BIS Working Papers
No 1161

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Monetary and Economic Department

January 2024

JEL classification: F31, E44, G21

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This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

Global Bank Lending and Exchange Rates*

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This draft: January 10, 2024
First draft: August 13, 2023

Abstract

We estimate the impact of banks' cross-currency lending on exchange rates to shed light on the importance of flows as a major force affecting FX market outcomes. When non-US banks extend more loans in US dollars (USD) relative to US banks originating foreign currency-denominated loans, 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 – which we estimate via a granular instrumental variable approach – 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 intermediate global portfolio flows in capital markets through their broker-dealer arms, 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 a key quantity—global bank lending flows. 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? We further motivate these questions by drawing on the specifics of the funding mechanism underlying cross-currency loans, which we detail in the next section.

In our empirical tests, 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

[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.

US banks. To give an example, the cross-currency net 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 is correlated with lending flows but has no direct effect on the exchange rate. We further control for macroeconomic conditions and saturate the model with a rich set of fixed effects.[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 non-US 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 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 non-US banks.

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

[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.* (2022), among others) that might drive the relation of cross-currency lending and spot exchange rates.

[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.

some of their home currency deposits for immediate liquidity in the foreign currency. This is commonly 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.

Banks' funding operations via the global FX swap market imply that cross-currency lending flows will have a bearing on conditions in this important market (as well as other segments of short-term funding markets 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. Quantitatively, our estimates imply that a one standard deviation rise in USD lending by foreign banks compared to US bank lending in foreign currency tends to widen the CIP deviations tend by around 4.8 basis points. 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. These results suggest that some banks, i.e., those with a superior rating and access to short-term USD funding via 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 additional empirical exercises to extend our key findings and to check for robustness. First, we find that the exchange rate elasticity is higher when cross-currency flows into USD come from banking systems that exhibit a dollar funding gap (see McGuire and von Peter, 2009) but not those with a surplus. Second, we show that our main results hold in a setting with an alternative, economically motivated, instrument capturing the tightening of bank lending as a result of the capital exercise by the European Banking Authority (EBA).

Related Literature. Our paper connects to various strands of 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 in 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. Engel and Wu (2018) show that changes in the liquidity yield can explain changes in G10 currency exchange rates. Liao and Zhang (2021) identify a 'currency hedging channel' that connects external imbalances to the exchange rate.[4] We contribute to this literature by investigating the funding process and frictions that affect global bank lending and how this process, in turn, has a bearing on 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, several recent 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) investigate 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. Du *et al.* (2023) show that dealers in the Treasury market switched from a net short to a net long position, which 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.[5] Bruno and Shin

[4]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.

[5]Buch and Goldberg (2020) provide an excellent summary on the literature on cross-border banking more generally. Niepmann (2023) provides a theoretical model in which banks engage in operations abroad. Avdjiev *et al.* (2020)

(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 loan supply has become less 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 plays an important role in shaping how strongly global lending flows affect 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.[6] We thereby shed light on a new mechanism showing how cross-currency bank flows can directly affect exchange rates.

In concurrent work, Bippus *et al.* (2023) independently employ a GIV framework to demonstrate that heightened net external USD debt positions can be associated with a strengthening of the USD in the case of global banks operating in the UK. They focus on supply and demand elasticities in the USD market and argue that, since UK-based banks' demand is price-inelastic, they act as a 'marginal' player. As in our paper, they underscore the importance of intermediaries' risk-bearing capacity. In contrast to their analysis, our study encompasses a broader selection of globally active banks and offers a more general conclusion applicable to various currencies: when non-US banks' provision of US dollar loans picks up (relative to the non-USD loans granted by US banks), the dollar tends to appreciate against the foreign currency.

Methodologically, our empirical approach relates to the growing literature that uses a Granular Instrumental Variables (GIV) estimation approach pioneered by Gabaix and Koijen (2021b).

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.* (2022b).

[6]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.

Closest to our approach, Camanho *et al.* (2022) estimate the exchange rate effect of global portfolio rebalancing on exchange rates. Aldasoro *et al.* (2022a) show how cross-border bank lending affects emerging market economies' (EMEs) macro-financial conditions deploying a GIV approach. Moreover, they highlight that commonly used instruments can correlate with global financial 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 Institutional Background and Funding Mechanism

To give some institutional background, we first discuss in this Section how global banks fund syndicated loans in foreign currency. We then draw on the model proposed in Gabaix and Maggiori (2015) to further build intuition and derive implications on the exchange rate impact of flows. This conceptual framing in turn serves as guidance for our empirical tests.

