_{uninsured}]$.

Table 8 reports the results. The uninsured beta premium is significant and positive across specifications, ranging between 11.8 in the 'levels' specification and 14.5 percentage points in the 'changes' specification. The coefficients on the interactions of the FFR with foreign deposit share also decrease compared to Table 6. In the 'levels' specification, the coefficient on $FFR_t \times$ Foreign Deposit Share$_{i,t-1}$ decreases from 0.19 to 0.143 after controlling for uninsured domestic time deposits. In the 'changes' specification, the coefficient on $\Delta FFR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$ decreases from 0.349 to 0.293. The total foreign deposit beta premium is estimated to be in the range of 14.3 and 29.3 percentage points based on the estimates from Table 8 and estimated to be up to 35 percentage points in other specifications (Table 6). Therefore, based on this analysis and putting more weight on the estimates under the 'changes' specifications, it is more likely than not that the uninsured treatment of foreign deposits only partially explains the larger foreign deposit betas. Roughly half of the estimated foreign deposit beta premium remains unaccounted for by

Table 8: Bank-level Regressions of Deposit Rates on the Federal Funds Rate and Accounting for the Uninsured Deposit Beta Premium

	Dependent variable:	
	Bank Deposit Rate (Level)	Bank Deposit Rate (4Q Change)
	(1)	(2)
FFR_t	0.703^{***}	
	(0.019)	
$FFR_t \times$ Foreign Deposit Share$_{i,t-1}$	0.143^{***}	
	(0.046)	
$FFR_t \times$ Asset Market Concentration$_{i,t-1}$	-4.153^{***}	
	(1.110)	
$FFR_t \times$ Uninsured Domestic Deposit Share$_{i,t-1}$	0.145^{***}	
	(0.028)	
$\Delta FFR_{t-4,t}$		0.464^{***}
		(0.022)
$\Delta FFR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$		0.293^{***}
		(0.055)
$\Delta FFR_{t-4,t} \times$ Asset Market Concentration$_{i,t-4}$		-2.336^{***}
		(0.623)
$\Delta FFR_{t-4,t} \times$ Uninsured Domestic Deposit Share$_{i,t-4}$		0.118^{**}
		(0.051)
Bank FE	Yes	Yes
Observations	16,747	15,567
Adjusted R^2	0.767	0.366

Note: Standard errors are clustered at the bank level. Estimation period is 1984Q1-2020Q1. '*', '**', '***' correspond to 10%, 5%, 1% significance, respectively. Sample of all bank-quarter observations with positive foreign deposits. Foreign deposit share (bank's foreign deposits as a percent of the bank's total deposits), asset market concentration (bank's total assets as a percent of market-wide assets), and uninsured domestic deposit share (bank's uninsured domestic time deposits as a percent of the bank's total domestic time deposits) lie between 0 and 1. Estimates correspond to Equations 8 and 9.

the uninsured deposit premium, leaving non-US monetary policy exposure as an additional explanation.

4.3.1 Controlling for Balance Sheet and Customer Composition

We extend the results shown in Table 8 by controlling for additional factors that may drive important variation in bank-level deposit betas. A larger share of domestic time deposits (as a percent of domestic deposits) will surely result in larger deposit betas. Importantly, the share of corporate depositors may also affect bank deposit betas. Most foreign depositors are corporate customers, but thus far we have not considered the marginal beta from domestic corporate deposits. Call Reports data does not disclose depositor type, so measuring corporate depositor shares is not trivial. To approximate the share of domestic corporate depositors within a bank, we use the share of commercial and industrial loans as a percent of total loans issued by a bank. The assumption we rely on is that banks specializing in commercial customers are likely to have a larger portfolio of commercial loans and also commercial deposits.

Table A.9 reports the results. A few remarks are in order. First, even after controlling for the share of domestic time deposits and the commercial loan share, larger foreign deposit shares are associated with larger bank-level deposit betas of 9-27 percentage points . Moreover, the estimated uninsured deposit premium is nearly unchanged and remains significant. Banks with more domestic time deposit do tend to have large deposit betas (according to column 1). Banks with high commercial loan shares also tend to have meaningfully larger deposit betas.

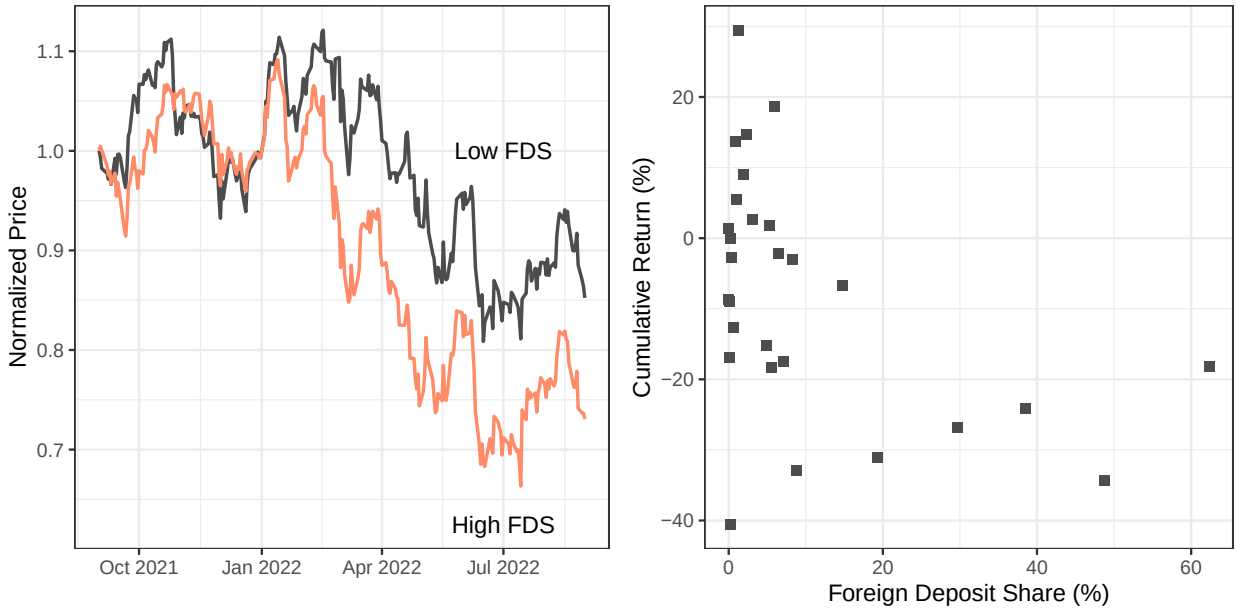
5 Bank-level and Aggregate Financial Stability

In previous sections, we showed that foreign deposit betas are larger than domestic deposit betas. In this section, we show that this bears important macro-financial implications.

