# Global Bank Lending and Exchange Rates*

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**Abstract**

We estimate the impact of banks' cross-currency lending on exchange rates, identified via a granular instrumental variable approach, to shed light on the importance of flows in the foreign exchange (FX) market. When more loans are extended in US dollars (USD) by non-US banks relative to foreign currency-denominated loans by US banks, the USD appreciates significantly. When a foreign bank grants a cross-currency USD loan, it needs to obtain USD liquidity which puts pressure on funding markets and leads to an appreciation of USD. This effect has greatly intensified since the global financial crisis, and crucially depends on how banks fund the provision of cross-currency loans. In line with this mechanism, we show that cross-currency lending also affects the FX swap market (and deviations from covered interest parity), as well as other segments of the US short-term funding market.

**Keywords:** Cross-currency lending, exchange rates, granular instrumental variable, CIP deviation.

**JEL Classification:** F31, E44, G21

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# 1. Introduction

A growing recent literature studies the nexus between capital flows and exchange rates, highlighting the crucial role of intermediaries. At the heart of this intermediation process are globally active banks. Not only do these financial institutions (through their broker-dealer arms) intermediate global portfolio flows in capital markets, but they are also crucial for supplying cross-currency loans to financial and non-financial borrowers. In all of these financial transactions the US dollar (USD) stands out given its special role in the global financial system.

Against this backdrop, the main goal of our paper is to shed light on the elasticity of exchange rates with respect to changes in this key quantity— the flow of global bank lending. Addressing this question is important given the recent findings of Gabaix and Koijen (2021a) on the crucial role of flows in driving asset prices (according to the "inelastic markets hypothesis"). Beyond the interest for academics, understanding how cross-currency lending activities of global banks affect exchange rates is also of major interest for policymakers that need to take into account the effects of their domestic policy on international financial markets through spillover effects.

We contribute to the literature on the role of financial flows and financial frictions by empirically exploring the impact of global bank lending on exchange rates. More specifically, we study the following set of questions: (i) how much, if at all, do exchange rates respond to shifts in cross-currency loan flows, (ii) what drives the elasticity of exchange rate changes with respect to shifts in cross-currency bank lending, and (iii) how do such shifts affect conditions in key funding markets (notably in the foreign exchange (FX) swap market)?

To answer these questions, we conceptually draw on a variation of the model in Ivashina *et al.* (2015) to derive implications which we subsequently test empirically. In the model, a foreign bank wants to lend in USD and needs to acquire liquidity either via wholesale funding that incurs an additional cost over the home currency deposit rate, or by swapping some of is local funding (say in EUR) for USD via a dealer. Our version of the model takes into account that a dealer incurs a balance sheet cost when offering swap contracts and we solve for the model implied spot exchange rate. A key implication is that the US dollar should appreciate against the foreign currency when a foreign bank increases its dollar loan supply. Additionally, when the dealer incurs higher balance sheet costs, or when the wholesale funding rate for US dollars increases, the US dollar should appreciate more.

To test these implications, we make use of a large sample of around 1.3 million syndicated lending relationships obtained from LPC DealScan. An important feature of these syndicated loans is that both US and non-US banks originate loans in USD and extend them to firms located in various currency areas.[1] More specifically, we observe 223 globally operative banks in our sample, of which 206 are domiciled outside the US.

Our interest centers on the flow of cross-currency loans. We define those as the net between USD lending flows by non-US banks and the reverse direction of non-USD lending flows by US banks. To give an example, the cross-currency lending flow in EUR/USD in a given period is equal to the flow of syndicated loans in USD by non-US banks (headquartered say in the euro area or Japan) minus the flow of syndicated loans in EUR by US banks.

A crucial aspect of our work lies in the accurate measurement of the elasticity of the exchange rate vis-à-vis cross-currency lending flows. As flows and prices are endogenously related, we make use of the significant degree of cross-sectional heterogeneity in our micro data of syndicated loans to construct a Granular Instrumental Variable (GIV), as proposed in Gabaix and Koijen (2021b), which we use to instrument cross-currency lending flows. The instrument affects the exchange rate, but only through its effect on lending flows.[2]

Based on this instrumental variable setup, we find a statistically significant and economically large effect of cross-currency lending flows on exchange rates, in line with the theoretical motivation discussed above. Our results imply a USD appreciation of about 36 basis points for a one standard deviation increase in net lending flows, i.e., the difference in volume between foreign banks granting USD denominated loans versus US banks granting foreign currency denominated loans.

Interestingly, we find that the effect of cross-currency lending on exchange rates only becomes economically sizable and significant following the global financial crisis (GFC) in 2008/2009 when the structure of funding markets changed and banks and their broker-dealers became more tightly regulated.[3] We further find that cross-currency lending flows exert a stronger effect on exchange rates when the US Fed is in a hiking cycle and when intermediaries' balance sheet usage via leverage is more constrained. Both findings suggest that the elasticity of the exchange

[1] In our sample period from 2000-2021, US banks only originate around 34% of the global USD syndicated lending market volume whereas around 61% of all syndicated loans flow to borrowers headquartered outside the US.

[2] In our empirical analysis, we additionally control for measures of global risk appetite (see, e.g., Kremens and Martin (2019), and Lilley *et al.* (2020), among others) that might drive the relation of cross-currency lending and spot exchange rates. We further control for macroeconomic conditions and saturate the model with a rich set of fixed effects.

[3] In a similar vein, e.g. Du *et al.* (2018b) and Avdjiev *et al.* (2019) document sharp increases in CIP deviations and violations of other no arbitrage conditions after the GFC that could be related to the same underlying factor, such as higher balance sheet costs for financial institutions.

rate vis-à-vis flows rises when liquidity conditions in dollar markets become tighter and when it is more costly for global dealers to supply liquidity to foreign banks as suggested by our model.

Digging deeper into the economic forces that generate these empirical results, we study how global banks typically fund the provision of cross-currency syndicated loans. When banks originate foreign currency denominated loans, they often obtain the necessary liquidity to pay out the loan through a foreign exchange swap with another bank. They do so by exchanging some of their home currency deposits for immediate liquidity in the foreign currency. This is typically done in the form of FX swaps, such that the originating bank acquires a term deposit and subsequently exchanges it for cash in the foreign currency.[4]

Banks' funding operations via the global FX swap market suggest that cross-currency lending flows will have a bearing on funding conditions in this market (as well as other segments that are connected to it). We empirically test for such an effect based on the same GIV setup described above. We start by investigating the impact on covered interest parity (CIP) deviations (e.g. Du *et al.*, 2018b; Correa *et al.*, 2020; Rime *et al.*, 2022, among others). In line with the intuition above on how banks fund the provision of loans, we find that dollar scarcity (as captured by the cross-currency basis) becomes more pronounced whenever we observe a rise in net cross-currency lending flow into USD. In terms of economic significance, our estimates suggest that when USD lending by foreign banks compared to US bank lending in foreign currency increases by one standard deviation, CIP deviations tend to widen by around 4.8 bp (annualized). Moreover, we find the effect of cross-currency lending flows on CIP deviations to be the strongest at the three-month maturity—the most popular tenor for banks' internal refinancing practices.

We go a step further by studying implications for crucial sources of direct short-term dollar funding markets, that is, the US market for commercial paper (CP) and certificates of deposits (CD). The idea is that while the provision of syndicated loans in USD may initially be funded by an FX swap, it could over time be replaced by cheaper sources of financing, provided that the bank has access to this funding market. In line with this reasoning, we find that banks *with an above average rating* and hence a funding advantage compared to lower-rated banks tend to increase their USD CP and CD issuance following large USD cross-currency loan outflows, i.e., when they need USD liquidity to match these USD loans. In essence, these results suggest that some banks, i.e., those with a superior rating with access to short-term USD funding via

[4]We provide a detailed explanation of the funding mechanism in Section 2.

CP or CD markets, fund their cross-currency loan flow-driven liquidity needs in domestic US funding markets. Lower-rated banks, by contrast, have to tap the FX swap markets for funding purposes, as discussed above.

We run a number of additional empirical exercises to extend our key findings and to check for robustness. Most importantly, we show that our results are hold in a setting with an alternative, economically easier to interpret instrument. We further show that our results extend to forward rates though with a slightly lower magnitude.

*Related Literature*

Our paper connects to various strands of the empirical and theoretical literature on the determinants of exchange rate fluctuations, the impact of capital flows, and, more generally, the importance of intermediary frictions and financial flows in affecting asset prices.

A recent literature has investigated the importance of flows for driving exchange rates. Gabaix and Maggiori (2015) develop a model in which constrained international financiers intermediate capital flows, affect the demand for currencies, and the determination of exchange rates. Liao and Zhang (2021) identify a 'currency hedging channel' that connects external imbalances to the exchange rate.[5] We contribute to this literature by investigating the funding process and frictions that affect global bank lending and how this process, in turn, affects exchange rates. In contrast to Liao and Zhang (2021), we identify an aggregated micro-level channel resulting from the operative business of banks rather than a macro-level demand for hedging resulting from imbalances as in their paper.

Related to this research, a host of papers study deviations from covered interest rate parity (CIP) to understand the sources of frictions in international funding markets. (Du *et al.*, 2018b; Avdjiev *et al.*, 2019; Rime *et al.*, 2022) study covered interest rate parity (CIP) deviations over the period after the financial crisis. We show that the cross-currency lending flows affect exchange rates more strongly in situations where CIP deviations indicate strained US dollar liquidity conditions. The cross-currency basis also tends to widen in response to a rise in cross-currency foreign currency lending. Avdjiev *et al.* (2019) describe a triangular relationship between the USD strength, CIP deviations and USD denominated cross-border lending. Du *et al.* (2022) show that dealers in the Treasury market switched from a net short to a net long position, which

[5] In a similar vein, Fang and Liu (2021) propose a model in which intermediaries in FX markets are Value-at-Risk-constrained, which means that higher volatility implies an (expected) appreciation of a currency so the intermediary still engages in the FX market. Malamud and Schrimpf (2018) show that intermediation markups affect the risk structure in FX markets.

can explain the co-movement of dealer positions, the FX rates and CIP deviations. We provide a mechanism and show empirically how the funding of USD denominated loans significantly affects exchange rates (USD appreciates), and widens CIP deviations.

We also contribute to a large literature on the impact of cross-border bank flows on economic and financial outcomes and how monetary policy interacts with these flows.[6] Bruno and Shin (2015) show that monetary policy spills over on cross-border bank capital flows and the US dollar exchange rate via the banking sector. Adrian and Xie (2020) find that a higher share of USD denominated assets in the portfolio of non-US banks forecasts a USD appreciation. Shen and Zhang (2022) show that cross-border lending supply has become less price-elastic since the global financial crisis, which suggests more stable cross-border funding and country-level funding shortages are met with smaller inflows of international capital. This resonates with our finding that the impact of global lending on exchange rates has strengthened significantly after the GFC. Correa *et al.* (2022) analyze the impact of monetary policy on bilateral cross-border bank flows and find evidence for a pronounced importance of domestic monetary policy. Meisenzahl *et al.* (2020) show that US dollar movements affect syndicated loan terms for US borrowers even without trade exposure. Bräuning and Ivashina (2020) show that international banks benchmark their foreign lending with domestic lending. Our results contribute to this literature by showing that domestic US monetary policy strongly affects how strongly global lending impacts upon exchange rates. Moreover, in contrast to Bräuning and Ivashina (2020), we analyze the first-order effect of cross-currency lending flows on exchange rates rather than funding cost differences that lead to differential lending flows.[7] We thereby shed light on a new mechanism showing how cross-currency bank flows can directly affect exchange rates.

Methodologically, our empirical approach relates to the growing literature that uses a Granular Instrumental Variables (GIV) estimation approach pioneered by Gabaix and Koijen (2021b). Closest to our approach, Camanho *et al.* (2022) estimate the exchange rate effect of global portfolio rebalancing on exchange rates. Aldasoro *et al.* (2022b) show how cross-border bank lending affects emerging market economies' (EMEs) macro-financial conditions deploying a

[6] Buch and Goldberg (2020) provide an excellent summary on the literature on cross-border banking more generally. Niepmann (2018) provides a theoretical model in which banks engage in operations abroad. Avdjiev *et al.* (2020) show that the responsiveness of global bank lending to global risk factors has declined after the financial crisis. Recent work also maps the USD funding sources of non-US banks more generally, see e.g. Aldasoro and Ehlers (2018), Aldasoro *et al.* (2020), and Aldasoro *et al.* (2022a).

[7] Funding frictions and interest rate differentials are important determinants of cross-border flows. Ivashina *et al.* (2015) study how funding differences between domestic and foreign currencies impact lending of global banks. Anderson *et al.* (2021) document that a large negative wholesale funding shock leads to a down-scaling in arbitrage positions rather than a reduction in lending.

GIV approach. Moreover, they highlight that commonly used instruments can correlate with global finance conditions, which biases estimation. We show that the GIV approach can also be fruitfully employed to understand the effect of global bank lending on exchange rates as well.

# 2. Funding Mechanism and Theoretical Motivation

In this section, we first provide institutional background and a brief discussion of how global banks fund syndicated loans in foreign currency (Section 2.1) to motivate our subsequent empirical analysis. In Section 2.2, we provide an extension of the model in Ivashina *et al.* (2015) to show how global lending, variation in funding costs, and dealer balance sheet constraints impact on the (spot) exchange rate. Drawing on this model, we derive additional implications that we test empirically in the remainder of the paper.

## 2.1. Details on the funding mechanism of syndicated loans

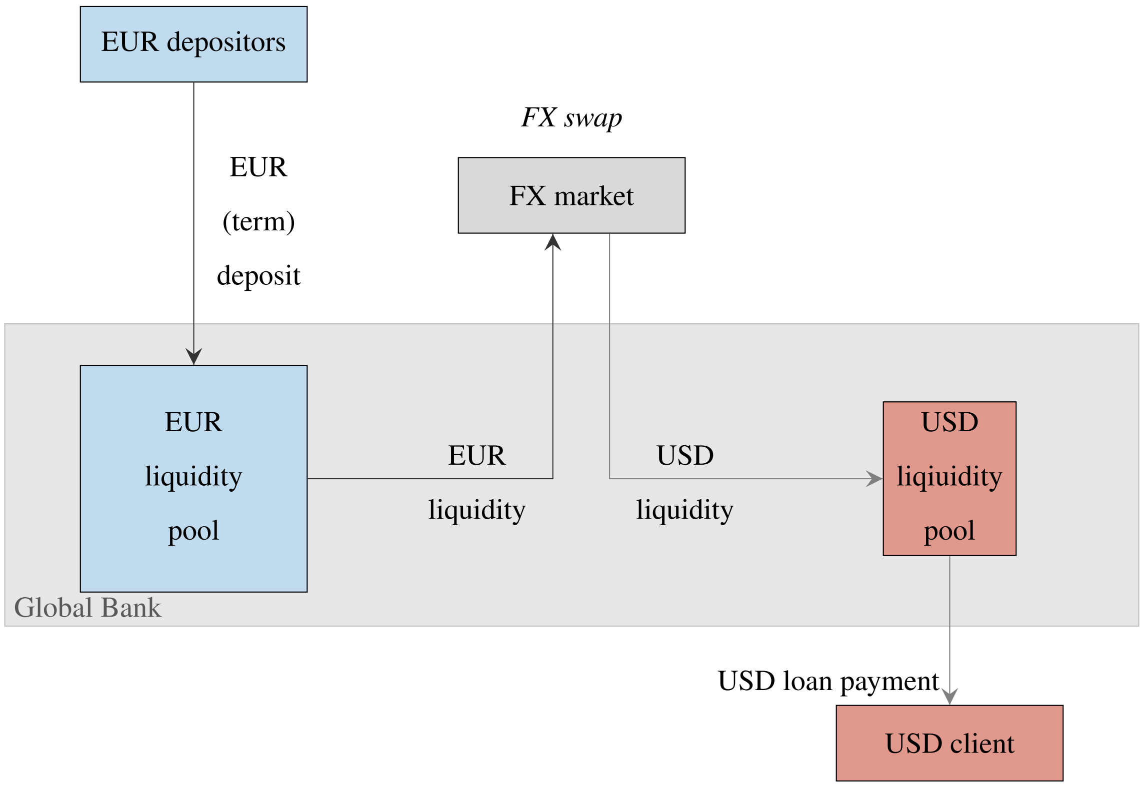
Global bank off-shore lending occurs in various currencies and countries, with lending in USD taking on a special role due to the reserve currency status of the dollar. Importantly, USD lending is global in the sense that neither USD borrowers nor lenders have to be located in the US. Indeed, USD lending regularly happens between counterparties that are headquartered outside the US so that neither party in the contract has direct access to USD funding.

Unlike US banks that have access to (customer) deposits, most non-US banks that originate USD loans do have to obtain funding for these loans. One flexible source to do so is the FX swap market. We detail this process in Figure 1 to show how global banks can tap the swap market for liquidity in foreign currency.

In the context of the outlined example, consider a EUR bank that wants to pay out a USD loan to its customer. To do so, the bank needs to have sufficient amounts of cash. For its operational needs the globally active bank maintains liquidity pools in the currencies the bank operates in. Natural sources of dollar liquidity are (customer) deposits via branches of the bank, USD denominated commercial papers (CPs) or certificates of deposits (CDs), or the issuance of longer-term debt securities. The liquidity pool maintained in the home currency typically amounts to a larger volume compared to the ones in foreign currencies.