2.1 Funding Mechanism

Global bank off-shore lending occurs in various currencies and countries, with lending in USD taking on a special role given the dollar's role as the world's primary investment and funding currency. 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 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.[7]

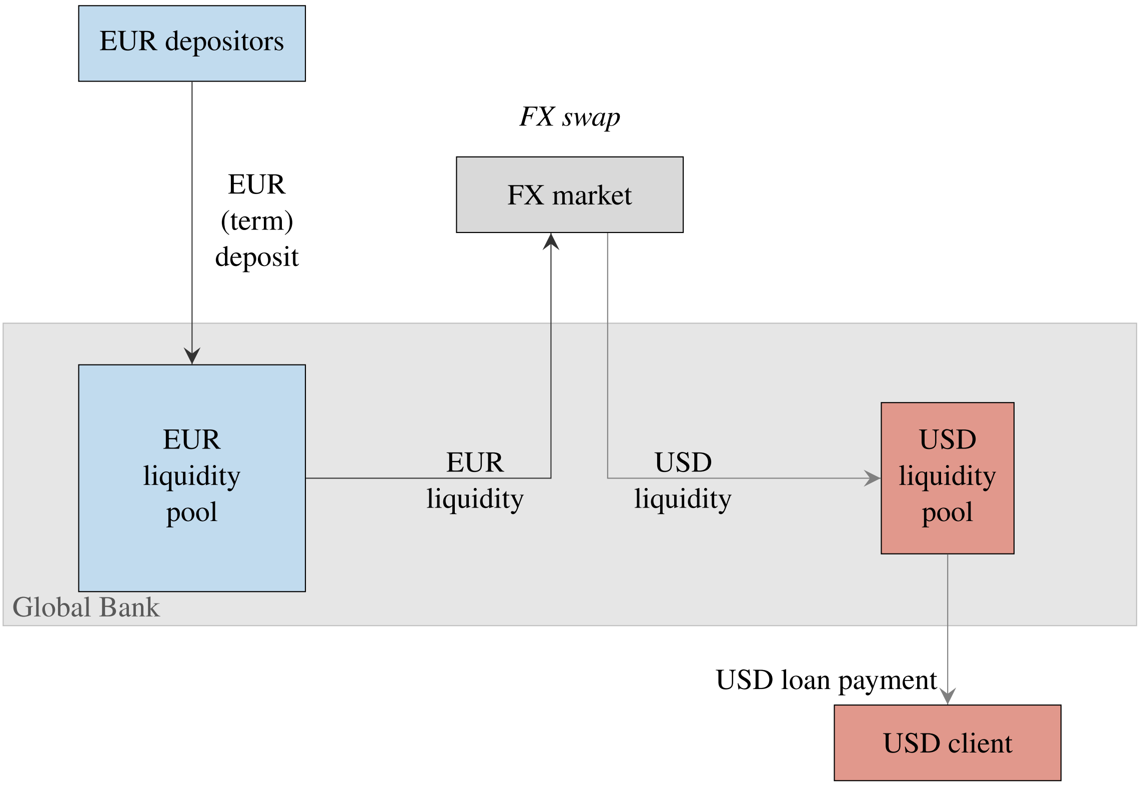
In the context of the outlined example, consider a EUR bank that wants to pay out a USD loan to its customer. To do so, the bank needs to have sufficient amounts of cash. For its operational needs the globally active bank maintains liquidity pools in the currencies the bank operates in. The bank can source short-term US dollar liquidity directly by raising customer deposits via branches of the bank or by issuing commercial paper (CP) or certificates of deposits (CDs).

[7] We provide more details on the funding mechanism in Section IA.1 of the Internet Appendix.

The liquidity pool maintained in the home currency (say, the euro or sterling) typically amounts to a larger volume compared to the ones in foreign currencies.

When large amounts of foreign currency drain the liquidity pool (i.e. here the USD), banks face the immediate necessity to obtain additional liquidity in the currency of the outflow. Such outflows will happen as soon as the customer draws down the syndicated loan amount granted by the bank.[8] 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). One can think of this short-term financing via FX swaps as obtaining USD liquidity synthetically (as opposed to directly).

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 an FX swap. In a final step, the USD loan is paid to the borrower from the USD liquidity pool. Figure IA.1 in the Internet Appendix depicts a stylized example featuring bank balance sheets.

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

[8] More precisely, the actual outflows materialize once the borrower takes out the funds (e.g. to pay a supplier) and the bank needs to transfer them to another bank. The previously entered book value of the foreign currency loan thus needs to be matched with corresponding liquidity.