Banks become more sensitive to interest rates when foreign deposit shares grow larger. As a result, foreign deposit betas give rise to important financial stability risks at the bank level and aggregate level. We start with a bank-level analysis that examines the stock prices of foreign deposit issuing US banks under rising interest rates. We then turn to an aggregate analysis that shows how the sensitivity of bank sector-wide funding costs can change under counter-factual (but plausible) foreign deposit shares.

5.1 Bank Stock Returns During the 2021-2022 Rate Hikes

Figure 7: Stock Performance of Publicly Traded US Banks from September 2021-2022 and *Ex Ante* Foreign Deposit Shares as of 2020 Q1



Note: 28 US listed equities out of the US banks that held foreign deposits as of 2020 Q1 shown in Figure 3. Left-panel plots the average 12-month performance of the 5 stocks with the lowest 2020 Q1 foreign deposit shares ('Low FDS') and the 5 stocks with the highest 2020 Q1 foreign deposit shares ('High FDS'). Right-panel plots individual stocks 2020 Q1 foreign deposit share against their September 2021-2022 stock return, with a correlation of -0.46.

In this subsection we present evidence that foreign deposits can make banks more sensitive to interest rates. Large foreign deposit betas imply that foreign deposit issuing banks have more interest rate sensitive funding costs. However, *a priori*, it is unclear if more interest rate sensitive funding leads to risker banks. For instance, banks might hedge this the additional

Table 9: Cross-sectional Regression of September 2021-2022 Bank Stock Returns on 2020 Q1 Bank-level Foreign Deposit Shares

	Dependent variable: 12-month Stock Return		
	(1)	(2)	(3)
Constant	−3.027 (3.668)	0.193 (4.054)	41.361 (25.572)
Foreign Deposit Share	−0.501*** (0.165)	−0.514*** (0.148)	−0.401*** (0.131)
Uninsured Deposit Share		−0.308 (0.211)	−0.338* (0.187)
ln(Assets)			−2.285* (1.375)
Observations	28	28	28
Adjusted R^2	0.185	0.235	0.274

Note: Robust standard errors. '*', '**', '***' correspond to 10%, 5%, 1% significance, respectively. Cross-sectional regression of 28 US listed bank stocks that held foreign deposits as of 2020 Q1 from Figure 3. September 2021 was chosen as the start date for calculating 12-month stock returns because it aligns with several measures of US monetary policy tightening, including the 2-year US Treasury yield, the shadow rate of Wu and Xia [2016], and the proxy rate of Choi et al. [2022].

interest rate exposure with derivatives or by holding large-beta assets. If not, then foreign deposits can make banks more risky, with rising interest rates inducing greater funding pressures that potentially impact bank margins and capital adequacy.

To formally test whether foreign deposits make banks more interest rate sensitive, we consider the recent 2021-2022 Federal Reserve monetary policy tightening episode as a case study. Over this period, the Federal Reserve embarked on its sharpest series of interest rate hikes since at least 1983. The FFR was raised over 500 basis points and much of the increase was unexpected by most banks, market participants and economists. We examine whether bank level *ex ante* foreign deposit shares from 2020 can explain the cross-section of stock price changes during this unexpected and sharp rate hike cycle. Our analysis is therefore conceptually similar to Aharony et al. [1986] and English et al. [2018] which examine how bank equity values respond to US monetary policy using stock prices. We compute stock price changes as 12-month log returns of bank stocks starting September 2021. Our sample of banks is restricted to the 28 US-listed banks that held foreign deposits in 2020 (i.e., a subset of the banks reported in Figure 3). We choose September 2021 as the start date because it

marks a key inflection point across several measures of US monetary policy including 2-year US Treasury yields, the shadow FFR of Wu and Xia [2016] and the proxy rate of Choi et al. [2022].[29]

Figure 7 left-panel plots the average price changes of the 5 banks with the lowest foreign deposit shares ('low FDS') and the 5 banks with the largest foreign deposit shares ('high FDS') as of 2020 Q1. Over the 12 month period of September 2021-2022, 'high FDS' banks saw their stock prices fall 10 percentage points more on average. The right-panel of Figure 7 plots 2020 foreign deposit shares of each bank in the sample against its September 2021-2022 cumulative stock return. A statistically significant negative correlation can be observed, with all banks with foreign deposit shares of roughly 20% or more losing over -18% over the 12-month period, compared to the sample average of -8%. Table 9 reports coefficient estimates from regressing September 2021-2022 bank stock returns on 2020 foreign deposit shares. The estimates suggest that bank stock prices fell 4-5 percentage points more for every 10 percentage points of foreign deposit share. This effect is robust to controlling for uninsured domestic deposit shares and bank size. These two variables also appeared to have impacted the cross-section of bank returns during the Fed tightening cycle, but to a lesser extent. These results suggests that investors recognize the additional risks inherent to banks issuing foreign deposits.