When large amounts of foreign currency drain the liquidity pool (e.g. resulting from the transfer of the syndicated loan amount from the customer's account to the account of, for instance, a supplier at another bank), banks face the immediate necessity to obtain additional liquidity in the currency of the outflow when syndicated loans are paid out. In the context of a USD loan, the EUR bank acquires USD liquidity by exchanging EUR liquidity for USD liquidity in an FX swap (i.e. receiving USD at the spot leg).

**Figure 1:** Exchange of EUR Liquidity for USD Liquidity




*Notes:* This figure provides a stylized example of a EUR bank obtaining USD liquidity to pay out a USD loan. EUR cash raised from depositors (or other forms of local debt securities) is used to swap for USD liquidity via a FX swap. Thereby, the EUR funded bank can acquire USD liquidity. In a final step, the USD loan is paid to the borrower from the USD liquidity pool.

If the loan notional is not repaid until the maturity of the loan contract and in the absence of the possibility to issue USD funding instruments, the bank would need to roll-over the FX swap until repayment of the loan. Banks choose different terms for the maturity of the FX swap when obtaining the liquidity. Discussions with market participants indicate that the most common choice is a three month maturity, which we will come back to in Section 5. This would imply that the FX swap would have to be rolled over every three months.

Dealers that offer FX swaps and, therefore, take the other side of the trade by providing the USD liquidity to the foreign banks, are confronted with more foreign currency liquidity (EUR in the context of the example) on their balance sheet as a consequence. In other words, the differential demand for USD liquidity of banks across currency areas leads to an imbalance of dealer's currency holdings that can have a bearing on the exchange rate.[8]

### 2.2. Theoretical Motivation: International lending

To guide our empirical analysis of the impact of global lending on exchange rates conceptually, we rely on a variation of the model in Ivashina *et al.* (2015). The model looks at the decision of a globally active bank residing in Europe. There are two time periods: at time 0, the bank obtains funding in EUR from depositors that require return $(1 + r^{€})$ and has lending opportunities in USD or in EUR that deliver a return at time 1. Obtaining EUR funding requires to pay depositors a rate $r^{€}$.

The bank has two options to acquire USD liquidity – via FX swaps, or via USD wholesale funding. We assume that funding via the USD wholesale market incurs a higher cost than obtaining local EUR deposits, $r^{\$} > r^{€}$.[9] If the bank wants to acquire USD funding via FX swaps, it has to raise EUR deposits, which it then has to swap for USD liquidity with a dealer. The amount the bank decides to swap is denoted by $D^S$, and $p^S D^S$ the corresponding price of the swap proportional to the swap notional.[10]

The bank can raise local EUR deposits, but faces convex adjustment costs when doing so, modelled by the function $\frac{\phi}{2} \max\left(0, L^E + D^S - \bar{D}\right)^2$, which describes the increasing cost of expanding the deposit base above a certain threshold $\bar{D}$, where $L^E + D^S$ describes the EUR deposit demand of the bank needed for EUR lending and USD swaps.

When the bank lends in USD, it obtains the return $g(L^D)$, where $g(\cdot)$ is a concave function in the USD loan supply, $L^D$. Similarly, when the bank lends in EUR, it obtains a return $h(L^E)$, where $h(\cdot)$ is a concave function reflecting decreasing returns to lending.

Compared to the setup in Ivashina *et al.* (2015), we relax the assumption of the exchange rate being equal to one and derive the model-implied exchange rate. We assume that the EUR bank wants to optimize the current EUR value of its profits at the moment of its lending decision, i.e.

[8] In practice, banks may later on also sell parts of the originated loan amount. Conversations with market participants confirm that the magnitude of these sales varies across specific deals but is roughly in the ballpark of 30-70%. Typical buyers are domestic non-bank financial corporations such as pension funds or smaller banks. As these domestic buyers face similar funding constraints, the ultimate need for USD funding is similar to those of the originating banks.

[9] This reflects the fact that in reality obtaining USD funding is more expensive for non-US banks than for US banks because of differential access and a segmentation in the funding market, see e.g. Rime *et al.* (2022). Alternatively, one can also think of home currency funding to be cheaper as a result of deposit insurance schemes operative mostly in the context of deposits of local banks.

[10] In practice, this would correspond to the forward points.

at $t = 0$, thus converting the return on the USD part of its operations back to home currency. In this simple setup, the bank does not internalize equilibrium effects it might have on the exchange rate. The bank's maximization problem is then given by

$$\max_{L^D, L^E, D^S} S^{E/D} \left[ g\left(L^D\right) - \left(L^D - D^S\right)(1 + r^{\$}) \right] - p^S D^S + h\left(L^E\right) - \left(L^E + D^S\right)(1 + r^{€}) \\ -\frac{\phi}{2} \max\left(0, L^E + D^S - \bar{D}\right)^2, \tag{1}$$

$$\text{s.t. } K - S^{E/D} L^D - L^E \geq c.$$

The spot exchange rate $S^{E/D}$ converts the net return on lending that results from lending in USD into EUR at (the end of) $t = 0$. A rise in $S$ implies an appreciation of the USD. $g\left(L^D\right)$ is the return on the USD lending and $h\left(L^E\right)$ the respective return of EUR lending. $\left(L^E + D^S\right)(1 + r^{€})$ describes the EUR funding cost, where $D^S$ is the amount of EUR liquidity that is used to swap for USD liquidity. $K - S^{E/D} L^D - L^E \geq c$ denotes the capital constraint the bank has to comply with taking into account the current EUR value of its USD lending position and an arbitrary minimal value of capital $c$. As in Ivashina *et al.* (2015), we assume this condition to bind. For expositional simplicity we thus model the bank's problem as a capital allocation problem for a fixed amount of capital $K$, abstracting from leverage considerations.

Deriving the optimal loan supply from equation (1) delivers

$$g'(L^D) = h'(L^E) + p^S + (1 - S^{E/D})(1 + r^{\$}). \tag{2}$$

Solving (2) for the exchange rate $S^{E/D}$ delivers

$$S^{E/D} = 1 - \frac{g'(L^D) - h'(L^E) - p^S}{(1 + r^{\$})}. \tag{3}$$

**Dealer.** When the bank decides to obtain some of the necessary USD liquidity via FX swaps, it can enter into these swaps with a dealer which acts as intermediary. The dealer has two investment opportunities to invest her wealth $W$ in. Either she offers swap contracts delivering return $p^S$ in which she invests amount $I^S$, or she invests an amount $I^O$ in an outside option that delivers return $f(\cdot)$, a concave function.[11] Similar to Ivashina *et al.* (2015), we assume that the

[11] This outside option could be, e.g., using the balance sheet space to conduct a matched book repo, or earn interest at the Federal Reserve.

dealer has to retain a fraction $\Gamma$ of her funds and to abstain from investing them in the outside opportunity when engaging in a swap contract. This aims to capture a balance sheet constraint preventing the dealer to take large positions in a specific currency. The dealer can thus invest $W - (1+\Gamma)I^S$ in the outside investment opportunity. The objective function is then given by

$$\max_{I^S} f(W - (1+\Gamma)I^S) + p^S I^S,$$

where $f(\cdot) = \theta \log(I) - I$. We can then derive the equilibrium price of the swap as

$$p^S = \frac{(1+\Gamma)I^S}{W - (1+\Gamma)I^S}. \tag{4}$$

As Ivashina *et al.* (2015), we assume that $p^S$ is 0 when the net demand for swaps is 0, but becomes positive whenever there is a positive net demand for swaps. This implies that $\theta = W$, see Ivashina *et al.* (2015), i.e. the dealer invests in all positive-NPV investments. We can then derive testable implications from the model implied exchange rate $S^{E/D}$, which is defined as the amount of EUR the bank can obtain for one unit USD (i.e. a rise in $S$ reflects a dollar appreciation). The proofs to the model implications are contained in the Appendix.

Implication 1: *When the European bank increases loan supply in USD, the USD appreciates.*

As the European bank supplies more USD loans, it has to demand more USD deposits directly in the USD wholesale market, or via the swap offered by the dealer. For a given USD wholesale deposit rate, a higher USD loan supply increases the price of the swap in Equation (4), as the dealer is only willing to expand the balance sheet if she is compensated for not being able to invest in the outside technology.

Implication 2: *For a given USD lending increase, when there are higher balance sheet costs for the dealer to provide swaps, the USD appreciates by more.*

An increase in the dealer's opportunity cost $\Gamma$ to provide a swap results in a corresponding increase in the swap's price. For a given USD lending increase, this, in turn, positively affects the exchange rate, as shown in equation (3), whereby a higher swap price leads to a stronger USD appreciation. The dealer's increased compensation reflects the rising opportunity cost and contributes to the appreciation of the USD, making the exchange rate more responsive to any increase in USD lending. Essentially, higher opportunity costs necessitate greater compensation for swap offerings.[12]

Implication 3: *For a given USD lending increase, when the USD wholesale funding rate increases, the USD appreciates by more.*

As the USD wholesale funding rate increases, the EUR bank faces greater incentives to seek USD liquidity through FX swaps and demands more FX swap funding accordingly. This prompts the dealer to offer swaps at a premium price to be compensated for not being able to invest in the outside opportunity. Thus, for a given increase in lending, as a result, the USD appreciates by more, as indicated by Equation 3.

Implication 4: *When the European bank increases net loan supply in USD, the CIP deviation widens.*

When the European bank demands more USD funding to finance more loans, (part of) the extra funding will be through FX swaps. An increase in the demand for swaps increases the price for them. The higher swap price in turn implies a wider (more negative) CIP deviation, see Equation (13).

# 3. Data and Empirical Approach

Cross-currency bank lending in an economically significant magnitude typically occurs in the form of syndicated lending. Within a syndicate, banks split the overall loan amount depending on their willingness to take a part in the provision of the loan. Lead banks organize the syndication process, while participating banks help to provide the necessary capital. The composition of the syndicate varies by borrower sector and country, and the currency demanded by the borrower.

*Syndicated Loans.* We obtain data on all issued term loans and credit lines from Refinitiv LPC DealScan for the time period 1997-01 to 2021-12. We obtain full information on the loan allocation between syndicate members for about 33% of all loans. For the remaining 67%, we follow De Haas and Van Horen (2013) and divide the loan facility equally among all participants where exact proportions are not available.

[12] In reality, the dealer might have the opportunity to place her USD funds at the Federal Reserve to earn interest on reserves or intermediate in a matched book repo. As the increased supply of FX swaps has to be benchmarked with the return on IOER, an increase in the outside option increases the FX swap price, which can then impact the exchange rate as outlined.

Apart from geographical information, DealScan contains information on the issuance and maturity date, currency, total amount and allocation of a loan facility. We construct a measure of monthly outstanding loans of a bank parent company in a given currency and study changes in this measure over time. In other words, we look at the syndicated lending flows between currency areas. We do not differentiate between the country of the borrower of the loan, but rather focus entirely on the currency.

Financial corporations can obtain foreign currency liquidity also via loans from other banks. For instance, a EUR funded bank can acquire USD liquidity by obtaining a USD denominated loan from a US bank. This would mitigate the effect of the mechanism outlined in Section 2, as less USD funding would be obtained via FX swaps. Therefore, we exclude loans granted to banks and non-bank financial corporations and only retain loans to non-financial customers. Figure B.9 in the Appendix depicts the sectoral decomposition of borrowers in our sample.

Our final sample consists of banks headquartered in Australia, Canada, China, Denmark, the Euro Area[13], Japan, Mexico, Norway, Singapore, South Africa, South Korea, Sweden, Switzerland, the United Kingdom, and the US.[14] We are left with 223 internationally operative banks, of which 206 are domiciled outside the US. Table 1 contains summary statistics.

Our sample comprises around 83,000 loans which entail around 1.3mn borrower-lender-loan connections. Overall, lending to non-US borrowers tends to be in larger volumes than lending to US borrowers. There are 209 banks granting loans to US borrowers, which underlines the large source of credit provided by non-US banks to borrowers domiciled in the US.

[13]We consider Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovenia, Slovakia and Spain for the Euro Zone. We exclude Hong Kong given its currency board and thereby close peg to the USD.

[14]To focus on a meaningful and active set of banks, we further exclude banks with less than USD 10mn of outstanding loans in a given month and retain only banks that have at least 40 changes in their outstanding loan volume over the sample period. This also excludes locally-oriented banks that do not contribute much to *cross-currency* lending flows. Finally, we exclude 7 observations of French banks granting loans in excess of USD 10bn in Indonesia to correct for a potential currency miscoding. We also exclude 10 observations where the change in outstanding loans exceeds 50% of the currently outstanding loans. Lastly, we exclude 41 public banks that primarily provide development loans.

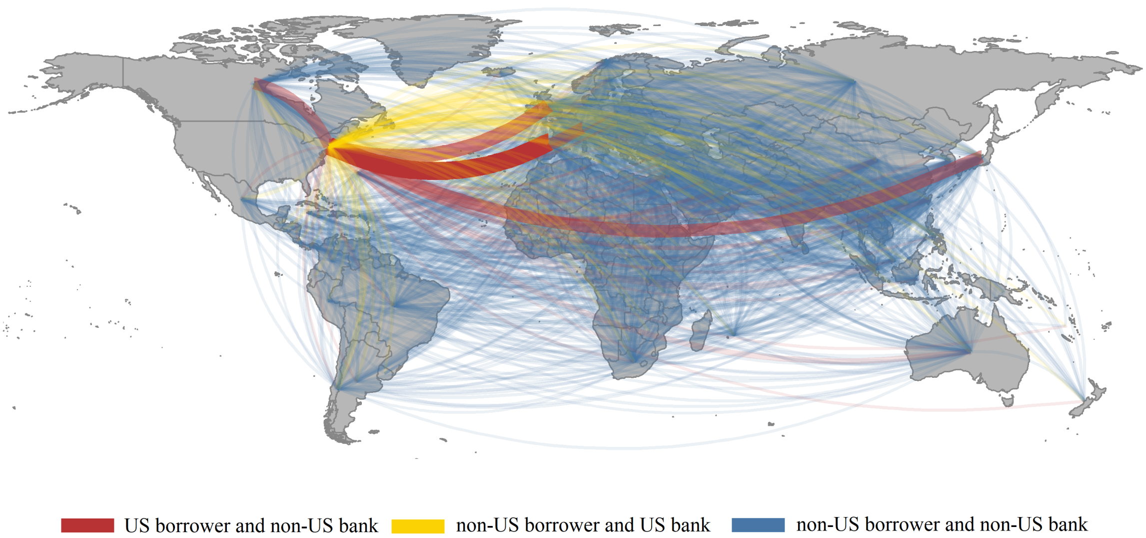
**Table 1:** Global syndicated lending differentiated by borrower and lender origin

| Category | Obs. | | | |
|---|---|---|---|---|
| Individual Loans | 83,563 | | | |
| Individual Tranches | 131,509 | | | |
| Borrower-Lender-Loan connections | 1,284,863 | | | |
| **USD loans** | to US borrowers | | to non-US borrowers | |
| | Obs. | Countries | Obs. | Countries |
| Lending Parent Banks | 209 | 31 | 222 | 31 |
| Borrowers | 16,289 | 1 | 29,297 | 165 |
| | Mean | Std. Dev. | Mean | Std. Dev. |
| Tranche Term | 4.21 | 2.05 | 4.90 | 3.43 |
| Ind. USD Loan size (mn) | 54.97 | 176.08 | 66.33 | 2,047.38 |

*Notes*: This table summarizes the characteristics of syndicated loans in our sample. We distinguish between US and non-US borrower. Our sample ranges from 1997/01-2021/12 and includes banks from Australia, Canada, China, Denmark, the Euro Area, Japan, Mexico, Norway, Singapore, South Africa, South Korea, Sweden, Switzerland, the United Kingdom, and the US.

### 3.1. Global Syndicated Bank Lending

**Figure 2:** Global USD syndicated lending flows between 2000/01 and 2021/12




*Notes:* This figure depicts lending relations between banks and firms in the syndicated loan market. The size of the red lines indicates the value of syndicated USD loans that flow to non-financial borrowers headquartered in the United States from non-US banks. Yellow lines depict the loan volume originated by US banks with a non-US borrower. Blue lines represent 'off-shore' syndicated lending flows in USD to borrowers located outside the US by non-US banks. Syndicated loan data are from LPC DealScan and the sample period is 2000/01-2021/12.

Figure 2 maps syndicated loan transaction flows denominated in USD where each line connects the country of the parent bank with the borrower's country of origin. The size of lines reflects the total value of loan flows such that a thicker line indicates greater loan flows. Red depicts loan flows from non-US banks to US borrowers, yellow the flow from US banks to non-US borrowers, and blue lines the "off-shore" credit flows where neither the borrower nor the bank's headquarter are located in the US.

Two patterns stand out from this graph. First, the US itself is connected to a large share of these loan flows, which underscores the importance of the USD and the US financial system in supplying and demanding USD financing. Second, however, this figure also highlights that many USD-denominated loans are between borrowers and lenders residing outside the US. The latter feature reflects the special role and global reach of the USD, see also, e.g., Bruno and Shin (2017), Maggiori *et al.* (2019), Avdjiev *et al.* (2019), and Gopinath and Stein (2021).

To benchmark the size of cross-currency lending flows, we compare the total outstanding syndicated loan volumes we obtain for a currency area in DealScan to the total banking systems asset claims as indicated in the BIS Locational Banking Statistics (LBS). Figure B.7 in the Appendix presents the results for Australia, Canada, Switzerland, the EU, the United Kingdom and Japan. In all displayed currency areas, the total outstanding loan volume resulting from syndicated loans increased over time. There is some heterogeneity among the countries relating to the importance of syndicated loans for total cross-currency claims reflecting the diverse importance of debt contracts other than syndicated loans.