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 non-US 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.[9]

2.2 Theoretical Motivation

To motivate the primary mechanisms that give rise to an exchange rate impact of cross-currency flows, we now briefly revisit the model by Gabaix and Maggiori (2015). In this model, intermediaries extend funds in two different currencies contingent upon the demand for goods in their respective national contexts. Within the framework of this model, preference shocks give rise to trade activities, thus necessitating capital flows.

The equilibrium exchange rate that results from this framework is characterized by

$$e_0 = \frac{(1+\Gamma)\iota_0 + \mathbb{E}\left[\iota_1\right] - \Gamma f^*}{2+\Gamma},$$

where e_t represents the exchange rate at time t, where lower values of e_t denote an appreciation of the USD against the foreign currency. Γ characterizes the intermediation cost incurred by the financiers and is governed by the function $\Gamma = \gamma\left(\mathrm{var}\left(e_1\right)\right)^{\alpha}$, with scaling parameters $\gamma \geq 0, \alpha \geq 0$. ι_t denotes the preference parameter for foreign-produced tradable goods at time t. In the model, f^* is an exogenous flow, which we interpret as the demand f^* of foreign banks to fund loans in the currency in the context of our empirical analysis. Thus, increases in f^* indicate an increase in the demand for USD. Specifically, this flow corresponds to foreign banks increasing lending in USD and hence exhibiting increased demand for USD funds, which directly reduces the exchange rate e_t, i.e. the USD appreciates.

[9] In practice, banks may later on also sell parts of the originated loan amount to other investors. 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 or smaller banks. Since many of these domestic buyers face very similar funding constraints, the ultimate need for USD funding is similar to those of the originating banks.

Based on the funding mechanism and theoretical motivation of cross-currency funding, we formulate three implications regarding the effect of net lending flows on foreign exchange rates that we use to guide our empirical analysis below.

IMPLICATION 1: *When foreign banks increase their lending in USD, the USD appreciates.*

An increase in cross-currency lending in USD induces a need for raising additional USD funding. To address this, banks have two options: (i) obtaining USD deposits in the USD wholesale market (or equivalently issuing CP or CDs) or (ii) acquiring USD funds through FX swaps. The former option involves increasing the demand for USD in the global deposit market, while the latter directly increases the demand for USD in exchange for the bank's home funding currency (such as EUR in this example). As a result, a pick-up in cross-currency lending by non-US banks directly impacts the demand for USD funding in both the deposit and FX swap markets. This increased demand leads to an appreciation of the USD. In the context of the model a higher f^* directly leads to a lower e_0 and thus an appreciation of the USD.

IMPLICATION 2: *Higher intermediation costs for dealers and/or tighter USD funding conditions amplify the effect of cross-currency lending flows on the exchange rates.*

Intermediaries, such as dealers, face liquidity constraints due to regulatory frameworks that can restrict their ability to provide liquidity, particularly during periods of stress or regulatory scrutiny, see e.g. Du *et al.* (2018b). Similarly, when USD funding conditions tighten, it becomes more difficult for non-US banks to obtain USD liquidity. Consequently, we would expect to see a stronger response of exchange rates to cross-currency lending flows when intermediaries are more constrained and/or USD funding conditions are tighter. In the context of the model, a higher parameter of intermediation cost Γ for an increasing demand of funds leads to a stronger appreciation of the USD.

IMPLICATION 3: *Higher net lending flows contribute to a widening of CIP deviations.*

A higher demand for synthetic USD liquidity funding via FX swaps on the back of higher net cross-currency lending flows implies a larger disparity between the direct borrowing cost of USD and the cost of acquiring USD liquidity through FX swaps. This wedge should in turn contribute to a widening of the CIP deviation. The widening deviation reflects that it has become more costly for banks from the home currency area of the originating bank to raise USD funding.[10] In the model of Gabaix and Maggiori (2015), the CIP deviation holds as long as $\alpha > 0$. When $\alpha = 0$, the intermediation cost is the constant parameter γ and does not depend on the (variance of the) future spot rate e_1. Despite the model not directly featuring an expression for the CIP deviation, intuitively, the more restrictive the value of γ, the less the financier is able to engage in CIP arbitrage. Higher demand imbalances resulting from higher net lending flows should hence lead to larger CIP deviations.

3 Data and Empirical Approach

This section describes the data used in our empirical analysis and details our empirical approach. Section 3.1 provides details on the syndicated loan data and basic descriptive statistics whereas Section 3.2 focuses on the global portion of syndicated loan flows (cross-currency loans). Section 3.3 briefly describes other data used in our empirical analysis. Section 3.4 details the empirical approach employed in the main part on our paper and how we build a generalized instrumental variable from micro data on syndicated loans.

3.1 Syndicated loans: Data

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 arrange 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.[11]

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.