5.2 Aggregate Impact of Foreign Deposits on Bank Sector Interest Rate Risk

The interest rate risk implications of large foreign deposit betas do not diminish with aggregation. To show this, we quantify how sector-wide deposit cost sensitivity to rising interest rates varies under alternative foreign deposit share scenarios. Specifically, we show that a ± 5 percentage point change in the foreign deposit share raises/lowers the sensitivity of bank

[29]Examining the 12 months following September 2021 allows us to isolate the period of sharply rising interest rates that came prior to the regional banking crisis of March 2023.

sector funding costs to a 100 bps FFR increase by ±$2.47 billion over four quarters. Key inputs for this calculation include: aggregate deposit balances, the foreign deposit share, and foreign and domestic deposit betas. This calculation is dynamic and allows deposit balances, foreign deposit shares and deposit rates to evolve endogenously following a rise in the FFR. To produce these calculations, we first estimate a VAR that generates impulse response functions (IRFs) of the key input variables following a 100 basis point increase in the FFR. In a second stage, we apply the IRFs to a set of initial assumptions over aggregate deposit balances and foreign deposit shares. This allows us to estimate the additional interest expense borne by the bank sector under counterfactual foreign deposit share scenarios relative to a baseline calibrated to Q3 2023 aggregates.

In order to produce dynamic responses to a rising FFR, we extend the macro-finance VAR frameworks of Bernanke and Blinder [1992] and Gerlach et al. [2018] and estimate a 8-variable VAR of: logged US CPI, logged US real GDP, FFR, domestic deposit rate, FPR, foreign deposit rate, logged deposits, and the foreign deposit share:

$$\mathbf{Y}_t = \Phi + \sum_{l=1}^{L} \boldsymbol{\beta}_l \mathbf{Y}_{t-l} + \boldsymbol{\epsilon}_t, \tag{10}$$

$\mathbf{Y}_t = \{\ln(\text{CPI}), \ln(\text{RGDP}), \text{FFR}, \text{Domestic DR},$
$\text{FPR}, \text{Foreign DR}, \ln(\text{Deposits}), \text{Foreign Deposit Share}\}.$

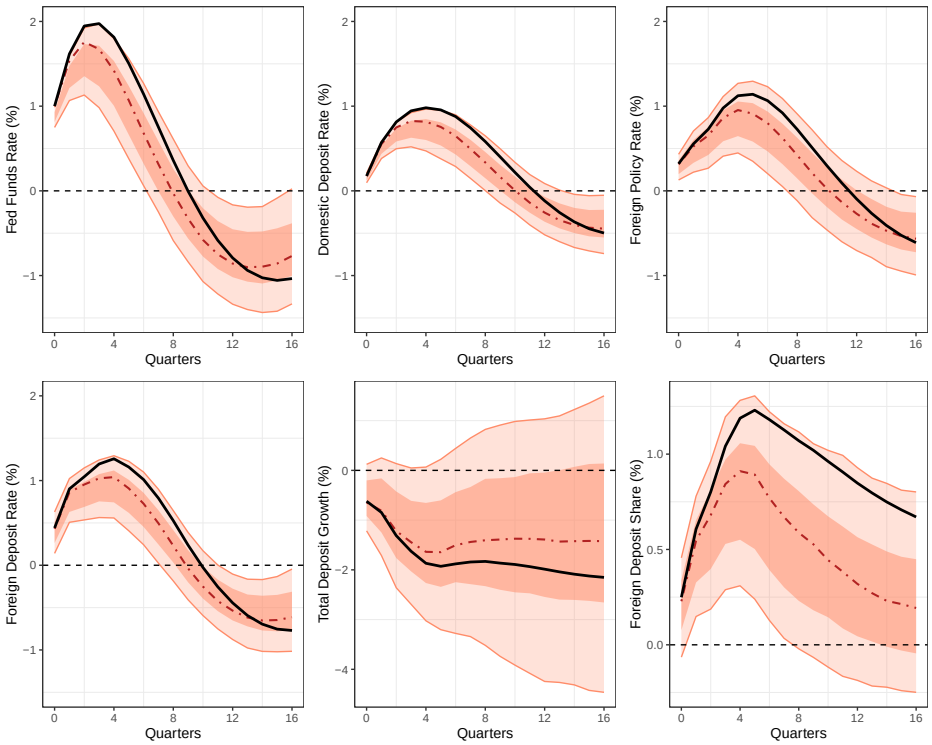
The VAR includes an intercept term and $L = 4$ lags. Following Gerlach et al. [2018], the FFR is Cholesky-ordered after CPI and real GDP so that FFR innovations do not contemporaneously affect US macro variables but can contemporaneously affect all other variables in the VAR. We use the the bank-weighted FPR for this analysis, but results do not change under the trade-weighted or GDP-weighted FPR.

We use the VAR to simulate responses of the variables to a +100 bps increase in the

FFR. The solid line in Figure 8 reports point-estimated IRFs following a +100 bps increase in the FFR. The dashed line reports the bootstrapped mean IRFs.[30] The 68% and 95% bootstrapped confidence bands are shown by the shaded regions. As the FFR rises (top-left panel), so does the domestic deposit rate (top-center) although with a lag and only about half of the FFR increase passes through to domestic deposit rates. The FPR also rises with a lag (top-right panel) but less than 1-for-1 with the FFR.[31] The bottom-left panel plots the response of the foreign deposit rate, which increases significantly following a rise in the FFR and by more than the domestic deposit rate. The foreign-domestic deposit rate differential grows to 23-33 basis points within the first 5 quarters, consistent with the regression estimates on foreign and domestic deposit betas reported in Table 4. Total deposits of the bank sector contract following an increase in the FFR (bottom-center panel).