Overall, syndicated cross-currency loans that are denominated in USD make up a sizable part of cross-currency bank claims. The increasing trend in outstanding loans underlines that cross-currency syndicated loans are a significant source of capital flows between countries.

### 3.2. Empirical Approach

Our interest is in the estimation of the effect of changes in syndicated lending flows on exchange rates. A crucial starting point for the precise measurement of this elasticity is the measurement of net cross-currency lending flows.

*Measuring Net Cross-Currency Lending.* We define (the logarithm of) *Net Cross-Currency Lending*, denoted NCCL, of foreign country $c$ at time $t$ as follows

$$\text{NCCL}_{c,t} = \log(\text{loans}_{c,t}^{\text{USD}}) - \log(\text{loans}_{US,t}^{\text{c}}),$$

where $\text{loans}_{c,t}^{\text{USD}}$ denotes outstanding USD loans originated by foreign banks, and $\text{loans}_{US,t}^{\text{c}}$ denotes outstanding foreign currency $c$ loans granted by US banks.

In our empirical analysis, we look at the time series difference (Δ) between the value of the net cross-currency lending at the end of month $t$ and the value at the end of month $t-1$. An increase in $\text{NCCL}_{c,t}$ implies more USD lending of banks from currency area $c$ relative to US bank lending denominated in currency $c$.

A key challenge in our estimation is that global loan flows can affect exchange rates, but exchange rates can also affect loan flows. For example, exchange rates can affect the funding cost of loan origination, the profitability of lending in the foreign currency, or the loan demand by non-financial firms. This in turn would affect the flows which we observe and lead to endogeneity in our estimate of the effect of loan flows on the exchange rates.

To confront potential bias in the estimates of the elasticity of the exchange rate with respect to flows, we make use of the granular micro-level information obtained from the syndicated lending information in DealScan. As there is a high degree of heterogeneity among the market shares in USD lending across currency areas (as well as with foreign currency lending by US banks), our setting is suitable to deploy a granular instrumental variables (GIV) approach as suggested by Gabaix and Koijen (2021b). The idea of the GIV approach rests on the notion that changes in flows result from common shocks affecting all banks and idiosyncratic shocks affecting individual banks. Aggregate flows move more when large banks receive an idiosyncratic shock than when small banks are affected. This differential effect on aggregate flows can be used to estimate the exchange rate elasticity. By capturing the degree of large banks being affected by idiosyncratic shocks, the resulting measure correlates with changes in aggregate flows that are not affected by exchange rate shocks that affect all banks.

*Definition of the Instrument.* To obtain a measure of the degree of large banks being affected by idiosyncratic shocks, we use the difference of the value-weighted (i.e. weighting the flows by the market share of a bank) average and the equally weighted average of the net cross-currency flow variable. More specifically, this corresponds to the difference between the loan-volume weighted (i.e. taking into account a bank's market share) average flow of loans from banks in a currency area and the equally weighted average of the same flow.[15]

The resulting instrument exhibits a high correlation with the cross-currency loan flows, and, shows no relation to the spot exchange rate changes. We provide further evidence on the validity of the instrument in the Appendix.[16]

[15] Gabaix and Koijen (2021b) use a similar instrument in the context of flows between equity and bond markets to measure the effect on the valuation, see Gabaix and Koijen (2021a).

[16] In fact, the correlation between the GIV instrument and the spot exchange rate change is 0.04 and the corresponding correlation to the endogenous variable is 0.31. Gabaix and Koijen (2021b) show that the GIV instrument

For the inflow (from the US perspective) of loans, defined as non-US bank lending in USD, we take the difference between value-weighted and equally-weighted average of loans originated by banks from currency area $c$ denominated in USD as follows

$$\Delta_{c,t}^{\text{Inflow}} = \underbrace{\sum_{j \in C_c} \Delta l_{j,USD,t}^{c} \times w_{j,USD,t-1}^{c}}_{\text{Value-weighted average}} - \underbrace{\frac{1}{N_{C_c}} \sum_{j \in C_c} \Delta l_{j,USD,t}^{c}}_{\text{Equally-weighted average}}, \tag{5}$$

where $w_{j,USD,t-1}^{c}$ is the share of outstanding USD loans in the previous month of bank $j$ from a given currency area $c$ in USD lending of total outstanding USD loans in that month. $\Delta l_{j,USD,t}^{c}$ the change in the outstanding loans of bank $j$ that occurred until the end of month $t$ compared to month $t-1$. From this value-weighted average, we subtract the equally weighted average of outstanding loan changes, where $N_{C_c}$ denotes the number of foreign banks in the set $C_c$ of foreign banks that grant USD loans.

In an analogous manner, we perform this calculation for outflows, i.e. loans originated by US banks denominated in foreign currency $c$ at time $t$:

$$\Delta_{c,t}^{\text{Outflow}} = \underbrace{\sum_{j \in C_{US}} \Delta l_{j,c,t}^{US} \times w_{j,c,t-1}^{US}}_{\text{Value-weighted average}} - \underbrace{\frac{1}{N_{C_{US}}} \sum_{j \in C_{US}.} \Delta l_{j,US,t}^{c}}_{\text{Equally-weighted average}} \tag{6}$$

Having constructed the value- and equally-weighed differentials for outflows (USD lending of banks from currency area $c$) and inflows (foreign currency lending of US banks) according to Equations (5) and (6), we use their net, defined as

$$z_{c,t} = \Delta_{c,t}^{\text{Inflow}} - \Delta_{c,t}^{\text{Outflow}}, \tag{7}$$

as our instrument for net currency lending flows in our micro-level panel regression section. In particular, we estimate the following two-step IV panel procedure

$$\text{First stage: } \Delta\text{NCCL}_{c,t} = z_{c,t} + \text{Controls}_{c,t} + \varepsilon_{c,t},$$

$$\text{Second stage: } \Delta s_{c,t} = \phi \Delta\widehat{\text{NCCL}}_{c,t} + \text{Controls}_{c,t} + \vartheta_{c,t}, \tag{8}$$

is particularly efficient when the excess Herfindahl index defined as $h := \sqrt{-\frac{1}{N} + \sum_{i=1}^{N} S_i^2}$ is large. Figure B.8 in the Appendix plots the Herfindahl index $h$ for USD lending in the respective currency areas over time. All indices are sufficiently large to provide a precise estimate. Our GIV instrument consistently delivers values of the first stage F-test above 10 and thus our estimates do not suffer from a bias induced by a weak instrument as suggested by Stock and Yogo (2005).

where $\Delta\text{NCCL}_{c,t}$ is the previously defined net cross-currency bank lending measure. An increase in $\Delta\text{NCCL}_{c,t}$ means that there is a positive net flow *into* the USD, i.e. the volume of loans originated in USD by non-US banks from currency area $c$ increases compared to the foreign currency lending by US banks. $z_{c,t}$ denotes the GIV instrument that allows to obtain an unbiased estimate of the demand elasticity of more net flows into the USD and the related price increase, i.e. appreciation of the USD. As control variables, we include the first difference of the VIX, the first four principal components of CPI inflation, 5 and 10 year sovereign yield and the 3 month interbank rate as well as enrich our setting with country and year fixed effects. $\vartheta_{c,t}$ and $\varepsilon_{c,t}$ are idiosyncratic error terms.

In the first stage, we obtain the changes in the net cross-currency lending measure that can be attributed to changes resulting from idiosyncratic shocks to large banks as opposed to smaller ones. In the second stage we then use this variation to infer the effect of changes in the lending flows on changes in the spot exchange rate.

# 4. Global Bank Lending and Spot Exchange Rates

In this section, we document our main result: when non-US banks grant more cross-currency loans denominated in US dollar compared to the foreign currency-denominated lending of US banks, the US dollar appreciates significantly. In the following, we first document this main effect in Section 4.1 using a GIV approach to identify the exchange rate elasticity with respect to cross-currency lending flows. We also show that the importance of lending flows for exchange rates only emerged after the great financial crisis (GFC). We document a structural shift that occurred in the USD funding of non-US banks after the GFC that is plausibly related to this effect. This evidence suggests that conditions in funding markets and balance-sheet constraints of intermediaries drive the response of exchange rates to cross-currency lending flows. Guided by the predictions of our model in Section 2.2, we then move on to empirically investigate the impact of intermediary balance sheet constraints and constraints in funding markets on the elasticity of exchange rates in Section 4.2.

### 4.1. Cross-currency lending flows and exchange rate elasticity

We start by reporting full-sample estimates for our main specification in Eq. (8) and report results in Table 2 for different combinations of fixed effects as well as macroeconomic controls. Throughout all these specifications, we find a significant appreciation whenever we observe a rise in net lending flows into the USD. Notably, controlling for year fixed effects, currency fixed effects and economic fundamentals leaves the point estimate of the elasticity of exchange rates with respect to lending flows largely unchanged.

The results in column (8) with year and currency fixed effects as well as macroeconomic controls, show a statistically and economically significant effect of net foreign currency lending on exchange rates. An increase in foreign banks' outstanding USD loans by 100 bp in excess of foreign currency lending by US banks, results in an appreciation of the USD by 72 bp (annualized), which is economically meaningful. On the same note, a one standard deviation increase, which corresponds to a 42.25bn USD additional net lending flow into the USD, leads to an appreciation of the USD by 36 basis points.

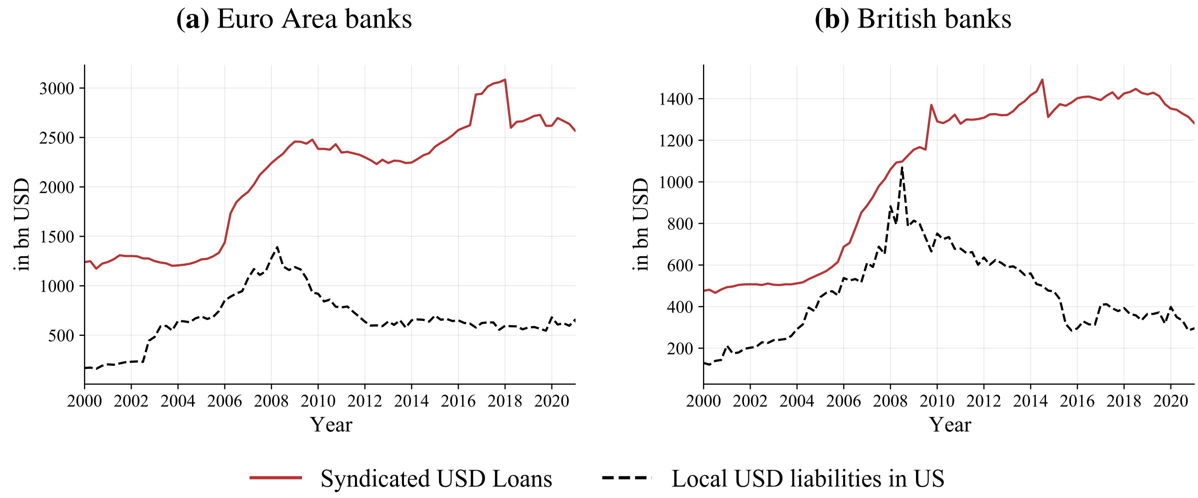
In sum, the results in Table 2 strongly support Implication 1 of our theoretical motivation in Section 2.2, i.e. that a rise in lending in a bank's foreign currency leads to an appreciation of the foreign currency.

**Table 2:** The exchange rate elasticity of net cross-currency lending flows

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| $\Delta\text{NCCL}_{c,t}$ | 81.06 | 66.87 | 82.23 | 73.37 | 95.63 | 72.33 | 96.17 | 72.33 |
| | (15.09) | (14.65) | (15.93) | (13.40) | (18.77) | (13.13) | (19.01) | (13.20) |
| Observations | 1266 | 1266 | 1266 | 1266 | 1184 | 1184 | 1184 | 1184 |
| Macro-controls | No | No | No | No | Yes | Yes | Yes | Yes |
| Currency FE | No | No | Yes | Yes | No | No | Yes | Yes |
| Year FE | No | Yes | No | Yes | No | Yes | No | Yes |
| Currency Areas | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Pseudo-$R^2$ | 0.03 | 0.09 | 0.05 | 0.10 | 0.07 | 0.12 | 0.09 | 0.15 |

*Notes:* HAC-robust standard errors in parentheses. We perform a Panel IV estimation with a granular instrument. The dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\Delta\text{NCCL}_{c,t}$ is the contemporaneous GIV instrumented difference between the USD syndicated lending of foreign banks and the logarithm of foreign currency syndicated lending of US banks. An increase in this measure implies that foreign banks lend more in USD than US banks in foreign currency. The first difference of the end of month VIX index is included in all regressions, but not reported. Macro-controls refers to the first four principal components extracted from CPI inflation, 5y and 10y government bond yields and 3 month interbank rates in the respective currency areas. The sample runs from 1997/01 to 2021/12 and includes the currencies AUD, CAD, CHF, CNY, DKK, EUR, GBP, JPY, KRW, MXN, NOK, SEK, SGD, ZAR. The coefficient describes the effect of a 100 bp increase in the lending measure on the spot exchange rate in annualized basis points.

**Figure 3:** USD syndicated loans in relation to local USD liabilities of non-US banks




*Notes*: This figure relates the volume of syndicated USD loans to local USD liabilities of banks from a given currency area. The data for the syndicated loans is obtained from LPC Refinitiv DealScan and the data on the local USD liabilities in the US is obtained from the confidential BIS Locational Banking Statistics by Nationality (LBSN) database. Euro Area banks refers to the banks domiciled in 11 Euro Area member countries. British banks refers to banks domiciled in the United Kingdom.

On a general level, both economic intuition and our theoretical motivation in Section 2.2, suggest that the elasticity of exchange rates with respect to global lending flows should have changed sharply after the Great Financial Crisis (GFC). First, the aftermath of the GFC saw the the implementation of tighter banking regulation, which raised constraints on banks and their affiliated broker-dealers to intermediate capital flows and derivatives transactions such as FX swaps. Second, the structure of dollar funding markets has changed notably, with a pronounced decline in unsecured interbank activity and a greater shift to non-bank sources. Both of these developments suggest tighter conditions in USD funding markets, which, according to our model, should result in a higher elasticity of exchange rates.

To highlight the structural shifts in USD funding markets that occured after the GFC in the context of our paper, Figure 3 plots outstanding volumes in cross-currency USD syndicated loans (solid line) and local USD liabilities by non-US banks (dashed line) for euro area and British banks. The latter can be seen as summarizing "conventional", on-balance sheet USD funding by foreign banks, such as USD deposits, commercial paper and certificates of deposit. As can be seen from Figure 3, conventional USD funding and syndicated steadily increase from 2000 until 2008. However, during the post-GFC period, cross-currency syndicated lending in USD continued to increase whereas local USD funding by non-US banks decreased significantly over the same period.

**Table 3:** Exchange rate elasticity before and after the GFC

| | Pre-GFC | | | Post-GFC | | |
|---|---|---|---|---|---|---|
| $\Delta \text{NCCL}_{c,t}$ | 26.63 | 14.40 | 18.90 | 125.6 | 110.4 | 71.95 |
| | (15.05) | (25.91) | (18.98) | (26.63) | (18.56) | (18.04) |
| Observations | 519 | 519 | 448 | 747 | 747 | 736 |
| Macro-controls | No | No | Yes | No | No | Yes |
| Currency FE | No | Yes | Yes | No | Yes | Yes |
| Year FE | No | Yes | Yes | No | Yes | Yes |
| Currency Areas | 10 | 10 | 8 | 14 | 14 | 14 |
| Pseudo-$R^2$ | 0.04 | 0.04 | 0.03 | 0.03 | 0.06 | 0.11 |

*Notes:* Pre-GFC refers to the time period before 2009/01, post-GFC refers to the subsequent time period. HAC-robust standard errors in parentheses. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\Delta \text{NCCL}_{c,t}$ is the contemporaneous GIV instrumented difference between the USD syndicated lending of foreign banks and the logarithm of foreign currency syndicated lending of US banks. An increase in this measure implies that foreign banks lend more in USD than US banks in foreign currency. The first difference of the end of month VIX index is included in all regressions, but not reported. Macro-controls refers to the first four principal components extracted from CPI inflation, 5y and 10y government bond yields and 3 month interbank rates in the respective currency areas. The sample runs from 1997/01 to 2021/12 and includes the currencies AUD, CAD, CHF, CNY, DKK, EUR, GBP, JPY, KRW, MXN, NOK, SEK, SGD, ZAR. The coefficient describes the effect of a 100 bp increase in the lending measure on the spot exchange rate in annualized bp.

This development implies that banks must increasingly rely on funding sources other than local USD liabilities in the US to finance USD-denominated loans, particularly syndicated ones. In situations where non-US banks are unable to secure direct USD funding (e.g., in the US interbank market), they may turn to FX swaps to obtain the requisite USD liquidity. This trend may explain the marked difference between pre- and post-GFC results documented in Table 3.[17]

To test whether such a structural shift has indeed affected the elasticity of exchange rates, we partition our sample into pre- and post-GFC, with the cut-off set at January 2009. The results, reported in Table 3, indicate that the effect is only statistically and economically significant after the GFC when comparing columns (3) and (6) with fixed effects and controls. Conversely, no statistically significant effect is discernible in the pre-GFC period. A further test on the difference between the two coefficients confirms a statistically significant higher coefficient in the post-GFC sample.

We take this finding as strong evidence that developments since the GFC have greatly increased the importance of lending flows for exchange rates. Moreover, this structural change in the importance of flows can likely be traced to intermediary and funding market constraints

[17] It is worth noting that the amplified funding of syndicated loans through FX swaps as delineated in Section 2.1 could be a contributing factor to the growing trend in off-balance sheet USD debt, as evidenced in Borio *et al.* (2022).

and frictions as suggested by Figure 3 above.

In the remainder of this section, we thus dig deeper into the exact mechanisms that drive the elasticity of exchange rates with respect to global lending flows. More specifically, we begin by examining the role of broker-dealer leverage before analyzing the impact of dollar funding tightness and funding conditions more broadly. We examine domestic and global USD funding markets but pay particular attention to the latter since the post-GFC period has been characterized by recurring instances of dollar funding tightness, which have forced banks to rely more heavily on FX swaps to obtain dollars (e.g. Correa *et al.* (2020).

## 4.2. Impact of funding constraints

In the following, we will highlight differences in the funding conditions resulting from differences arising from broker-dealer leverage constraints (Section 4.2.1), the US monetary policy stance (Section 4.2.2), funding scarcity and concentration (Section 4.2.3) in the US, and cross-country differences in USD funding (Section 4.2.4).

### 4.2.1. Impact of broker-dealer leverage

Besides a structural shift in funding markets, another major factor that could be driving the change in the elasticity of exchange rates to lending flows are intermediary balance sheet constraints. In this context, (e.g. Gabaix and Maggiori, 2015) suggest that tighter balance sheet constraints of intermediaries (as introduced after the GFC) can have a bearing on the exchange rate, which is generally in line with our findings in Table 3. Du *et al.* (2018b) in turn trace violations of the CIP (arbitrage) condition to balance sheet constraints. To shed light on the possible impact of such constraints, we examine the role of broker-dealer leverage more explicitly in the following.

Following the financial crisis several regulatory reforms, which culminated in the Basel III capital accord, implied tighter capital constraints for broker-dealers. For example, the implementation of a Tier 1 leverage ratio requires large banks to hold sufficient capital against their total leverage exposure. This makes balance sheet space costly and constrains the bank in its provision of certain on-balance sheet activities, e.g. FX repo transactions.

**Table 4:** Exchange rate elasticity and broker-dealer constraints

| | Low Leverage | High Leverage |
|---|---|---|
| $\Delta$NCCL$_{c,t}$ | 78.29 | -35.31 |
| | (25.65) | (76.72) |
| Observations | 774 | 410 |
| Macro-controls | Yes | Yes |
| Currency FE | Yes | Yes |
| Year FE | Yes | Yes |
| Currency Areas | 12 | 13 |
| Pseudo-$R^2$ | 0.04 | 0.06 |

*Notes:* HAC-robust standard errors in parentheses. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\Delta$NCCL$_{c,t}$ is the contemporaneous GIV instrumented difference between the USD syndicated lending of foreign banks and the logarithm of foreign currency syndicated lending of US banks. An increase in this measure implies that foreign banks lend more in USD than US banks lend in foreign currency. We obtain data on the leverage and capital ratio from He *et al.* (2017). A high (low) leverage ratio period corresponds to times with above (below) average in the leverage measure. The first difference of the end of month VIX index is included as control variable, but not reported. Macro-controls refers to the first four principal components extracted from CPI inflation, 5y and 10y government bond yields and 3 month interbank rates in the respective currency areas. The sample runs from 1997/01 to 2021/12 and includes the currencies AUD, CAD, CHF, CNY, DKK, EUR, GBP, JPY, KRW, MXN, NOK, SEK, SGD, ZAR. The coefficient describes the effect of a 100 bp increase in the lending measure on the spot exchange rate in annualized basis points.

FX swaps are off-balance sheet items. However, under Basel III these are converted into "credit exposure equivalents" through the use of credit conversion factors (CCFs).[18] Larger off-balance sheet activity resulting e.g. from greater FX swap activities, thereby leads to larger operative constraints for liquidity providing intermediaries. Consequentially, we would expect to observe that the elasticity of exchange rates is higher when broker-dealers are more constrained, which corresponds to Implication 2 of our theoretical motivation in Section 2.2.

To test this, we analyze broker-dealer leverage and their interaction with the exchange rate elasticity. To that end, we draw on the measures of broker-dealer leverage as proposed by He *et al.* (2017). More specifically, we look at the leverage ratio measure, defined as the ratio of total financial assets to the difference between total financial assets and total liabilities in the broker-dealer sector, as conceptualized by Adrian *et al.* (2014).

We compare time periods in which banks exhibit low leverage ratios (below average) to times in which the leverage ratio is above average. Table 4 presents the results and shows that exchange rates react more strongly to flows when leverage is low. An explanation for this could be that low leverage of broker-dealers implies that these entities are more balance-sheet constrained.

[18] More information is provided in the Basel III leverage ratio framework and disclosure requirements (Basel Committee on Banking Supervision (BCBS) (2014)).

Table 4 shows that such times go hand in hand with a higher exchange rate elasticity as implied by Implication 2 of our model (higher balance cost of intermediaries increases the exchange rate elasticity) and it is is conceptually well in line with the mechanism outlined in Gabaix and Maggiori (2015). As the funding constraints of intermediaries also critically depend on the US monetary policy stance, we look at the role the US monetary policy cycle plays for the exchange rate elasticity in the following.

#### 4.2.2. The role of US monetary policy cycles and funding conditions

Another important determinant of USD liquidity provision to non-US banks is the state of financial conditions in the US banking system more generally. If the Federal Open Market Committee (FOMC) tightens monetary conditions at the time of foreign USD-denominated loan origination, competition for funds intensifies. Drechsler *et al.* (2017) demonstrate that US banks hold a market power advantage over deposits. As a result, foreign banks are required to seek alternative sources of funding, such as the commercial paper/certificate of deposit market, leading to higher costs and a disadvantage relative to US banks. This would result in a higher exchange rate elasticity, aligning with Implication 3 of the theoretical framework, which posits that higher USD wholesale funding rates result in a larger appreciation of the USD.

To validate our hypothesis, we divide our sample into monetary policy cycles characterized as "hiking", "easing", or "no change" as depicted in Figure A.1. Our objective is to examine the impact of changes in funding market conditions over the monetary policy cycle on the exchange rate elasticity with respect to global loan flows. In accordance with Implication 3 of our model, we expect that tighter USD funding conditions (i.e., during a hiking cycle) for banks lacking direct USD funding access will amplify the impact of loan flows on exchange rates.

Table 5 categorizes the sample periods based on monetary policy cycles and demonstrates that the impact is most prominent during the Federal Reserve's interest rate hike periods. The results, as compared to the baseline findings in Table 2 column (8), exhibit a larger effect. Hence, a rise in federal fund rates leads to an increase in the exchange rate elasticity with respect to cross-currency lending flows, supporting Implication 3 of our model outlined in Section 2.2.

To better understand the impact of funding market conditions on the elasticity of exchange rates, we also study deviations from covered interest parity (CIP). A substantial body of literature has demonstrated that the tightness of funding markets is closely related to CIP deviations (Rime *et al.*, 2022) and that post-financial crisis bank regulation has exacerbated funding stress in the FX swap market (e.g. Du *et al.*, 2018b; Correa *et al.*, 2020).

To investigate the effect of USD funding market tightness on the exchange rate's elasticity with respect to lending flows, we categorize our sample period into different buckets based on the magnitude of the negative CIP deviation observed after the global financial crisis. The CIP deviation is a measure of the synthetic cost of obtaining USD funding, i.e. borrowing foreign currency, swapping it for USD and then selling it forward, compared to direct USD funding costs. The more negative the CIP deviation, the more costly it is to access USD via FX swaps in comparison to direct USD borrowing.[19]

We divide our sample into two groups, one with 'small' negative CIP deviations (between -25 and -50 basis points) and another with 'large' negative CIP deviations (below -50 basis points), and then analyze the 3-month term. The results presented in columns (4) and (5) of Table 5 indicate that when USD funding markets are tight (i.e. CIP deviations are large), the exchange rate elasticity is higher. Thus, stress in the USD funding markets directly shapes the exchange rate elasticity when more lending flows into USD.

**Table 5:** Exchange rate elasticity and US monetary/funding conditions

| | Fed Cycle | | | CIP deviation (3M) | |
|---|---|---|---|---|---|
| | Hike | No Change | Ease | Small | Large |
| $\Delta \text{NCCL}_{c,t}$ | 100.9 | 21.20 | -22.38 | 33.60 | 112.7 |
| | (18.87) | (49.83) | (144.7) | (53.93) | (51.93) |
| Observations | 332 | 629 | 223 | 189 | 73 |
| Macro-controls | Yes | Yes | Yes | Yes | Yes |
| Currency FE | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Currency Areas | 11 | 13 | 10 | 7 | 8 |
| Pseudo-$R^2$ | 0.06 | 0.10 | 0 | 0.02 | 0.05 |

*Notes:* HAC-robust standard errors in parentheses. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\Delta \text{NCCL}_{c,t}$ is the contemporaneous GIV instrumented difference between the USD syndicated lending of foreign banks and the logarithm of foreign currency syndicated lending of US banks. An increase in this measure implies that foreign banks lend more in USD compared to what US banks lend in foreign currency. 'Hike' refers to time periods with an increasing federal funds rate, 'No Change' refers to periods with moderate or no change in the federal funds rate and 'Ease' refers to a declining federal funds rate. "Small" refers to the CIP deviation being between -50 and -25bp, as defined in Section B.2. "Large" means that the 3M CIP deviation is below -50bp. The CIP deviation is defined as the cross-currency basis describing the difference between direct USD borrowing cost and synthetic USD borrowing cost. A negative CIP deviation implies higher synthetic than direct USD borrowing cost. The first difference of the end of month VIX index is included as control variable, but not reported. Macro-controls refers to the first four principal components extracted from CPI inflation, 5y and 10y government bond yields and 3 month interbank rates in the respective currency areas. The sample runs from 1997/01 to 2021/12 and includes the currencies AUD, CAD, CHF, CNY, DKK, EUR, GBP, JPY, KRW, MXN, NOK, SEK, SGD, ZAR. The coefficient describes the effect of a 100 bp increase in the lending measure on the spot exchange rate in annualized basis points.

[19] We provide details on CIP and the computation of CIP deviations in Appendix B.2. We also dig deeper into the relation between funding costs, net cross-currency loan growth, and CIP deviations in Section 5 below.

### 4.2.3. USD funding scarcity and concentration

To further explore the impact of funding conditions on exchange rates, we examine the role of direct borrowing in USD as a source of funding for non-US banks. As previously discussed, if US banks have ample liquidity and are able to easily provide funding to non-US banks, we would expect the exchange rate elasticity to be lower than in circumstances where US banks are more constrained in their ability to provide liquidity.

To test this hypothesis, we use balance sheet information of US banks obtained from the Federal Financial Institutions Examination Council (FFIEC) through call reports. As Correa *et al.* (2020) show, the largest US banks operate as reserve distributors to other (especially foreign) banks. We, therefore, focus on the largest 30 banking institutions in the US and relate their reserve holdings at the Fed to their total (risk-weighted) assets to obtain a measure of "reserve abundance" for the time period after January 2009. Figure A.2 in the Appendix defines periods of high and low shares of reserves relative to total risk-weighted assets.

Table 6 shows that when the share of reserves to total risk-weighted assets is low, i.e. US banks have less liquidity to distribute to other (foreign) banks, the exchange rate elasticity is higher. This suggests that when US banks have limited liquidity to distribute, the cost of providing USD funding rises, which leads to a stronger appreciation of the USD.

To further analyze the effect, we examine the relationship between the share of loans granted to foreign banks and the exchange rate elasticity. The share of loans granted to foreign banks, either in the US through a branch or abroad, is a crucial factor in determining the amount of USD liquidity supplied to non-US banks in interbank markets. In turn, this affects the need for non-US banks to obtain USD liquidity from the FX swap market. Figure A.3 in the Appendix defines periods of high and low shares of loans granted to foreign banks. The results in Table 6 confirm that, as expected, when the share of loans granted to foreign banks is low, the exchange rate elasticity is higher. This supports the hypothesis that a lower availability of USD liquidity supplied by US banks to non-US banks leads to higher demand for USD liquidity obtained through the FX swap market, thereby resulting in higher exchange rate elasticity.

The 2019 spike in US repo rates (cf. Correa *et al.*, 2020) has shown that not only the general availability of liquidity (i.e. reserves at the Fed in this case), but also its distribution across banks can play a key role for liquidity provision. Intuitively, for any given level of reserves, if only a few large banks hold most of the reserves and are unwilling to lend them out, there might be detrimental effects on smaller and/or foreign banks that cannot access (claims on) reserves

**Table 6:** Exchange rate elasticity and US bank funding scarcity measures

| | Share of reserves | | Share of loans to foreign banks | | Reserve concentration | |
|---|---|---|---|---|---|---|
| | High | Low | High | Low | High | Low |
| $\Delta \text{NCCL}_{c,t}$ | -68.43 | 98.69 | -0.803 | 134.7 | 79.63 | 47.85 |
| | (50.51) | (22.88) | (48.34) | (38.17) | (29.88) | (34.43) |
| Observations | 338 | 393 | 459 | 277 | 395 | 341 |
| Macro-controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Currency FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Currency Area | 12 | 12 | 14 | 11 | 13 | 12 |
| Pseudo-$R^2$ | 0.10 | 0.09 | 0.10 | 0.07 | 0.11 | 0.07 |

*Notes:* HAC-robust standard errors in parentheses. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\Delta \text{NCCL}_{c,t}$ is the contemporaneous GIV instrumented difference between the USD syndicated lending of foreign banks and the logarithm of foreign currency syndicated lending of US banks. An increase in this measure implies that foreign banks lend more in USD than US banks lend in foreign currency. The periods of high share of reserves and loans to foreign banks (in relation to risk-weighted assets) are defined in Appendix A. A high concentration of reserves refers to the HHI index for the concentration of reserves within the group of 30 largest US banks, see Appendix A for a concrete definition. The first difference of the end of month VIX index is included as control variable, but not reported. Macro-controls refers to the first four principal components extracted from CPI inflation, 5y and 10y government bond yields and 3 month interbank rates in the respective currency areas. The sample runs from 1997/01 to 2021/12 and includes the currencies AUD, CAD, CHF, CNY, DKK, EUR, GBP, JPY, KRW, MXN, NOK, SEK, SGD, ZAR. The coefficient describes the effect of a 100 bp increase in the lending measure on the spot exchange rate in annualized basis points.

other than through these large banks. Therefore, we would expect that a higher concentration of reserves among the major US banks leads to difficulties for foreign banks in obtaining USD funding, resulting in an increase in the exchange rate elasticity.

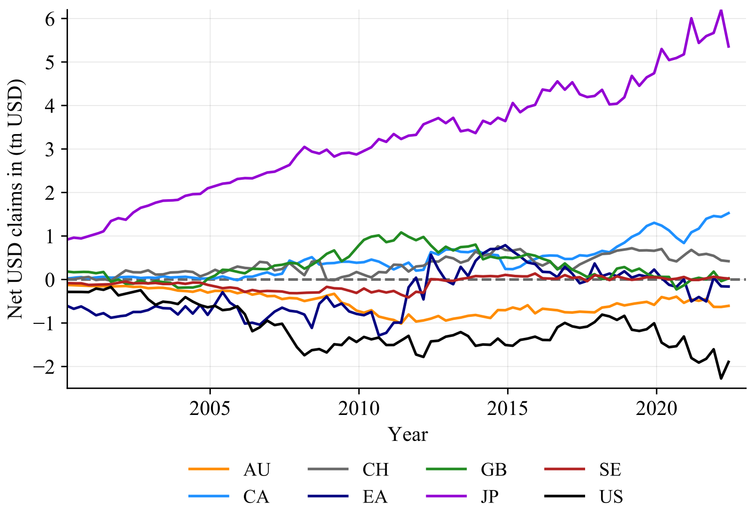
To test this implication, we compute the Herfindahl-Hirschman index to quantify the concentration of reserves among the top 30 largest US banks. Our findings, as displayed in Table 6, indicate that when the concentration of reserves is high among the top 30 US banks, exchange rates are significantly affected by lending flows and that the elasticity is notably higher compared to instances of low reserve concentration.

Overall, and across the different measures of funding tightness we have explored so far, we find that the stance of the Fed's monetary policy exerts the strongest impact on the elasticity of exchange rates. More specifically, when US monetary conditions tighten, funding market conditions also tighten, leading to a greater impact on the exchange rate. A possible explanation for this is that money market funds receive inflows during periods of monetary tightening, see e.g. Kacperczyk and Schnabl (2013). This can decrease available USD funding liquidity for foreign banks, and lead to a greater impact on the exchange rate elasticity. Building on these insights, we look at structural differences between countries in their reliance on USD funding in the next subsection.

### 4.2.4. Impact of cross-country differences in USD funding

Different currency areas have different degrees of reliance on USD-denominated assets and liabilities. For instance, Australian banks have historically accumulated more USD liabilities than USD claims, meaning that they have acquired a larger amount of USD funding than what was needed to acquire USD claims. As a result, these banks can act as USD providers in FX swaps, or more readily extend USD-denominated loans, as they do not have to obtain USD liquidity prior to lending. This contrasts with banks in other currency areas that may have to rely on FX swaps to obtain the necessary USD liquidity. As a consequence, we anticipate that the exchange rate will be less responsive to cross-currency lending flows in currency areas that are net providers of USD in FX swaps.