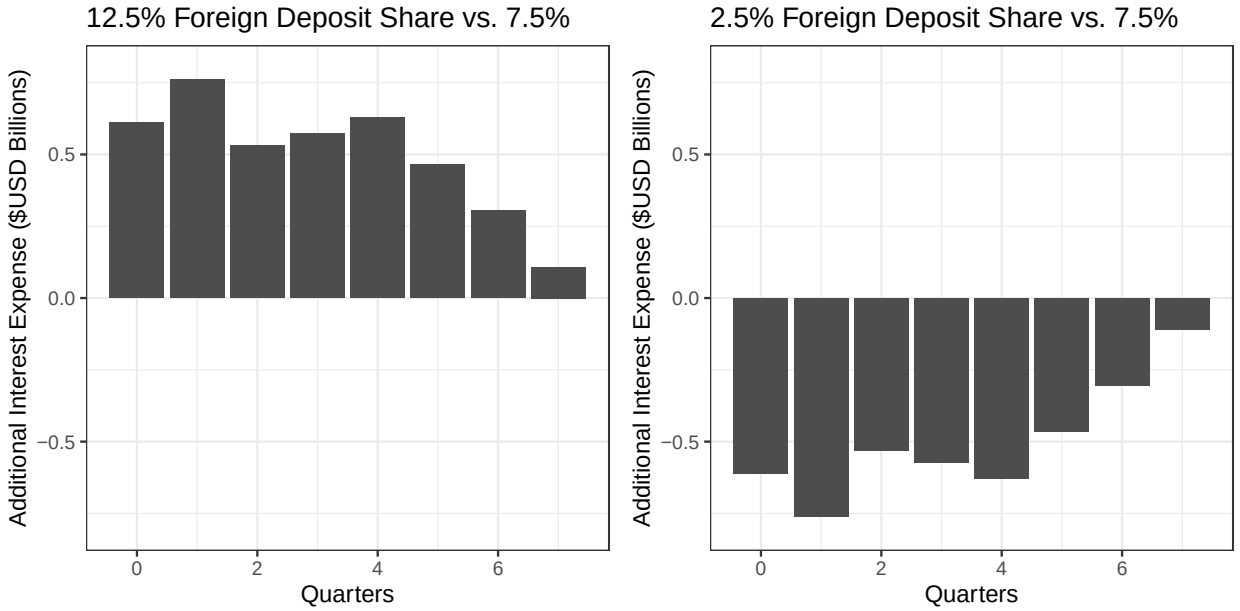
Deposit migration from lower-beta domestic deposits to higher-beta foreign deposits can also be seen (bottom-right panel). The foreign deposit share rises by more than 1 percentage point over 4-5 quarters per 100 bp increase in the FFR. As a result, the aggregate deposit beta of the bank sector – measured as the weighted average of foreign and domestic deposit betas – is itself increasing when interest rates are rising. In other words, the presence of foreign deposits in the banking system makes the interest rate risk profile of aggregate deposits exhibit positive convexity [Greenwald et al., 2023]. Consequently, the sensitivity of bank sector funding costs to US monetary policy keeps increasing (decreasing) as interest rates keep rising (falling).

Figure 8: Impulse Responses Following a 100 bps Increase in the Fed Funds Rate



Note: Impulse response functions following a 100 bp increase in the FFR. The solid line is the point-estimated IRF and the dashed line is the bootstrapped mean IRF. Shaded regions are 68% and 95% confidence bands based on 1000 bootstrapped samples from a VAR(4) as in Equation 10. The differences between the point estimates of the foreign and domestic deposit rate responses range between 23 and 33 basis points within the first five quarters. Y-axis refers to the response variable. Sample period is 1984-2023.

Figure 9: Additional Interest Paid on Deposits per 100 bps Increase in the Fed Funds Rate over a 7.5% Foreign Deposit Share Benchmark: Assuming Total Deposits at 2023 Q3 Levels and Foreign Deposit Share of 12.5% (left-panel) and 2.5% (right-panel)



Note: Additional interest paid on deposits per 100 bps increase in the FFR based on IRF estimates from Figure 8 estimated from Equation 10. Comparison is between a 7.5% foreign deposit share benchmark against foreign deposit share scenarios of 7.5% ± 5 percentage points. Assumes 2023Q3 level of aggregate deposits of $18.553 trillion.

5.3 Interest Expense Sensitivity of the Bank Sector under Counterfactual Foreign Deposit Shares

We now illustrate the macroeconomic significance of foreign deposit funding for interest rate risk. We use the IRF estimates shown in Figure 8 estimated from (10) to generate calculations of the *additional* cost of deposits under rising rates in two counterfactual scenarios. These counterfactual foreign deposit share scenarios are both benchmarked against a scenario of 7.5% foreign deposit share as in Q3 2023. First consider a bank sector with a foreign deposit share of 12.5%, a +5 percentage point increase from 2023. Second, consider a scenario with a foreign deposit share of 2.5%, a -5 percentage point reduction in the foreign deposit share from 2023. This way, we cover scenarios where the foreign deposit share either continues its post-2008 decline or reverses its trend. The following formula defines our estimates of additional deposit interest expense under a +100bps FFR increase (IE):

$$\begin{aligned}\text{Additional IE } (t+h) \mid FDS_t(2.5\%, 12.5\%) \;=\; \\ E[Deposits_{t+h} \mid +100\text{bps } FFR_t] \times \{FDS_t(2.5\%, 12.5\%) + E[\Delta FDS_{t+h} \mid +100\text{bps } FFR_t]\} \times \\ E[FDR_{t+h} - DDR_{t+h} \mid +100\text{bps } FFR_t] - \\ \text{Additional IE } (t+h) \mid FDS_t(7.5\%). \quad (11)\end{aligned}$$

A few remarks are in order regarding (11). First, (i) note that we start with an initial aggregate deposit balance of $18.553 trillion. However, we allow the deposit balance path to endogenously evolve folllowing the IRF of total deposits shown in Figure 8, denoted $E[Deposits_{t+h} \mid +100\text{bps } FFR_t]$. Second, (ii) we take deposit migration into account and allow the initial foreign deposit share scenarios of 2.5%, 7.5%, and 12.5% to evolve over time. These projections are based on the expected migration inferred from

[30] We omit IRF plots for CPI and RGDP to conserve space. We do not assume asymmetry in the VAR: regression results reported in Table A.2 indicate that the difference between foreign and domestic deposit betas is similar under symmetric or asymmetric regression specifications.