**Figure 4:** USD funding providers and receivers over time




*Notes:* This figure depicts the difference between USD claims and liabilities by nationality of a bank over time. Positive values indicate that banks from this country have more USD claims than liabilities and are thus net USD *receivers*, i.e. they receive USD in an FX swap. Conversely, negative values correspond to the banking sector having more USD funding than acquired assets and thus serving as net *providers* of USD to banks from other countries. The data has been obtained from the BIS LBSN database by aggregating USD claims (liabilities) across bank and non-bank counterparties and adding local currency claims (liabilities) vis-à-vis all sectors in the US for the time period 2000/01-2022/12.

To determine whether these funding disparities between currency areas influence the exchange rate elasticity, we utilize data from the confidential Locational Banking Statistics by Nationality (LBSN) data base maintained by the BIS. We calculate the difference between outstanding USD claims and USD liabilities of banks from a specific currency area vis-à-vis the banking sector, and non-bank sector. For non-US banks, we also include local claims and liabilities in the US with all sectors as counterparties.

To illustrate our point, we present the disparity between USD denominated claims and liabilities of a various currency areas in Figure 4. Australian banks consistently exhibit the largest positive difference between their USD liabilities and claims, thereby indicating their potential as providers of USD swap funding. To account for funding disparities among banks from different currency areas, we divide our sample into two groups based on their net USD provision: positive and negative.

The results shown in Table 7 indicate that there is no significant effect of foreign currency lending on exchange rates for countries whose banking systems possess a net USD surplus. Conversely, there is a notable effect of net foreign currency lending flows on exchange rates of countries with a net USD deficit. These results are intuitive, as the latter are required to resort to the FX swap market to finance their foreign currency lending, while the former do not.

These findings are particularly noteworthy in light of the conclusions reached in Avdjiev *et al.* (2019), as they demonstrate that it is not solely a strong dollar that influences USD denominated cross-border lending, but rather persistent cross-country patterns, such as whether a currency area's banking system is a net receiver or supplier of USD, also play a crucial role.

**Table 7:** Exchange rate elasticity accounting for country-level USD funding differences

| | Net USD surplus | Net USD deficit |
|---|---|---|
| $\Delta\text{NCCL}_{c,t}$ | -53.84 | 84.75 |
| | (88.69) | (12.60) |
| Observations | 441 | 638 |
| Macro-controls | Yes | Yes |
| Currency FE | Yes | Yes |
| Year FE | Yes | Yes |
| Currency Areas | 5 | 6 |
| Pseudo-$R^2$ | 0.110 | 0.110 |

*Notes:* HAC-robust standard errors in parentheses. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\Delta\text{NCCL}_{c,t}$ is the contemporaneous GIV instrumented difference between the USD syndicated lending of foreign banks and the logarithm of foreign currency syndicated lending of US banks. An increase in this measure implies that foreign banks lend more in USD than US banks lend in foreign currency. The first difference of the end of month VIX index is included as control variable, but not reported. Macro-controls refers to the first four principal components extracted from CPI inflation, 5y and 10y government bond yields and 3 month interbank rates in the respective currency areas. The sample runs from 1997/01 to 2021/12 and includes the currencies AUD, CAD, CHF, EUR, GBP, JPY, SEK. The coefficient describes the effect of a 100 bp increase in the lending measure on the spot exchange rate in annualized basis points. Net USD providers are countries whose banks show more USD liabilities than claims on aggregate. Conversely, USD receivers are countries with more USD claims than USD liabilities. When the bank is from a country where the banking system serves as net USD provider, no USD liquidity needs to be acquired via FX swaps, which explains the absence of an effect. In USD receiver countries we indeed find a stronger effect compared to our baseline.

In this section, we have so far disregarded the potential feedback effects of cross-currency lending flows on the underlying funding markets. To explore this possibility, we turn our attention to the effect of lending flows on funding conditions, both domestically and globally in the next section. By doing so, we hope to gain a more complete understanding of the factors that shape exchange rate determination. Specifically, we seek to examine whether increased cross-currency lending flows are indicative of tighter funding conditions, and whether this has a subsequent effect on exchange rate movements.

# 5. Global Bank Lending and USD Funding Markets

When global banks pay out a loan in a currency in which they do not have direct access to deposits, they obtain the necessary liquidity by swapping liquidity denominated in their home currency for the denomination currency of the loan, see Figure 1 for a graphical illustration. In the following, we show that increased net lending flows into the USD affect the cross currency basis of the currency area vis-à-vis the USD in which the bank is headquartered in the month of the loan origination.

In Subsection 5.1, we calculate the effect of the net cross-country loan flow measure on the cross currency basis measured as deviation from the CIP condition. Our results show that the basis is significantly affected at a 3 month term, the term that most banks use to acquire and roll over foreign currency funding, see Section 2.

In addition, in Subsection 5.2, we explore whether some banks turn to the CP/CD market to obtain USD funding instead of relying on FX swap funding, which carries higher costs associated with rolling over.

## 5.1. Lending flows and the term structure of CIP deviations

We follow Du *et al.* (2018b) and define the cross-currency basis,$x_{t,t+n}$, in log form as

$$x_{t,t+n} = y^{\$}_{t,t+n} - \left(y_{t,t+n} - \rho_{t,t+n}\right), \tag{9}$$

where the basis $x_{t,t+n}$ is the difference between the *direct* USD borrowing cost, $y^{\$}_{t,t+n}$, and the *synthetic* USD borrowing cost, $\left(y_{t,t+n} - \rho_{t,t+n}\right)$. The forward premium $\rho_{t,t+n}$, is defined as $\rho_{t,t+n} \equiv \frac{1}{n}\left(f_{t,t+n} - s_t\right) = y_{t,t+n} - y^{\$}_{t,t+n}$.

A negative currency basis implies tightness of funding conditions in USD in that the synthetic

USD borrowing cost implied by borrowing in the foreign currency and exchanging spot while agreeing on a forward purchase of the foreign currency after term $n$ is higher than the direct USD borrowing cost.

As a measure for the risk-free rate, we use the OIS rate for terms 1M, 3M, 6M, 9M, 1Y, 2Y, 3Y. We obtain data from Refinitiv Eikon on the OIS rates, spot and forward rates on a monthly basis (end of month). Our sample spans the currencies AUD, CAD, CHF, DKK, EUR, GBP, JPY, and SEK for the time period 04/2010 to 08/2021.

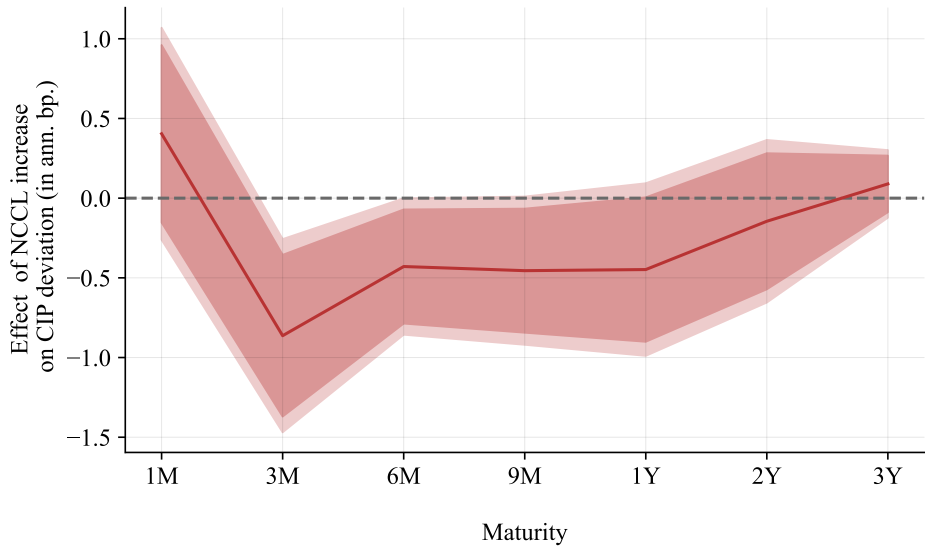
We analyze how changes in the net cross-currency lending by global banks affects the CIP deviation across terms from 1 month to 3 years. When CIP deviations are wide, this implies stressed USD funding markets. As this might also resonate in lower lending of foreign banks in USD, we need to rely again on an exogenous measure that affects lending, but not directly the CIP deviation. Given the detailed information we obtain from the syndicated lending data, as in Section 4, we rely on the GIV estimation approach as suggested by Gabaix and Koijen (2021b). Therefore, the regression equations read as follows

$$\begin{aligned} \Delta \text{NCCL}_{c,t} &= z_{c,t} + \text{Controls}_{c,t} + \varepsilon_{c,t}, \\ \text{CIP deviation}_{n,c,t} &= \phi \widehat{\Delta \text{NCCL}_{c,t}} + \text{Controls}_{c,t} + \vartheta_{c,t}, \end{aligned} \tag{10}$$

where the dependent variable is CIP deviation$_{n,c,t}$, the cross currency basis for term $n$. $\Delta\text{NCCL}_{c,t}$ is the previously defined relative cross-currency bank lending measure. An increase in $\Delta\text{NCCL}_{c,t}$ means that foreign banks grant more USD loans than US banks grant loans in the respective FC. $z_{c,t}$ is the GIV instrument defined in equation (7). We include the first four principal components of CPI inflation, 5 and 10 year sovereign yield and the 3 month interbank rate, and the first difference of the VIX measure as control variables and country and year fixed effects. $\vartheta_{c,t}$ is an idiosyncratic error term. To mitigate the effect of outliers, we exclude values above the 99th percentile and below the 1st percentile.

Figure 5 shows the effect of increasing net cross-currency bank lending on the CIP deviation across different maturities. Notice that a negative effect of an increase in net cross-currency lending implies a wider (negative) deviation of the CIP condition. The most significant (negative) effect occurs at a term of three month. When net lending flows into the USD increases by one standard deviation, the estimated coefficient implies that the CIP deviation decreases by around 4.8 annualized basis points, an economically significant amount.

**Figure 5:** Effect of net cross-currency lending on CIP deviation




*Notes:* This figure illustrates the effect of differential global bank lending on the CIP deviation. For a term of 3M the effect implies that when foreign banks grant more USD loans than US banks grant FC loans, the CIP deviation decreases, i.e. synthetic borrowing costs increase compared to direct USD borrowing costs. For a one standard deviation increase in the lending measure, the CIP deviation decreases by around 4.8 annualized basis points. The (light) red area indicates the (95) 90% confidence intervals.

When banks obtain short-term liquidity, they commonly do so via FX swaps with a maturity of three months. If non-US banks expand their USD lending more than their US counterparts in the respective foreign currency, the imbalance in demand for FX swaps would thus be most visible at a three month maturity. Indeed the graphical illustration in Figure 5 shows that whereas there is an effect for slightly longer maturities as well, the largest and most significant effect on the CIP deviation occurs at a three month maturity, implying that increased lending has a bearing on the (widening of the) CIP deviation as well. Net lending flows into the USD thus exacerbate stress in the USD funding markets.

This finding validates the prediction in Implication 4 of our model in Section 2.2 that when foreign banks increase their loan supply, the CIP deviation widens. Our findings corroborate the proposed triangular relationship between the dollar strength, CIP deviations and USD lending in Avdjiev *et al.* (2019). They show that a stronger dollar leads to wider CIP deviations, which contracts USD denominated cross-border lending. In contrast, we find that the funding of loans widens the CIP deviation directly, as well as leads to an appreciation of the USD. USD denominated lending, thus, is an important factor for the determination of the CIP deviation and strength of the USD.

Foreign banks can obtain USD liquidity not only via FX swaps, but can also acquire liquidity for longer horizons via USD CP and CD issuance instead. Whereas it appears unlikely that banks issue a CP or CD for each syndicated loan they originate, they could obtain funding via FX swaps in the short-run and substitute rolling-over the FX swaps by issuing more USD CPs and CDs. This would also imply a lower effect of syndicated USD denominated lending on the exchange rate and CIP deviation. To analyze whether foreign banks indeed issue USD CPs and CDS, we study USD CP and CD issuance more closely in the next section.

### 5.2. Cross-Currency Lending and USD Funding Markets

Non-US banks can acquire USD liquidity via a multitude of instruments and funding sources. The most common liquidity acquisition mechanism is either via FX swaps (see Section 2), or by placing USD-denominated commercial paper (CP) and certificates of deposits (CD) with money market funds. In comparison to continuously rolling-over FX swaps to obtain USD liquidity, placing CPs or CDs with longer maturities at money market funds, however, requires preparation and might only be available to banks with sufficiently high credit ratings or with an investor base willing to hold their debt instruments. However, if banks can place their CPs or CDs, the cost of obtaining USD liquidity is lower and thus preferable to FX swap funding.

To investigate whether banks rely on USD CPs and CDs to (at least partially) fund USD denominated syndicated loans, we obtain information on all available active and inactive CPs and CDs from Refinitiv Eikon issued between 2009 and 2021. We focus on the post-GFC period since USD interbank lending dried up after the GFC, creating the necessity to explore alternative USD funding sources such as FX swaps or the issuance of paper, see e.g. Rime *et al.* (2022).

Within a given currency area, we would expect a higher need for USD funding when more banks grant USD denominated loans. In Section 4, we show that increased USD funding leads to an appreciation of the USD in comparison to the home currency of the bank. Based on the discussion above, more USD denominated cross-currency loans might thus lead to an increase in USD denominated CP and CD issuance as well.

USD money markets are segmented, see e.g. Rime *et al.* (2022). This prevents banks with lower credit ratings to place their CPs and CDs with money market funds. These banks can (if at all) only place their debt instruments under higher cost, which might prevent them from obtaining USD liquidity via the USD money market in the first place. We would expect these banks to rely on the FX swap market to a larger extent than their competitors that can tap the USD money market.

To test for such a differential effect between banks with high and low ratings, we split our sample into two buckets depending on whether they are above or below the average rating.[20] We then analyze the effect of increases in the USD outstanding loans in a given currency area on the issuance growth within the group of high (above average) or low (below average) rated banks.

More specifically, we calculate monthly changes in outstanding USD denominated loans granted by banks from a given currency area $c$ and estimate the following panel regression separately for banks with above and below average ratings:

$$\Delta(\text{CP+CD})_{c,t+i} = \Delta\text{USD Lending}_{c,t} + \text{Controls}_{c,t} + \vartheta_{c,t}, \tag{11}$$

where $\Delta(\text{CP+CD })_{c,t}$ is the change in the logarithm of outstanding USD CPs and CDs at the end of month $t$ within currency area $c$. $\Delta\text{USD Lending}_{c,t}$ is the change in the logarithm of outstanding USD loans originated within currency area $c$. We control for the state of macroeconomic factors by including the first four principal components of CPI inflation, 5 and 10 year sovereign yield and the 3 month interbank rate, a currency area and year-month fixed effect. Following Jordà (2005), we run this regression as a local linear projections where the dependent variable is the difference between the previous month's value and the value $i = 0, 1, ..., 18$ months ahead. Thereby, we can better understand the short- and long-term response of CP and CD funding to changes in USD lending.

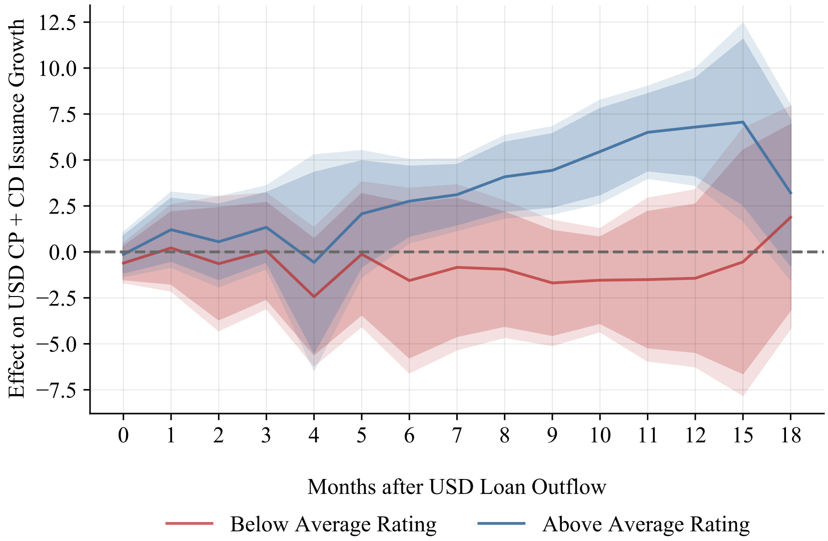
Figure 6 plots the results of this exercise. As expected, banks with below average credit ratings do not increase their USD CP and CD issuance following an increase in USD lending, presumably because their rating prevents them from tapping this market. However, we find that banks with above-average credit ratings indeed significantly increase their USD CP and CD issuance starting around 6 months after the increase in USD denominated loans.

Banks appear to experience a significant time lag after large loan flows into the USD from a particular currency area before increasing their CP and CD issuance volume. This lag could be due to factors such as preparation for the issuance or the bank's preference to continue rolling over FX swaps before exploring other funding sources. The time lag of six months observed in Figure 6 corresponds with market participants' comments, which suggest that banks often roll short-term funding until a specific threshold is met before securing a larger batch of long-term USD funding, depending on the bank's risk management practices.

[20]The necessary rating information of the issuer is obtained from Refinitiv Eikon.

The response of USD-denominated CP and CD issuance to changes in USD lending is economically significant, with a 1% increase in the growth of USD loans resulting in approximately a 5% increase in USD-denominated CPs and CDs issuance.

**Figure 6:** Effect of loan flows into USD on USD CP and CD issuance




*Notes:* This figure depicts the effect of USD lending within a country on subsequent commercial paper (CP) and certificate of deposit (CD) of banks from this country. A coefficient of 1 implies that a 1% increase in USD lending growth affects the growth in issuance of CDs and CPs in equal amount. The currency areas included are AUD, CAD, CNY, DKK, EUR, GBP, JPY, NOK, SEK, SGD. Blue presents the reaction of banks with above average credit rating, red shows the reaction of banks with below average rating.

# 6. Robustness

To demonstrate the robustness of our findings, we first utilize an alternative, economically easier to interpret instrument instead of the Granular IV we deployed in our main analysis. Second, we explore effect on exchange rates beyond the spot exchange rate by analyzing the impact on forward rates.

## 6.1. Lending tightness as an alternative instrument

Finding an instrument that only impacts cross-currency loan flows but not exchange rates is challenging because most potential candidates can also affect overall economic conditions and thus exchange rates over time. To overcome this issue, the GIV used in our empirical analysis so far provides a suitable identification mechanism for studying the impact of cross-currency loan flows on exchange rates. However, to test for the robustness of our main finding, we also construct an alternative instrument that is based on a shift in credit lending conditions but uncorrelated with exchange rate changes This alternative instrument offers a clearer economic interpretation, but has limitations in terms of the sample of countries and the time period that can be covered in our estimation.

Specifically, we utilize the EBA capital exercise as a quasi-natural experiment. The EBA capital exercise, conducted in 2011/2012, mandated the largest European banks to raise their capital ratios by the end of June 2012. As this only affected European banks, we employ our global lending data to analyze the differential impact of lending on the exchange rate of European banks in comparison to banks in the United Kingdom and Canada.[21]

We gather data on the (expected) lending conditions banks anticipate to face from central bank surveys (Bank Lending Survey for the Euro area, Senior Loan Officer Survey for Canada, and Credit Conditions Survey for the UK). These surveys capture the anticipated lending conditions by senior lending officers. We use the respective proxies for the expected lending demand to capture the loan demand banks anticipate within the near future. Additionally, we obtain information on average bank balance sheet characteristics from Bank Focus.

We then define the alternative instrument, which we label "Lending tightness" as follows

$$\text{Lending tightness}_{c,t} = \text{lending conditions}_{c,t-3} \times \text{Tier 1 capital}_{c,t} \times \mathbb{1}_{c,t}^{EBA}.$$

We exert that country-level lending tightness is affected by three factors, (i) the (expected) demand for loans extracted from the central bank survey (lagged by one quarter to make expectation and actual estimation period coincide), (ii) the (log of) average Tier 1 capital holdings of banks, and (iii) whether the banks had to comply with the EBA capital exercise rules (binary variable being 1 for respective banks from July 2012 to March 2013).

Higher values in the lending conditions variable reflect worse expected lending conditions. Requiring European banks to withhold more capital should lead to lower lending (compared to their Canadian and British peers), as the capital needed for lending might be restricted by having to comply with the capital ruling. This is in line with Gropp *et al.* (2019), who find that banks reduced their lending in the context of the EBA capital exercise. The last factor takes on the value 1 if the currency area is subject to the EBA capital exercise. In sum, we would thus expect a negative effect of the lending tightness measure on cross-border lending in the first stage of our later estimation, as higher values in the lending tightness measure imply worse

[21] We restrict our attention to banks from these countries as they are most similar and comparable lending condition surveys are available for our period of interest.

lending conditions for banks. We restrict our sample to the time period 06/2011 until 12/2013.

Table 8 shows the results of the estimation of net cross-currency lending on the spot exchange rate. In the first stage, the lending tightness measure indeed implies a negative effect on lending for higher values. Thus, tighter lending conditions imply less net cross-currency lending.

In the second stage, we repeat our baseline analysis including an additional control variable for current lending expectations. The obtained results are positively significant and around double the magnitude of our baseline estimate (compare Table 2). This shows that differences arising between countries in the ease of originating new syndicated loans, have a bearing on the exchange rate via less cross-currency loan flows.

Notably, the EBA capital exercise did not directly affect exchange rates, which makes the lending tightness measure a valid exogenous instrument for the net cross-currency lending. This is also supported by a low correlation of around 0.04 of the lending tightness measure and the spot exchange rate changes.

**Table 8:** Baseline regression with alternative instrument

| | First Stage | Second Stage |
|---|---|---|
| Lending tightness | -0.013 | |
| | (0.004) | |
| $\Delta$NCCL$_{c,t}$ | | 142.6 |
| | | (70.81) |
| Observations | 93 | 93 |
| Macro-controls | Yes | Yes |
| Currency FE | Yes | Yes |
| Year FE | Yes | Yes |
| Currency Areas | 3 | 3 |
| | F-test: 10.62 | $Pseudo-R^2$: 0.167 |

*Notes:* HAC-robust standard errors in parentheses. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\Delta$NCCL$_{c,t}$ is the contemporaneous instrumented difference between the USD syndicated lending of foreign banks and the logarithm of foreign currency syndicated lending of US banks. An increase in this measure implies that foreign banks lend more in USD than US banks lend in foreign currency. As instrument, we use the *interaction* between lending conditions reported by the largest banks (obtained from central bank surveys; lagged by one quarter), the (log of) Tier 1 capital holdings, and a binary variable indicating European banks under effect of the EBA capital exercise (07/2012-03/2013). The first difference of the end of month VIX index is included as control variable, but not reported. Macro-controls refers to the first four principal components extracted from CPI inflation, 5y and 10y government bond yields and 3 month interbank rates in the respective currency areas. Additionally, we control for the current lending conditions expectation in the regression. The sample runs from 2011/06 to 2013/12 and includes the currencies CAD, EUR, GBP. The coefficient describes the effect of a 100 bp increase in the lending measure on the spot exchange rate in annualized basis points.

## 6.2. Spot and forward exchange rates

In our main analysis in Section 4 we show that cross-currency lending flows affect *spot* exchange rates. However, as banks hedge the exchange rate risks from cross-currency loans, a natural question is whether both spot and forward markets are affected in the same way or not.

Against this backdrop, we compare our baseline regression involving spot exchange rates and the net cross-currency lending flows to the same regressions with forward rates and forward points as dependent variables.[22] As endogeneity can equally arise in the context of forward rates, we deploy a Granular IV approach as for our baseline results.

The effect on forward rates is equally strongly statistically significant, but slightly smaller in economic terms, as Table 9 shows. A 1% increase in net USD lending of foreign banks leads to an appreciation of the USD by around 52 annualized basis points vis-à-vis the home currency of the foreign bank. This compares to the 72 annualized basis points appreciation when the spot exchange rate is used as dependent variable.

**Table 9:** Elasticity of spot exchange rate, forward rate and forward points

| | Spot rate | Forward rate | Forward points |
|---|---|---|---|
| $\Delta\text{NCCL}_{c,t}$ | 72.33 | 52.37 | -119.5 |
| | (13.20) | (8.677) | (74.69) |
| Observations | 1184 | 1038 | 1038 |
| Macro Controls | Yes | Yes | Yes |
| Currency FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Currency Areas | 14 | 13 | 13 |
| Pseudo-$R^2$ | 0.15 | 0.11 | 0.03 |

*Notes:* We compare the baseline regression of the first difference of the logarithm of the spot exchange rate vis-à-vis the USD on net cross-currency loan flows ($\Delta NCCL$) with analogous regressions for forward exchange rate (log) changes and forward points as dependent variables. The dependent variable for each regressions is indicated in the top row. $\Delta\text{NCCL}_{c,t}$ is the contemporaneous GIV instrumented difference between the USD syndicated lending of foreign banks and the logarithm of foreign currency syndicated lending of US banks. An increase in this measure implies that foreign banks lend more in USD than US banks lend in foreign currency. The first difference of the end of month VIX index is included as control variable (not reported for brevity). Macro-controls refers to the first four principal components extracted from CPI inflation, 5y and 10y government bond yields and 3 month interbank rates in the respective currency areas. The sample runs from 1997/01 to 2021/12 and includes the currencies AUD, CAD, CHF, CNY, DKK, EUR, GBP, JPY, KRW, MXN, NOK, SEK, SGD, ZAR. The coefficient describes the effect of a 100 bp increase in the lending measure on the spot exchange rate in annualized basis points. We report HAC-robust standard errors in parentheses.

[22] Forward points essentially measure the difference between spot and forward rates (expressed in bp) and, if covered interest parity held, should equal the interest rate differential between two currencies.

Furthermore, we test whether cross-currency lending affects the forward points as well. The estimated coefficient is negative and implies that a 1% increase in net USD lending by foreign banks reduces forward points by 119 basis points, i.e. the forward rate moves less than the spot exchange rate even though it is not statistically significant. However, this result based on forward points, might mask a more subtle effect of cross-currency lending on covered interest parity deviations, which we explore in Section 5.

# 7. Conclusion

We examine cross-currency lending in the syndicated loan market to study the impact of flows on exchange rates. To guide our empirical analysis we draw on an adaptation of the model presented in Ivashina *et al.* (2015), which looks at the cross-border lending decisions by foreign banks in US dollars and how these are funded. Our findings indicate that exchanges rates respond significantly to cross-currency loan flows: A net increase of lending in USD by foreign banks (relative to that in foreign currencies by their US peers) implies that the USD appreciates significantly, both statistically and in economic terms, vis-à-vis the foreign currency. We establish this finding by using a granular instrumental variable approach and loan-level lending information for a large cross-section of globally active banks. This setup, in turn, allows us to estimate the elasticity of exchange rates with respect to cross-currency loan flows.

We further provide evidence that this effect emerged after the GFC. The effect is also stronger when funding conditions in the US dollar tighten, e.g., during the hiking phase of the monetary policy cycle, when USD reserve holdings in the banking system are more concentrated, or when dealers face difficulties in flexibly expanding their balance sheet by adding more leverage. All in all, these findings suggest an important role for intermediary frictions in affecting exchange rates (Gabaix and Maggiori, 2015).

We further provide evidence that shifts in cross-currency bank lending also have a bearing on CIP deviations. The effect is strongest at a three-months term, the most popular maturity for foreign currency hedging among global banks. Additionally, we show that top-tier banks with the best credit ratings, i.e. those that have access to USD short-term funding markets in commercial paper or certificates of deposit at the most attractive rates, tend to markedly increase their issuance of short-term, USD-denominated paper. While they may, in the short-run, tap the FX swap market to fund the provision of the cross-currency loan, they will over time roll over the funding through other cheaper financing sources.

Overall, our paper has a number of implications both for the literature on frictions in FX markets and the importance of intermediaries for asset prices as well as for policy makers. First, we add to the literature on inelastic markets (Gabaix and Koijen, 2021a) and provide evidence that cross-currency lending flows significantly move exchange rates. While the earlier literature recognizes the importance of cross-currency capital flow "bonanzas" in emerging markets, our results suggest sizeable effects generated by international bank lending flows even in developed markets. Importantly, banks are not simply intermediaries here that accommodate other investors' flows, e.g. through their dealer subsidiaries that intermediate trade in instruments such as bonds or derivatives, but they are also at the heart of this effect by making lending decisions themselves. Second, our results emphasize the importance for policymakers to consider international spillover effects of monetary policy that may be magnified by the cross-currency lending activities of global banks.

# References


**Adrian, Tobias, Etula, Erkko, and Muir, Tyler**, 2014, "Financial Intermediaries and the Cross-Section of Asset Returns", *Journal of Finance*, *69*(6), 2557–2596.

**Adrian, Tobias and Xie, Peichu**, 2020, "The Non-U.S. Bank Demand for U.S. Dollar Assets", *IMF Working Paper No. 20/101*.

**Aldasoro, Iñaki, Beltrán, Paula, Grinberg, Federico, and Mancini-Griffoli, Tommaso**, 2022b, "The Macro-financial Effects of International Bank Lending on Emerging Markets", *BIS Working Paper No. 899*.

**Aldasoro, Iñaki and Ehlers, Torsten**, 2018, "The geography of dollar funding of non-US banks", *BIS Quarterly Review December*.

**Aldasoro, Iñaki, Ehlers, Torsten, and Eren, Egemen**, 2022a, "Global banks, dollar funding, and regulation", *Journal of International Economics*.

**Aldasoro, Iñaki, Ehlers, Torsten, McGuire, Patrick, and von Peter, Goetz**, 2020, "Global banks' dollar funding needs and central bank swap lines", *BIS Bulletin*.

**Anderson, Alyssa, Du, Wenxin, and Schlusche, Bernd**, 2021, "Arbitrage Capital of Global Banks", *NBER Working Paper No. 28658*.

**Avdjiev, Stefan, Du, Wenxin, Koch, Cathérine, and Shin, Hyun Song**, 2019, "The Dollar, Bank Leverage, and Deviations from Covered Interest Parity", *American Economic Review: Insights*, *1*(2), 193–208.

**Avdjiev, Stefan, Gambacorta, Leonardo, Goldberg, Linda S., and Schiaffi, Stefano**, 2020, "The shifting drivers of global liquidity", *Journal of International Economics*, *125*, 1–17.

**Basel Committee on Banking Supervision (BCBS)**, 2014, *Basel III leverage ratio framework and disclosure requirements*.

**Borio, Claudio, McCauley, Robert, and McGuire, Patrick**, 2022, "Dollar debt in FX swaps: huge, missing and growing", *BIS Quarterly Review, December 2022*.

**Bräuning, Falk and Ivashina, Victoria**, 2020, "Monetary Policy and Global Banking", *Journal of Finance*, *75*(6), 3055–3095.

**Bruno, Valentina and Shin, Hyun Song**, 2015, "Cross-Border Banking and Global Liquidity", *Review of Economic Studies*, *82*(2), 535–564.

**Bruno, Valentina and Shin, Hyun Song**, 2017, "Global Dollar Credit and Carry Trades: A Firm-Level Analysis", *Review of Financial Studies*, *30*(3), 703–749.

**Buch, Claudia M. and Goldberg, Linda S.**, 2020, "Global Banking: Toward an Assessment of Benefits and Costs", *Annual Review of Financial Economics*, *12*, 141–175.

**Camanho, Nelson, Hau, Harald, and Rey, Hélène**, 2022, "Global Portfolio Rebalancing and Exchange Rates", *Review of Financial Studies*, *35*(11), 5228–5274.

**Correa, Ricardo, Du, Wenxin, and Liao, Gordon Y.**, 2020, "U.S. Banks and Global Liquidity", *NBER Working Paper 27491*.

**Correa, Ricardo, Paligorova, Teodora, Sapriza, Horacio, and Zlate, Andrei**, 2022, "Cross-Border Bank Flows and Monetary Policy", *Review of Financial Studies*, *35*(1), 438–481.

**De Haas, Ralph and Van Horen, Neeltje**, 2013, "Running for the Exit? International Bank Lending During a Financial Crisis", *Review of Financial Studies*, *26*(1), 244–285.

**Drechsler, Itamar, Savov, Alexi, and Schnabl, Philipp**, 2017, "The Deposits Channel of Monetary Policy", *Quarterly Journal of Economics*, *132*(4), 1819–1876.

**Du, Wenxin, Hébert, Benjamin M., and Li, Wenhao**, 2022, "Intermediary Balance Sheets and the Treasury Yield Curve", *NBER Working Paper No. 30222*.

**Du, Wenxin, Tepper, Alexander, and Verdelhan, Adrien**, 2018b, "Deviations from Covered Interest Rate Parity", *Journal of Finance*, *73*(3), 915–957.

**Fang, Xiang and Liu, Yang**, 2021, "Volatility, Intermediaries, and Exchange Rates", *Journal of Financial Economics*, *141*(1), 217–233.

**Gabaix, Xavier and Koijen, Ralph S. J.**, 2021a, "In Search of the Origins of Financial Fluctuations: The Inelastic Markets Hypothesis", *NBER Working Paper 28967*.

**Gabaix, Xavier and Koijen, Ralph S. J.**, 2021b, "Granular Instrumental Variables", *NBER Working Paper No. 28204*.

**Gabaix, Xavier and Maggiori, Matteo**, 2015, "International Liquidity and Exchange Rate Dynamics", *Quarterly Journal of Economics*, *130*(3), 1369–1420.

**Gopinath, Gita and Stein, Jeremy**, 2021, "Dollar Invoicing and the Heterogeneity of Exchange Rate Pass-Through", *The Quarterly Journal of Economics*, *136*(2), 783–830.

**Gropp, Reint, Mosk, Thomas, Ongena, Steven, and Wix, Carlo**, 2019, "Banks Response to Higher Capital Requirements: Evidence from a Quasi-Natural Experiment ", *Review of Financial Studies*, *31*(1), 266–299.

**He, Zhiguo, Kelly, Bryan, and Manela, Asaf**, 2017, "Intermediary Asset Pricing: New Evidence From Many Asset Classes", *Journal of Financial Economics*, *126*(1), 1–35.

**Ivashina, Victoria, Scharfstein, David S., and Stein, Jeremy C.**, 2015, "Dollar Funding and the Lending Behavior of Global Banks", *Quarterly Journal of Economics*, *130*(3), 1241–1281.

**Jordà, Òscar**, 2005, "Estimation and Inference of Impulse Responses by Local Projections", *American Economic Review*, *95*(1), 161–182.

**Kacperczyk, Marcin and Schnabl, Philipp**, 2013, "How Safe Are Money Market Funds?", *Quarterly Journal of Economics*, *128*(3), 1073–1122.