[31] The results are practically unchanged if using the trade-weighted or GDP-weighted FPR instead of the bank-weighted FPR.

the VAR model (denoted $\{FDS_t(2.5\%, 12.5\%) + E[\Delta FDS_{t+h} \mid +100\text{bps } FFR_t]\}$). Third, (iii) we apply the foreign-domestic deposit beta differential implied from the VAR to quantify the additional cost of foreign deposits under varying foreign deposit shares (denoted $E[FDR_{t+h} - DDR_{t+h} \mid +100\text{bps } FFR_t]$).[32] A crucial assumption underlying (iii) is that the ± 5 percentage point change in the foreign deposit share results entirely from a ∓ 5 percentage point migration from/to domestic *interest-bearing* deposits. This results in conservative estimates of interest expense sensitivity under alternative foreign deposit shares. Our estimates are conservative because any positive quantity of migration from domestic *non-interest bearing* deposits to foreign deposits entails strictly larger changes in funding costs, because non-interest bearing deposits pay zero interest.

Using this method, we calculate the *additional* deposit cost of the bank sector when the FFR increases by 100bps, under counterfactual 2.5% and 12.5% foreign deposit shares. These foreign deposit share scenarios are compared against a benchmark 7.5% initial foreign deposit share. Under a foreign deposit share of 12.5%, the left-panel of Figure 9 shows that quarterly interest paid on all deposits would increase by an additional \$53 to \$76 billion per quarter for at least 5 quarters compared to the 7.5% foreign deposit share baseline. The right-panel of Figure 9 shows that quarterly interest paid on deposits would decrease by \$53 to \$76 billion per quarter over the first 5 quarters if foreign deposit shares were to decline to 2.5% from 7.5%. On a cumulative basis, the 4-quarter period following the FFR increase results in $\pm$\$2.47 billion in interest expense on deposits by the bank sector under a ± 5 percentage point change in the foreign deposit share, respectively. Recall that these estimates are conservative because we assume that the change in the foreign deposit share comes entirely from interest bearing domestic deposit migration.

To contextualize this impact, consider the approximate +400 bps increase in the FFR through 2022 under a 7.5% foreign deposit share. Over this period, bank sector interest

[32] The deposit rate differential, in basis points, has to be de-annualized, i.e., divided by 4 in order to arrive at quarterly interest expense estimates.

expense on deposits was about $89.23 billion.[33] Had the foreign deposit share been 12.5%, our estimates imply additional interest expense of 2.47×4, or close to $10 billion, increasing bank sector interest expense by about 10%.

These results present an important macro-financial policy implication. If the foreign deposit share grows larger, bank sector funding costs become more sensitive to monetary policy. Therefore larger foreign deposit shares would potentially increase the efficacy of monetary policy by improving interest rate pass through to bank funding costs. But at the same time, larger foreign deposit shares would make bank profitability more interest rate sensitive, potentially raising financial stability concerns. Conversely, if the foreign deposit share declines, bank sector funding costs become more stable, but this also implies less efficient monetary policy transmission.

6 Concluding Remarks

Foreign deposit betas to US monetary policy are larger than domestic deposit betas. Large foreign deposit betas arise partly because foreign deposits are uninsured and therefore riskier. However, large foreign deposit betas also result from foreign deposit rates' additional sensitivity to non-US monetary policy. Because foreign deposit betas differ meaningfully from domestic deposit betas, they have important macro-financial implications. Foreign deposits contribute to bank-level and aggregate interest rate risk and they can open channels through which non-US monetary policy may influence US financial conditions.

Consequently, foreign deposits contribute to the monetary policy-financial stability trade off. Larger foreign deposit shares improve the efficacy of monetary policy by increasing the aggregate deposit beta of the bank sector. But at the same time, bank profitability becomes more volatile with respect to monetary policy, potentially raising funding stability risks. As such, a deeper understanding of the nature and regulatory treatment of foreign deposits may

[33] Interest expense paid on deposits by the bank sector in each quarter of 2022 was approximately $5.7, $9.75, $26, and $47.78 billion, respectively.

offer opportunities to enhance existing macro-prudential frameworks.

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Appendix

Table A.1: Federal Funds Rate Pass-through to Domestic Deposit Rates by Segment

	Transaction	Savings & MMDA	Time
ΔFFR_t	0.076^{***}	0.284^{***}	0.198^{**}
	(0.02)	(0.042)	(0.098)
$\sum_{l=0}^{3} \Delta FFR_{t-l}$	0.102^{***}	0.321^{***}	0.508^{***}
	(0.013)	(0.037)	(0.057)
$[FFR_{t-1} - \overline{DR}_{t-1}]$	0.006	0.047^{***}	0.082^{***}
	(0.007)	(0.017)	(0.019)
Adjusted R^2	0.367	0.641	0.608
Observations	146	146	146

Note: Standard errors are adjusted for autocorrelation and heteroscedasticity. Estimation period is 1987Q1-2023Q3. '*','**','***' correspond to 10%, 5%, 1% significance, respectively. Estimates correspond to Equation 3 with different domestic deposit rate segments as the dependent variable.

Table A.2: Asymmetric Federal Funds Rate Pass-through to Foreign and Domestic Deposit Rates

	Foreign		Domestic		F-D Difference	
	β_{down}	β_{up}	β_{down}	β_{up}	β_{down}	β_{up}
ΔFFR_t	0.737^{***}	0.263	0.318^{***}	0.120^{**}	0.418^{**}	0.144
	(0.166)	(0.219)	(0.043)	(0.054)	(0.166)	(0.209)
$\sum_{l=0}^{3} \Delta FFR_{t-l}$	0.830^{***}	0.470^{**}	0.580^{***}	0.164	0.250	0.306
	(0.169)	(0.199)	(0.052)	(0.133)	(0.174)	(0.200)
$[FFR_{t-1} - \bar{DR}_{t-1}]$	0.084^{*}		0.137^{***}		-0.053	
	(0.046)		(0.039)		(0.043)	
Adjusted R^2	0.441		0.796		0.098	
Observations	155		155		155	

Note: Standard errors are adjusted for autocorrelation and heteroscedasticity. Estimation period is 1984Q1- 2023Q3. '*','**','***' correspond to 10%, 5%, 1% significance, respectively. Estimates correspond to Equation 3 augmented with the following interaction terms to test for asymmetric deposit betas: $\Delta FFR_{t-l} \times \mathbf{1}_{FFR_{t-l}>0}$ for $l = 0, 1, 2, 3$.