**Kremens, Lukas and Martin, Ian**, 2019, "The Quanto Theory of Exchange Rates", *American Economic Review*, *109*(3), 810–843.

**Liao, Gordon Y. and Zhang, Tony**, 2021, "The Hedging Channel of Exchange Rate Determination", *Working Paper*.

**Lilley, Andrew, Maggiori, Matteo, Neiman, Brent, and Schreger, Jesse**, 2020, "Exchange Rate Reconnect", *NBER Working Paper 26046*.

**Maggiori, Matteo, Neiman, Brent, and Schreger, Jesse**, 2019, "The Rise of the Dollar and Fall of the Euro as International Currencies", *AEA Papers and Proceedings*, *109*, 521–526.

**Malamud, Semyon and Schrimpf, Andreas**, 2018, "An Intermediation-based Model of Exchange Rates", *BIS Working Paper 743*.

**Meisenzahl, Ralf, Niepmann, Friederike, and Schmidt-Eisenlohr, Tim**, 2020, "The Dollar and Corporate Borrowing Costs", *CEPR Discussion Paper 14892*.

**Niepmann, Friederike**, 2018, "Banking Across Borders with Heterogeneous Banks", *CEPR Discussion Paper No. DP12606*.

**Rime, Dagfinn, Schrimpf, Andreas, and Syrstad, Olav**, 2022, "Covered Interest Parity Arbitrage", *Review of Financial Studies*, *35*(11), 5185–5227.

**Shen, Leslie Sheng and Zhang, Tony**, 2022, "Risk Sharing and Amplication in the Global Financial Network", *Working Paper*.

**Stock, James H. and Yogo, Motohiro**, 2005, *Testing for Weak Instruments in Linear IV Regression*, chap. 5, In: Andrews DWK Identification and Inference for Econometric Models. New York: Cambridge University Press, 80–108.

# A. Appendix

## A.1. Proof of Propositions

IMPLICATION 1: *When the European bank increases loan supply in USD, the USD appreciates.*

*Proof.*

$$\begin{aligned}\frac{dS^{E/D}}{dL^D} &= -\frac{dg'(L^D)}{dL^D} + \frac{\partial h'(L^E)}{\partial L^E}\frac{dL^E}{dL^D} + \frac{dp^S}{dL^D},\\ &= -g''(L^D) + h''(L^E)\frac{dL^E}{dL^D} + \frac{\partial p^S}{\partial I^S}\frac{dI^S}{dL^D}.\end{aligned} \tag{12}$$

As $g(\cdot)$ and $h(\cdot)$ are concave, $g''(\cdot) < 0$ and $h''(\cdot) < 0$. From $K - L^E - S^{E/D}L^D \geq c$, $\frac{dL^E}{dL^D} < 0$. $\frac{\partial p^S}{\partial I^S} > 0$ from (4) and $\frac{dI^S}{dL^D} > 0$ as more demand for swaps leads to more swaps offered. ■

IMPLICATION 2: *When the dealer is more balance-sheet constrained, the USD appreciates.*

*Proof.*

$$\frac{dS^{E/D}}{d\Gamma} = \frac{dp^S}{d\Gamma} = \frac{W(W-(1+\Gamma)I^S)) + W(1+\Gamma)I^S}{(W-(1+\Gamma)I^S)^2},$$

which is positive whenever

$$W^2 > 0,$$

which is always satisfied. ■

IMPLICATION 3: *When USD funding becomes more expensive, the USD appreciates.*

*Proof.*

$$\frac{dS^{E/D}}{dr^{\$}} = -\frac{1}{(1+r^{\$})^2}(-1) > 0.$$

■

IMPLICATION 4: *When the European bank increases loan supply, the CIP deviation widens.*

*Proof.*

$$\frac{dp^S}{dL^D} = \frac{\partial p^S}{\partial I^S}\frac{dI^S}{dL^D} = \frac{(1+\Gamma)W}{(W-(1+\Gamma)I^S)^2}\frac{dI^S}{dL^D} > 0. \tag{13}$$

Considering that $\frac{dp^S}{dL^D} = \frac{\partial p^S}{\partial I^S}\frac{dI^S}{dL^D}$, as $\frac{dI^S}{dL^D} > 0$, given that increased demand leads to a higher supply by the dealer, the result follows. Notice that in our context, a higher swap price implies larger CIP deviations. ■

## A.2. Granular Instruments

The idea of granular instrumental variables following Gabaix and Koijen (2021b) rests on the the identification of an elasticity of flows on prices by using variation from idiosyncratic shocks. We model flows as a result of common sectoral shocks and idiosyncratic (bank-level) shocks.

Suppose we have:

$$\Delta l_{ict} = -\alpha \Delta s_{ct} + f^{v}_{ict}, \tag{14}$$

$$\text{where } f_{ict} = \lambda_i' \eta_t + u_{ict}, \tag{15}$$

where $c$ denotes the currency area and $t$ the given month. $\Delta l_{ict}$ denotes the change in lending flow of bank $i$ in currency area $c$ at time $t$. $\Delta s_{ct}$ denotes the change in the spot exchange rate of currency $c$ at time $t$. The quantity of loan flows is affected by the exchange rate and exposure of a bank to common shocks, $\lambda_i'$, and an idiosyncratic shock, $u_{ict}$. Our estimation equation of interest is given by

$$\Delta s_{ct} = \kappa \Delta l_{ict} + \varepsilon_{ct}, \tag{16}$$

In a simple regression of $\Delta l_{ict}$ on $\Delta s_{ct}$, $\mathbb{E}[\Delta l_{ict} \varepsilon_{ct}] \neq 0$ due to the simultaneous determination of prices and quantities. We, thus, need an instrument, $Z_{ct}$, such that

$$\mathbb{E}[Z_{ct} \varepsilon_{ct}] = 0,$$

i.e. the instrument is exogenous, and additionally that it is relevant

$$\mathbb{E}[Z_{ct} \Delta l_{ict}] \neq 0.$$

Similar to Camanho *et al.* (2022), we propose to use the GIV instrument defined as

$$Z_{ct} := \Delta l_{Sct} - \Delta l_{Ect},$$

where $\Delta l_{Sct}$ and $\Delta l_{Ect}$ are the value (market share)-weighted and equally-weighted average of flows in currency area $c$ at time $t$. Assuming for ease of exposition that exposure to the common shock is equivalent across all banks[23]

$$Z_{ct} := \Delta l_{Sct} - \Delta l_{Ect} = (-\alpha \Delta s_{ct} + \lambda \eta_t + u_{Sct}) - (-\alpha \Delta s_{ct} + \lambda \eta_t + u_{Ect}) = u_{Sct} - u_{Ect} = u_{\Gamma ct}.$$

The key assumption in GIV frameworks is that the common shock and the idiosyncratic shock

[23]Notice that results can be generalized to incorporate idiosyncratic exposure as well.

are unrelated, i.e. $\mathbb{E}[u_{it}\eta_t] = 0$, see Gabaix and Koijen (2021b). With this in mind, the instrument can be shown to be consistent. It is also exogenous as it contains only idiosyncratic bank-level errors, which are by assumption orthogonal to supply shocks $\varepsilon_{ct}$.

The instrument is relevant for our endogenous measure of cross-currency lending trivially, as

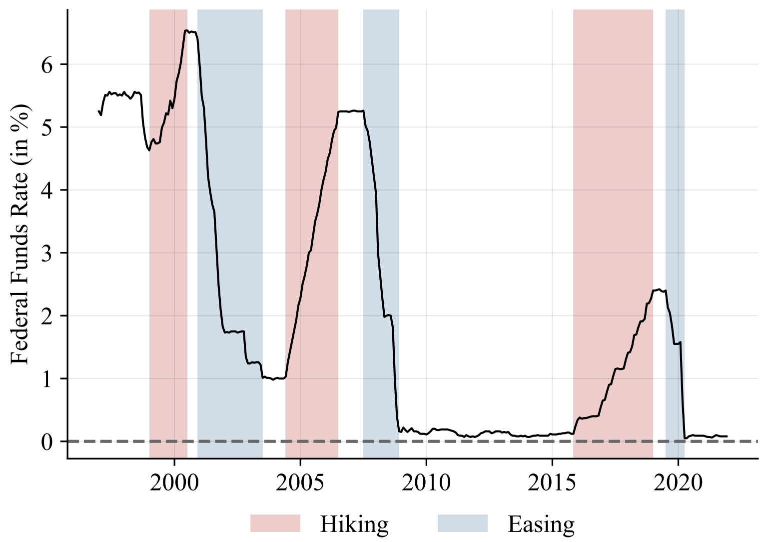
$$\mathbb{E}[(\Delta l_{Sct} - \Delta l_{Ect})\Delta l_{ict}] \neq 0.$$

It exhibits a correlation of 0.31 with the net cross-currency lending measure. Furthermore, the F-statistic in the first stage is consistently above 10, compare Stock and Yogo (2005).

### A.3. Fed monetary policy cycles

Figure A.1 illustrate the hiking and easing cycles underlying our results in Table 5. Light blue indicates easing cycles, whereas red areas indicate tightening cycles. Areas that are not marked are defined as "No Change" in Table 5.

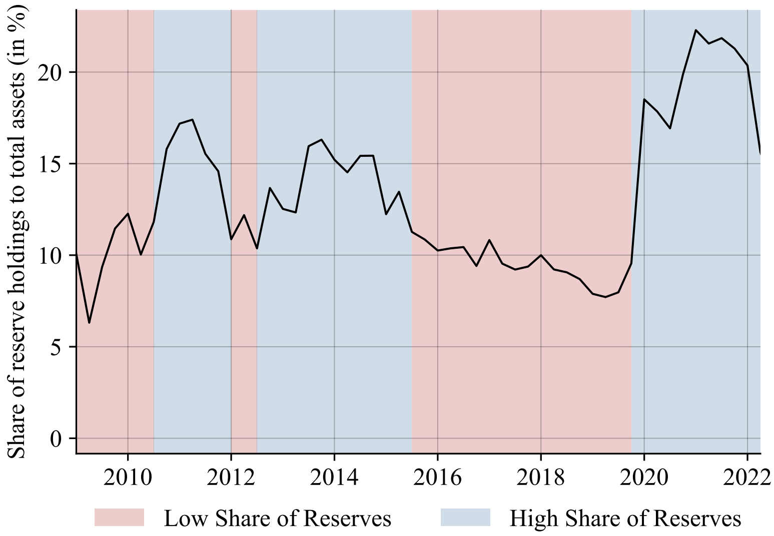
**Figure A.1:** Definition of monetary policy cycles




*Notes*: This figure defines the hiking (red) and easing (blue) cycles depending on the slope of the federal funds rate curve.

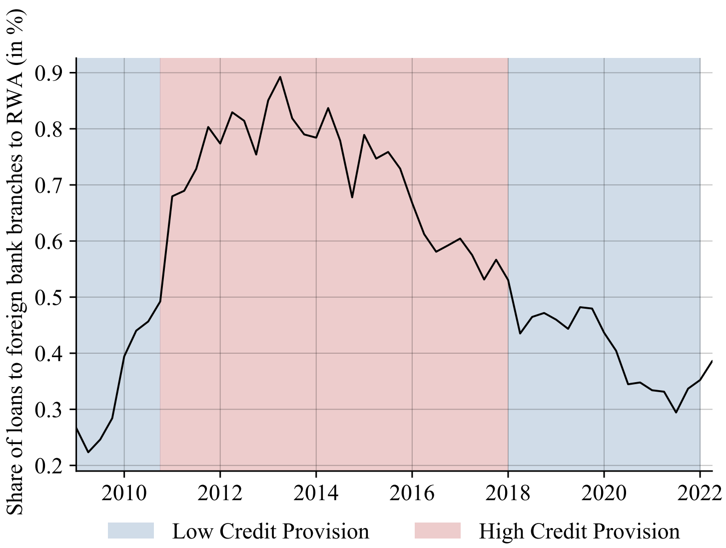
## A.4. Relative liquidity measures

**Figure A.2:** Definition of reserve scarcity and abundance



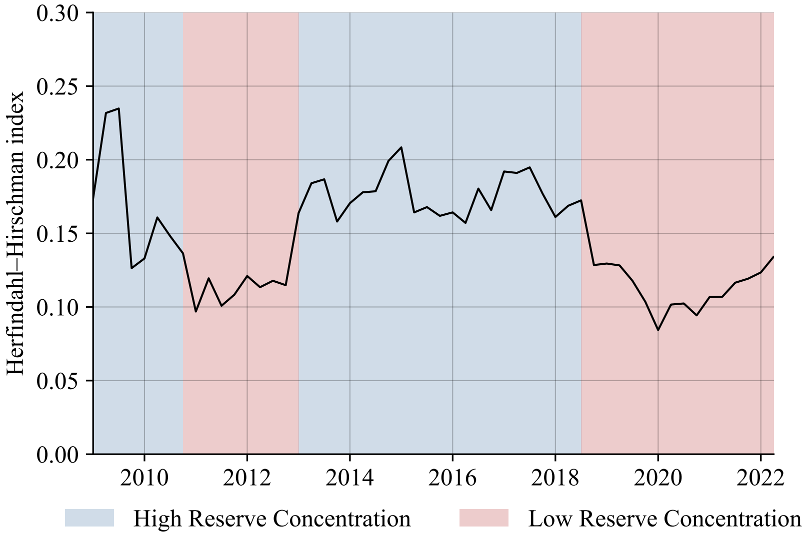

*Notes*: This figure defines the periods of low reserve scarcity (low share of reserves in relation to total risk-weighted assets) (red) and high reserve scarcity (blue).

**Figure A.3:** Definition of high and low share of loans to foreign banks




*Notes*: This figure defines periods of high credit provision defined as high share of loans to US subsidiaries of foreign banks (red) and low share of loans to foreign bank subsidiaries (blue).

**Figure A.4:** Definition of high and low concentration of reserves

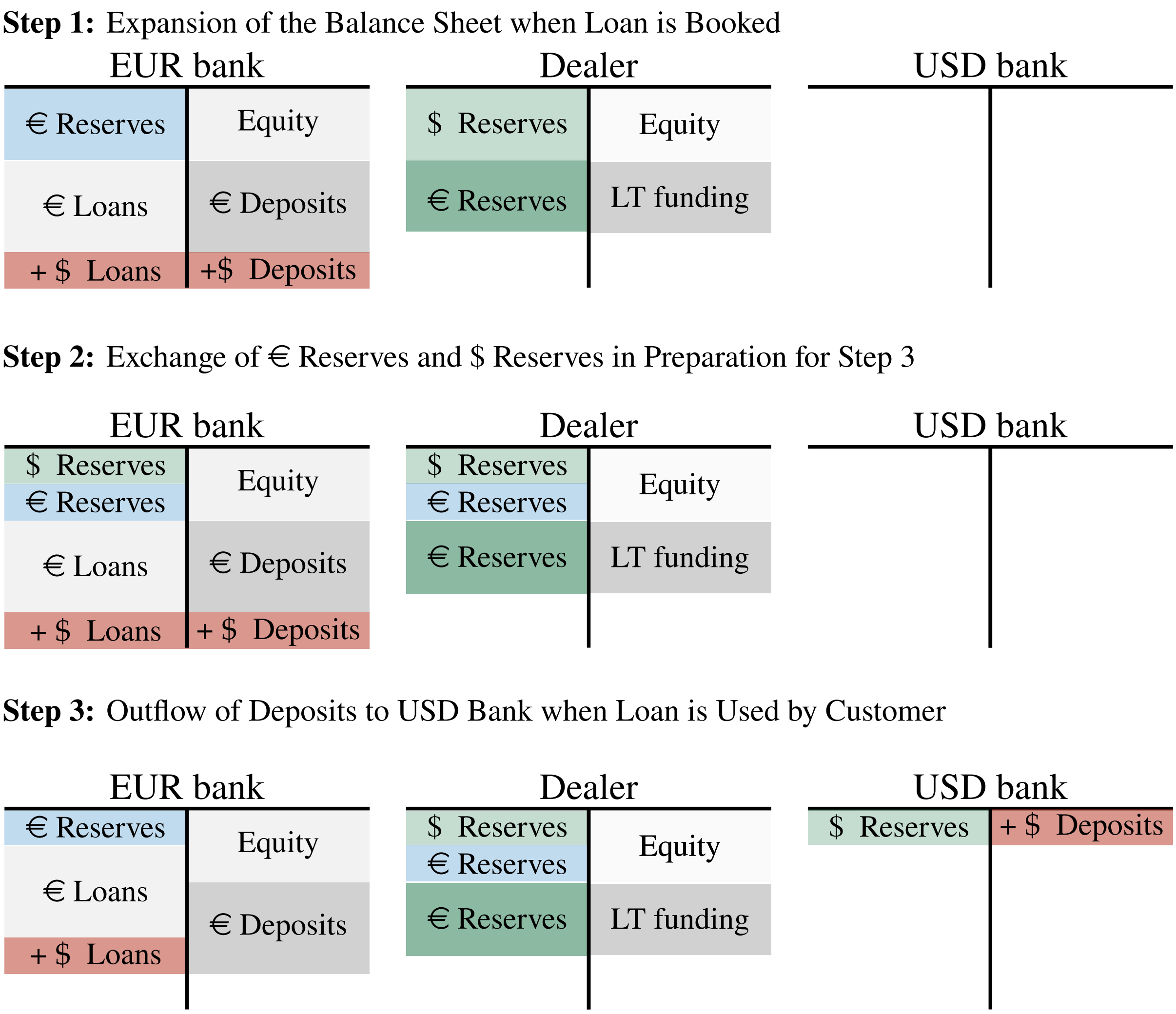



*Notes*: This figure defines the periods of high and low concentration of reserves among the top 30 banks in the US. The figure depicts the Herfindahl-Hirschman index of the reserve holdings over time. High reserve concentration periods are marked in blue. Low concentration periods are marked in red.