Table A.3: Federal Funds Rate Pass-through to Foreign and Domestic Deposit Rates Since 2000

	Foreign	Domestic	F-D Difference
ΔFFR_t	0.657***	0.267***	0.389***
	(0.127)	(0.035)	(0.133)
$\sum_{l=0}^{3} \Delta FFR_{t-l}$	0.632***	0.428***	0.203
	(0.147)	(0.041)	(0.142)
$[FFR_{t-1} - \overline{DR}_{t-1}]$	0.048	0.061***	-0.013
	(0.044)	(0.011)	(0.046)
Adjusted R^2	0.705	0.94	0.297
Observations	91	91	91

Note: Standard errors are adjusted for autocorrelation and heteroscedasticity. Estimation period is 2000Q1-2023Q3. '*','**','***' correspond to 10%, 5%, 1% significance, respectively. Estimates correspond to Equation 3.

Table A.4: Federal Funds Rate Pass-through to Foreign and Domestic Deposit Rates after Controlling for Trade-weighted Foreign Monetary Policy

	Foreign	Domestic	F-D Difference
ΔFFR_t	0.396***	0.274***	0.123
	(0.131)	(0.05)	(0.121)
$\sum_{l=0}^{3} \Delta FFR_{t-l}$	0.48***	0.47***	0.010
	(0.156)	(0.045)	(0.139)
$[FFR_{t-1} - \overline{DR}_{t-1}]$	0.068*	0.12***	-0.052
	(0.038)	(0.038)	(0.032)
ΔFPR_t	0.327**	-0.098	0.426***
	(0.144)	(0.048)	(0.124)
$\sum_{l=0}^{3} \Delta FPR_{t-l}$	0.270	-0.063	0.333
	(0.246)	(0.088)	(0.223)
Adjusted R^2	0.427	0.783	0.132
Observations	155	155	155

Note: Standard errors are adjusted for autocorrelation and heteroscedasticity. Estimation period is 1984Q1-2023Q3. '*','**','***' correspond to 10%, 5%, 1% significance, respectively. Estimates correspond to Equation 4.

Table A.5: Federal Funds Rate Pass-through to Foreign and Domestic Deposit Rates after Controlling for GDP-weighted Foreign Monetary Policy

	Foreign	Domestic	F-D Difference
ΔFFR_t	0.453***	0.282***	0.171
	(0.131)	(0.041)	(0.124)
$\sum_{l=0}^{3} \Delta FFR_{t-l}$	0.503***	0.475***	0.028
	(0.132)	(0.035)	(0.120)
$[FFR_{t-1} - \overline{DR}_{t-1}]$	0.051	0.117***	-0.067
	(0.040)	(0.035)	(0.031)
ΔFPR_t	0.366**	-0.145	0.511***
	((0.178)	(0.069)	(0.159)
$\sum_{l=0}^{3} \Delta FPR_{t-l}$	0.454*	-0.051	0.505**
	(0.261)	(0.081)	(0.230)
Adjusted R^2	0.433	0.792	0.154
Observations	155	155	155

Note: Standard errors are adjusted for autocorrelation and heteroscedasticity. Estimation period is 1984Q1-2023Q3. '*','**','***' correspond to 10%, 5%, 1% significance, respectively. Estimates correspond to Equation 4, where the FPR is constructed using PPP-GDP weights instead of US trade weights.

Table A.6: Bank-level Regressions of Deposit Rates on the Federal Funds Rate and Trade-weighted Foreign Policy Rates

	Dependent variable:	
	Bank Deposit Rate (Level)	Bank Deposit Rate (4Q Change)
	(1)	(2)
FFR_{it}	0.792^{***}	
	(0.010)	
$FFR_{it} \times$ Foreign Deposit Share$_{i,t-1}$	-0.187^{**}	
	(0.074)	
$FFR_{it} \times$ Asset Market Concentration$_{i,t-1}$	-3.420^{***}	
	(1.098)	
$FPR_{it} \times$ Foreign Deposit Share$_{i,t-1}$	0.405^{***}	
	(0.096)	
$\Delta FFR_{t-4,t}$		0.523^{***}
		(0.012)
$\Delta FFR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$		0.165^{***}
		(0.058)
$\Delta FFR_{t-4,t} \times$ Asset Market Concentration$_{i,t-4}$		-2.458^{***}
		(0.654)
$\Delta FPR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$		0.383^{***}
		(0.104)
Bank FE	Yes	Yes
Observations	16,867	15,672
Adjusted R^2	0.772	0.371

Note: Standard errors are clustered at the bank level. Estimation period is 1984Q1-2020Q1. '*', '**', '***' correspond to 10%, 5%, 1% significance, respectively. Sample of all bank-quarter observations with positive foreign deposits. Foreign deposit share (bank's foreign deposits as a percent of the bank's total deposits) and asset market concentration (bank's total assets as a percent of market-wide assets) lie between 0 and 1 and their standard deviations are 0.213 and 0.013, respectively. Foreign policy rate is the trade-weighted average of non-US advanced economy policy rates. Estimates correspond to Equations 5 and 6 augmented with the interaction of the foreign policy rate with foreign deposit share.