# B. Internet Appendix

## B.1. Additional details on the funding mechanism

**Figure B.5:** Loan Origination in Foreign Currency for Global Banks




*Notes:* This figure provides a stylized example of an origination of a syndicated USD denominated loan of a bank without access to USD deposits (EUR bank). Step 1 shows the balance sheet expansion following the agreement on the loan terms and booking of the agreed upon amounts in the banks own accounts. Step 2 depicts the exchange of EUR reserves for USD reserves to be able to pay out the drawdown of the loan to the customer's beneficiary which happens in Step 3., i.e. transfer of USD reserves to the USD bank.

To illustrate how non-US banks fund their USD lending, Figure B.5 shows an example of the necessary balance sheet operations for the case in which a euro area (with home currency EUR) bank grants a USD loan without having direct access to USD deposits in the US onshore financial system. When the euro bank agrees with its customer on the terms of the loan, the loan is booked on the balance sheet of the bank. This occurs in the form of a balance sheet expansion equal to the size of the USD loan, which is accompanied by granting the customer an equivalent deposit, see Step 1.

In anticipation of the drawdown of USD liquidity of the customer, say, to transfer it to a foreign supplier with a USD account (in the context of this example at a USD bank), the bank first has to acquire USD reserves for the subsequent transfer. These reserves are typically obtained via FX swaps offered by FX dealers. In essence, EUR reserves are swapped for USD reserves.[24]

In a last step, the bank transfers the loan notional to the other bank, for instance because the borrower has to pay a foreign supplier. The foreign bank would receive USD reserves and credit its customer's account with USD deposits. The EUR bank remains with a new position of USD denominated loans and fewer EUR liquidity on the asset side of its balance sheet. As the dealer took the opposite side of this transaction, she now holds more EUR reserves than USD reserves.

### B.2. Definition of the CIP deviation

We define the CIP condition as

$$\left(1 + y^{\$}_{t,t+n}\right)^n = \left(1 + y_{t,t+n} + x_{t,t+n}\right)^n \frac{S_t}{F_{t,t+n}},$$

where $y^{\$}_{t,t+n}$ denotes the risk-free interest rate in USD for the term (in years) $n$. Equivalently, $y_{t,t+n}$ denotes the risk-free interest rate in the foreign currency. $S_t$ and $F_{t,t+n}$ denote the spot rate at time $t$ and forward rate at time $t$ for time $t+n$ respectively. $x_{t,t+n}$ denotes the cross-currency basis, which we can also express in log form as

$$x_{t,t+n} = y^{\$}_{t,t+n} - \left(y_{t,t+n} - \rho_{t,t+n}\right),$$

where the basis $x_{t,t+n}$ is the difference between the *direct* USD borrowing cost, $y^{\$}_{t,t+n}$, and the *synthetic* USD borrowing cost, $\left(y_{t,t+n} - \rho_{t,t+n}\right)$. The forward premium $\rho_{t,t+n}$, is defined as

$$\rho_{t,t+n} \equiv \frac{1}{n}\left(f_{t,t+n} - s_t\right) = y_{t,t+n} - y^{\$}_{t,t+n}.$$

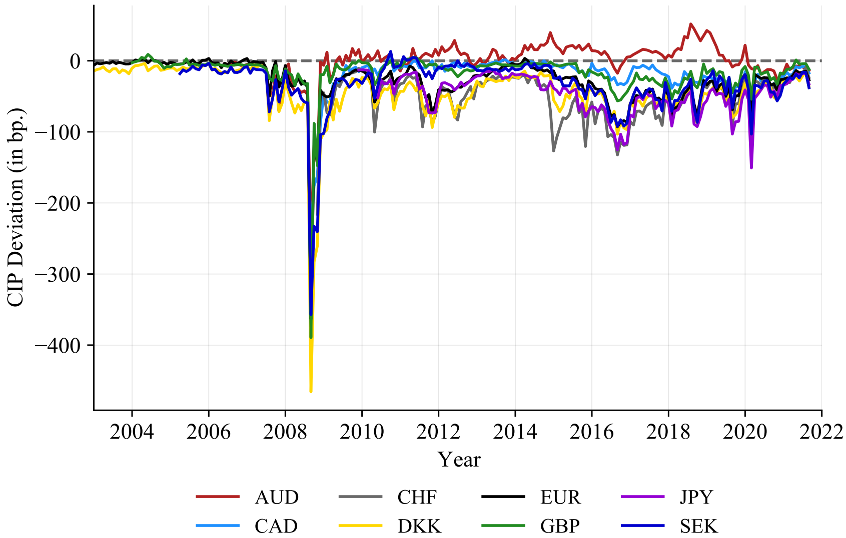
A negative currency basis implies that the synthetic USD borrowing cost implied by borrowing in the foreign currency and exchanging spot while agreeing on a forward purchase of the

[24] For the sake of illustration, the FX swap in this example takes place as a simple exchange of EUR versus USD *reserves* (base money) on the balance sheet of the dealer and the lender bank. In practice, FX swaps are off-balance sheet instruments, need not settle in reserves directly, and the euro bank does not necessarily have a reserve account at the US Federal Reserve. In the latter case, the euro bank would hold a $ claim against a bank with Fed access. We abstract from such technicalities to keep the exposition focused.

foreign currency after term $n$ is higher than the direct USD borrowing cost.

Figure B.6 shows the evolution of CIP deviations over time. Akin to Du *et al.* (2018b) we find that whereas before 2009 CIP deviations were essentially 0, large (mostly negative) CIP deviations persist thereafter. This implies that USD borrowing costs for banks without access to direct USD borrowing exceed those of their US counterparts.

**Figure B.6:** CIP Deviations at 3 Month Term




*Notes:* This figure depicts the deviations from the CIP condition as defined in equation (9) at 3 month term. The data is obtained from Refinitiv Eikon. Large negative CIP deviations persist since the 2009.

### B.3. Global Bank Lending Locational Statistics

Global USD syndicated lending is not confined to the US, or countries that use the USD as payment currency. Table B.1 shows a large fraction of USD lending occurring from non-US lenders to borrowers outside the US. The last row indicates that US banks grant around 87% of their USD denominated loans in the US, the highest fraction among all other countries. Around 34% of all USD denominated syndicated loans originates from banks domiciled in the US, again the largest country in providing USD credit globally. In comparison, banks form the Euro Area and the United Kingdom originate 19 and 11% of all syndicated USD loans. There is a stark heterogeneity in the syndication country of the USD loan across the origin countries of banks, albeit most of the banks have a high preference to lend in the US, or their home country.

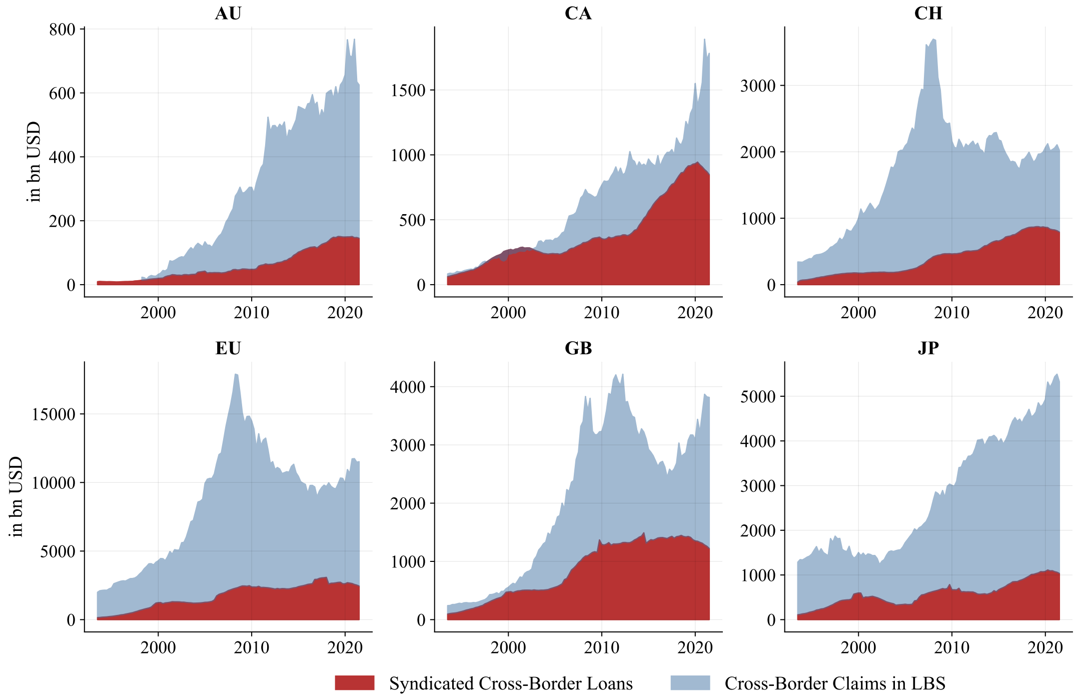
Figure B.7 relates the cross-currency syndicated loan volumes obtained from DealScan to the total claims banks headquartered in a currency area towards the rest of the world obtained from the BIS Locational Banking Statistics. Across countries, there is a large difference in the importance of syndicated loans among all total claims. Canada for instance has a high share of syndicated loans among total claims, whereas Australia or Japan have lower shares of syndicated lending in relation to total claims.

**Table B.1:** Distribution of USD Loan Syndication Country by Bank Origin Country

| | | Syndication Country | | | | | | | | | | | Share of |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AU | CA | CH | CN | EU | GB | JP | OTH | SE | SG | US | Total |
| Bank Origin Country | AU | 10.20 | 3.10 | 4.16 | 1.34 | 3.24 | 10.55 | 1.91 | 12.83 | 0.31 | 3.90 | 48.46 | 0.90 |
| | CA | 0.35 | 12.67 | 0.90 | 0.02 | 2.48 | 2.72 | 0.29 | 3.69 | 0.12 | 0.31 | 76.44 | 5.14 |
| | CH | 1.08 | 2.06 | 2.30 | 0.21 | 4.15 | 3.48 | 0.06 | 3.97 | 0.19 | 0.45 | 82.05 | 4.48 |
| | CN | 2.46 | 1.34 | 1.71 | 15.06 | 4.00 | 2.54 | 0.22 | 39.67 | 0.04 | 4.94 | 28.01 | 1.23 |
| | EU | 0.47 | 2.52 | 2.35 | 0.42 | 10.19 | 4.86 | 1.22 | 18.94 | 0.48 | 0.80 | 57.77 | 19.11 |
| | GB | 0.52 | 2.11 | 1.46 | 0.54 | 4.68 | 7.59 | 0.81 | 28.82 | 0.30 | 0.58 | 52.59 | 11.65 |
| | JP | 1.06 | 1.83 | 1.09 | 0.38 | 5.01 | 3.46 | 3.42 | 16.96 | 0.23 | 0.91 | 65.65 | 7.52 |
| | OTH | 0.11 | 4.09 | 0.61 | 0.67 | 1.16 | 0.75 | 0.08 | 55.02 | 0.46 | 31.41 | 5.64 | 14.30 |
| | SE | 0.34 | 1.31 | 3.95 | 0.24 | 7.20 | 4.66 | 0.24 | 26.14 | 23.26 | 2.53 | 30.11 | 0.27 |
| | SG | 0.88 | 0.49 | 1.78 | 1.79 | 1.96 | 1.05 | 0.10 | 77.42 | 0.01 | 5.62 | 8.91 | 1.18 |
| | US | 0.27 | 2.15 | 0.70 | 0.08 | 2.25 | 2.08 | 0.27 | 4.97 | 0.11 | 0.17 | 86.95 | 34.21 |
| Share of Total | | 0.54 | 2.98 | 1.27 | 0.52 | 4.24 | 3.34 | 0.73 | 19.78 | 0.33 | 5.05 | 61.23 | |

*Notes:* Vertically the country codes denote the lending bank's parent headquarter country, horizontally the country codes denote syndication countries for USD loans. Each row adds up to 100%, with each entry denoting the likelihood of a given country's banking system to lend in a given syndication country. The last row denotes the share of the syndication country in relation to the global USD lending market. The last column denotes the share of the bank origin country among the global USD lending market.

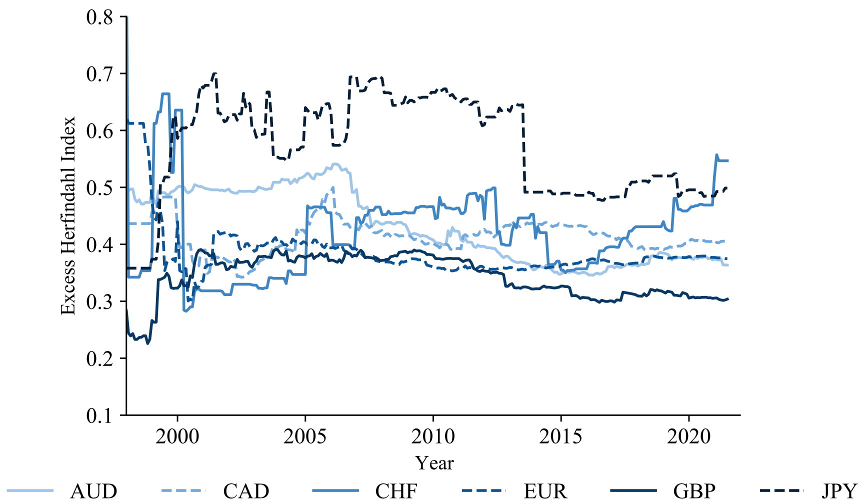
**Figure B.7:** Cross-Currency Syndicated Loan Claims Compared to Total Claims against RoW




*Notes:* Red indicates USD cross-currency syndicated loan claims of banks headquartered in a currency area towards the rest of the world obtained from aggregating individual loan level data from Refinitiv DealScan. Blue indicates total claims banks headquartered in a currency area towards the rest of the world as obtained from the BIS Locational Banking Statistics.

## B.4. Additional illustrations

**Figure B.8:** Excess Herfindahl Index Over Time




*Notes:* This figure depicts the excess Herfindahl index defined as $h := \sqrt{-\frac{1}{N} + \sum_{i=1}^{N} S_i^2}$. For each currency area, the index is between 0.2 and 0.7 over time. his implies that the GIV instrument should have sufficient precision as discussed in Gabaix and Koijen (2021b).

Figure B.8 shows the evolution of the excess Herfindahl Index over time. The excess Herfindahl index is defined as $h := \sqrt{-\frac{1}{N} + \sum_{i=1}^{N} S_i^2}$. Across all countries, the values of the Herfindahl index indicate a level of concentration that is suitable for a precise estimation of the endogenous flow variable by the GIV instrument as discussed in Gabaix and Koijen (2021b).

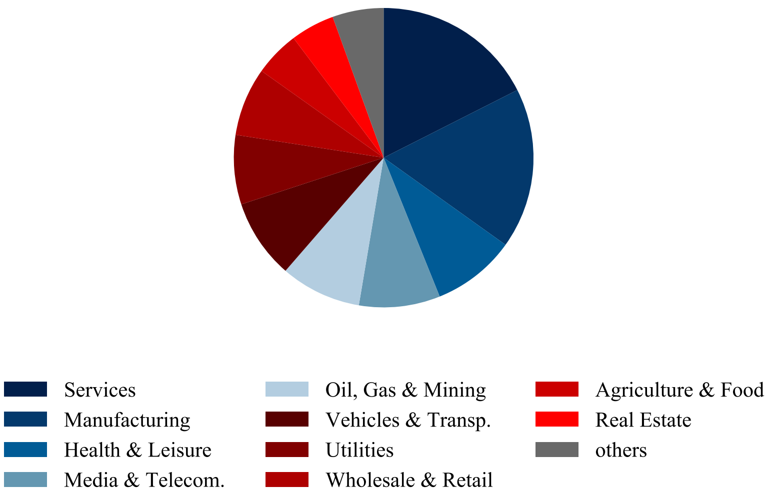
## B.5. Additional information on empirical approach

*Exchange Rates.* We obtain information on the daily spot exchange rate (FC/USD) data from the Bank for International Settlements (BIS) and use the last observation in each month to convert them to monthly frequency. In our regressions below, we employ log changes in monthly exchange rates (measured in bp).

*Control Variables.* As control variables, we include measures of the first difference of the CBOE VIX index as a measure for the global risk appetite (see Kremens and Martin (2019), and Lilley *et al.* (2020), among others), which we retrieve from the Federal Reserve Bank of St. Louis (FRED) on an averaged monthly basis. We further include the first four principal components of the sovereign 5 and 10 year bond yields from Refinitiv Eikon, the 3-month interbank interest rates and period-on-period CPI inflation growth rates, which we obtain from the Federal Reserve Bank of St. Louis (FRED) to net out the effect of business cycle macro movements.

Figure B.9 depicts the sectoral distribution of the borrowers included in our starting sample. Most borrowers are from the service and manufacturing sector, but no sector seems to dominate over-proportionately compared to their size of the world economy.

**Figure B.9:** Borrowing Sector Distribution




*Notes:* This figure depicts the distribution of the borrower sector within our initial sample of syndicated loans. Most of the borrowers are from the service sector, followed by the manufacturing and health sector.