Table A.7: Bank-level Regressions of Deposit Rates on the Federal Funds Rate and Foreign Policy Rates: Subset of Non-FBO Banks

	Dependent variable:			
	Bank Deposit Rate (Level)		Bank Deposit Rate (4Q Change)	
	(1)	(2)	(3)	(4)
FFR_t	0.826***	0.825***		
	(0.020)	(0.019)		
$FFR_t \times$ Foreign Deposit Share$_{i,t-1}$	0.280**	−0.332***		
	(0.112)	(0.121)		
$FFR_t \times$ Asset Market Concentration$_{i,t-1}$	−5.388***	−4.120***		
	(1.117)	(0.787)		
$FPR_t \times$ Foreign Deposit Share$_{i,t-1}$		0.847***		
		(0.158)		
$\Delta FFR_{t-4,t}$			0.541***	0.542***
			(0.025)	(0.026)
$\Delta FFR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$			0.245***	0.065
			(0.070)	(0.078)
$\Delta FFR_{t-4,t} \times$ Asset Market Concentration$_{i,t-4}$			−2.322***	−2.535***
			(0.683)	(0.682)
$\Delta FPR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$				0.551***
				(0.060)
Bank FE	Yes	Yes	Yes	Yes
Observations	4,240	4,240	4,098	4,098
Adjusted R^2	0.805	0.833	0.363	0.380

Note: Standard errors are clustered at the bank level. Estimation period is 1984Q1-2020Q1. '*', '**', '***' correspond to 10%, 5%, 1% significance, respectively. Sample of all bank-quarter observations with positive foreign deposits, further filtered to include only non-FBO US banks. Estimates correspond to Equations 5 and 6 augmented with the interaction of the foreign policy rate with foreign deposit share.

Table A.8: Bank-level Regressions of Deposit Rates on the Federal Funds Rate and Foreign Policy Rates: Subset of Banks with Majority Dollar-denominated Foreign Deposits

	Dependent variable:			
	Bank Deposit Rate (Level)		Bank Deposit Rate (4Q Change)	
	(1)	(2)	(3)	(4)
FFR_t	0.829^{***}	0.822^{***}		
	(0.022)	(0.022)		
$FFR_t \times$ Foreign Deposit Share$_{i,t-1}$	0.239^{**}	-0.384^{***}		
	(0.096)	(0.144)		
$FFR_t \times$ Asset Market Concentration$_{i,t-1}$	-4.072^{***}	-3.367^{***}		
	(0.485)	(0.344)		
$FPR_t \times$ Foreign Deposit Share$_{i,t-1}$		0.830^{***}		
		(0.251)		
$\Delta FFR_{t-4,t}$			0.465^{***}	0.466^{***}
			(0.030)	(0.032)
$\Delta FFR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$			0.628^{***}	0.397^{**}
			(0.107)	(0.167)
$\Delta FFR_{t-4,t} \times$ Asset Market Concentration$_{i,t-4}$			-1.974^{***}	-2.136^{***}
			(0.309)	(0.248)
$\Delta FPR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$				0.658^{***}
				(0.201)
Bank FE	Yes	Yes	Yes	Yes
Observations	1,220	1,220	1,189	1,189
Adjusted R^2	0.902	0.915	0.505	0.524

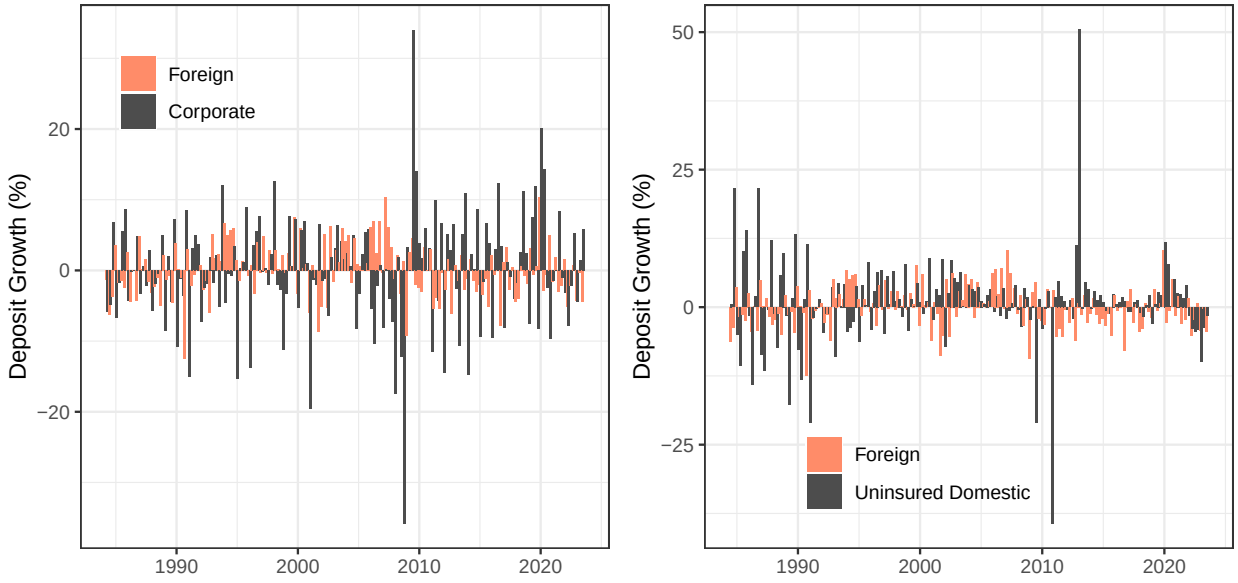
Note: Standard errors are clustered at the bank level. Estimation period is 1984Q1-2020Q1. '*', '**', '***' correspond to 10%, 5%, 1% significance, respectively. Sample of all bank-quarter observations with positive foreign deposits, further filtered on banks that averaged non-local currency denominated foreign office liabilities of at least 70% of total foreign office liabilities. Non-local currency liabilities are a proxy for dollar-denominated foreign deposits. Data on currency denomination is from bank-level FFIEC 009 supervisory data. Estimates correspond to Equations 5 and 6 augmented with the interaction of the foreign policy rate with foreign deposit share.

Table A.9: Bank-level Regressions of Deposit Rates on the Federal Funds Rate and Accounting for the Uninsured Deposit Beta Premium: Controlling for Balance Sheet Composition

	Dependent variable:	
	Bank Deposit Rate (Level)	Bank Deposit Rate (4Q Change)
	(1)	(2)
FFR_t	0.537^{***}	
	(0.026)	
$FFR_t \times$ Foreign Deposit Share$_{i,t-1}$	0.094^{**}	
	(0.045)	
$FFR_t \times$ Asset Market Concentration$_{i,t-1}$	-4.643^{***}	
	(1.135)	
$FFR_t \times$ Uninsured Deposit Share$_{i,t-1}$	0.101^{***}	
	(0.029)	
$FFR_t \times$ Time Deposit Share$_{i,t-1}$	0.182^{***}	
	(0.041)	
$FFR_t \times$ Commercial Loan Share$_{i,t-1}$	0.233^{***}	
	(0.046)	
$\Delta FFR_{t-4,t}$		0.468^{***}
		(0.034)
$\Delta FFR_{t-4,t} \times$ Foreign Deposit Share$_{i,t-4}$		0.269^{***}
		(0.052)
$\Delta FFR_{t-4,t} \times$ Asset Market Concentration$_{i,t-4}$		-2.520^{***}
		(0.668)
$\Delta FFR_{t-4,t} \times$ Uninsured Deposit Share$_{i,t-4}$		0.132^{**}
		(0.054)
$\Delta FFR_{t-4,t} \times$ Time Deposit Share$_{i,t-4}$		-0.097
		(0.063)
$\Delta FFR_{t-4,t} \times$ Commercial Loan Share$_{i,t-4}$		0.100
		(0.072)
Bank FE	Yes	Yes
Observations	14,872	13,671
Adjusted R^2	0.737	0.377

Note: Standard errors are clustered at the bank level. Estimation period is 1984Q1-2020Q1. '*', '**', '***' correspond to 10%, 5%, 1% significance, respectively. Sample of all bank-quarter observations with positive foreign deposits. Foreign deposit share (bank's foreign deposits as a percent of the bank's total deposits), asset market concentration (bank's total assets as a percent of market-wide assets), uninsured domestic deposit share (bank's uninsured domestic time deposits as a percent of the bank's total domestic time deposits), time deposit share (bank's domestic time deposits as a percent of total domestic deposits), and commercial loan share (bank's commercial and industrial loans as a percent of total loans) lie between 0 and 1. Estimates correspond to Equations 8 and 9 augmented with time deposit share and commercial loan share variables.

Figure A.1: Foreign Deposit, Corporate Deposit, and Uninsured Deposit Growth



Note: Quarterly deposit growth rates calculated as de-meaned log-differences of deposit levels. Correlation between corporate deposit growth and foreign deposit growth is -0.05. Correlation between corporate deposit growth and uninsured deposit growth is -0.03. Neither correlation is statistically distinguishable from 0. Corporate deposits measured as. the sum. of Nonfinancial corporate business checking and time and savings deposits from the Federal Reserve Flow of Funds. Sample period is 1984-2023.

Figure A.2: Aggregate Interest Expense of Foreign Deposits as a Percent of Total Bank Sector Interest Expense



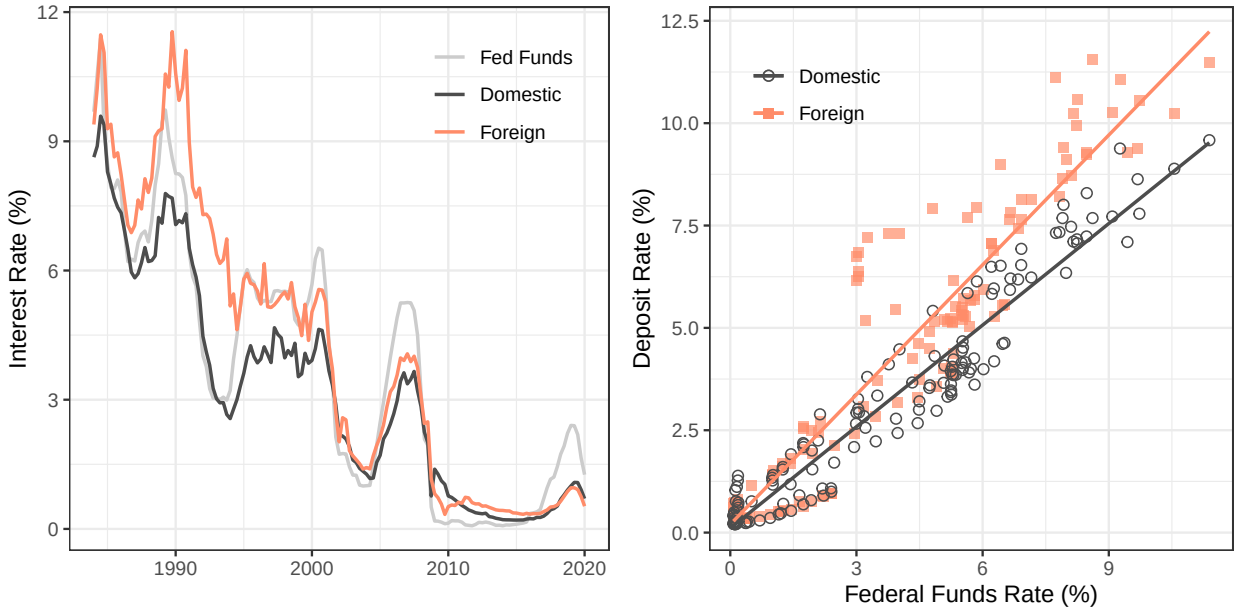
Note: Calculated by dividing quarterly aggregate interest expense paid on foreign deposits by aggregate total interest expense of US banks. Sample period is 1984-2023.

Figure A.3: Aggregate Reserves and Cash Assets of US Commercial Banks



Note: Quarterly reserve balances and cash assets of US commercial banks. Sample period is 1984-2023.

Figure A.4: Aggregate Foreign and Domestic Deposit Rates from Subset of US Commercial Banks that Hold Foreign Deposits



Note: Quarterly foreign (domestic) deposit rates calculated as annualized interest paid on foreign (interest-bearing domestic) deposits divided by total foreign (interest-bearing domestic) deposits from the sub-sample of US banks that hold foreign deposits along with domestic deposits. Sample period is 1984-2020 and deposit rates are estimated using aggregated bank-level data from Call Reports.