[10] Borio *et al.* (2016) suggest that a combination of hedging demand and tighter limits to arbitrage drive CIP deviation. As hedging demand commonly increases with the origination of foreign currency denominated loans, wider CIP deviations might follow.

[11] Table IA.1 in the Internet Appendix describes the sectoral distribution of the borrowers in our sample.

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.[12] To ensure a clean estimation in our empirical analysis, we focus on loans to non-financial customers and exclude loans granted to banks and non-bank financial corporations.

Table IA.1 in the Internet 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.

3.2 Syndicated loans: Global loan flows

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, that is, a thicker line indicates greater loan flows. Red depicts loan flows from non-US banks to US borrowers, green the flow from US banks to non-US borrowers,

[12] See, e.g. Avdjiev *et al.* (2019) who make the case that the focus on jurisdictional boundaries in academic research can be misleading given the widespread use of internationalized currencies in cross-border transactions.

[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 mis-coding. 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

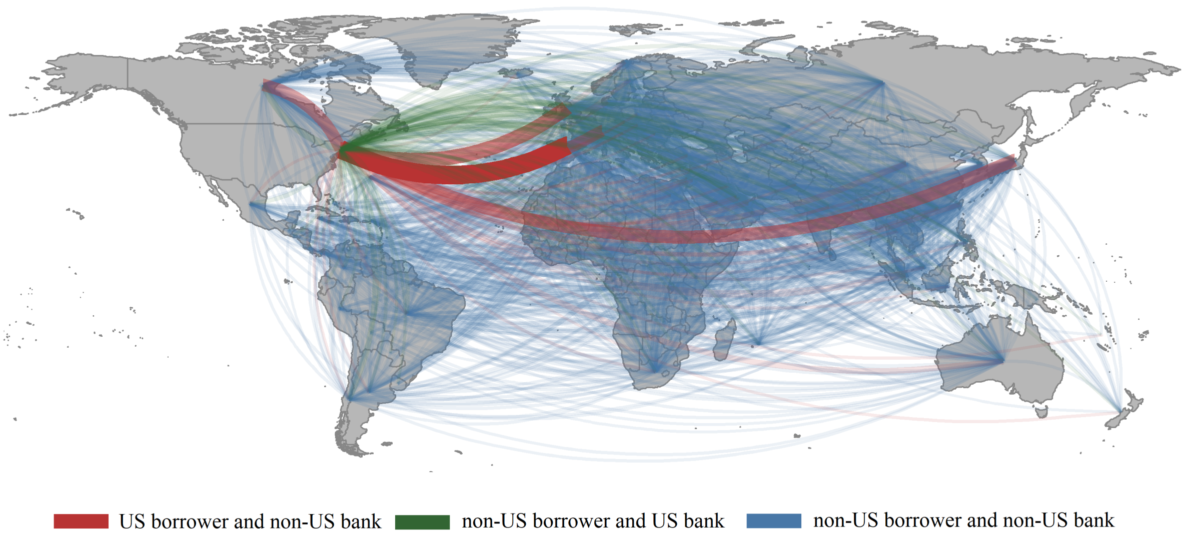
Category	Obs.			
Loans				
Individual Loans	83,563			
Individual Tranches	131,509			
Borrower-Lender-Loan connections	1,284,863			
Banks	Number of Banks	Median Tranche (in mn USD)	Std. Dev. (in mn USD)	
United States	17	350	1164	
Euro Area	83	235	1226	
United Kingdom	12	300	1276	
Japan	19	360	1286	
Rest of World	92	301	1192	
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.

and blue lines capture 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). Our empirical setup to identify the impact of global loan flows on exchange rates exploits the rich heterogeneity in lending relationships which are depicted in Figure 2.[15]

Figure 2: Global USD syndicated lending flows between 1997/01 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. Green 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 1997/01-2021/12.

To benchmark the size of cross-currency lending flows, we also compare the total outstanding syndicated loan volumes for a currency area from DealScan to the total banking systems cross-border claims in all currencies from the BIS Locational Banking Statistics (LBS). Figure IA.2 in the Internet 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

[15]In our empirical analysis we contrast USD loans extended by non-US banks (red and blue lines) with foreign currency loans extended by US banks. The latter are not shown in Figure 2 to preserve readability of the figure. We provide descriptive statistics on those loans in Table 1.

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.

3.3 Other data used in the empirical analysis

In our regressions below, we also employ spot exchange rates for a number of currencies (all against USD), which are available from the BIS website. More specifically, we compute log changes for monthly exchange rates (measured in basis points) based on the last trading day in each month. We complement these spot exchange rate data with forward exchange rates and overnight index swap (OIS) rates for maturities from one month to three years to compute deviations from covered interest parity. We also make use of a number of (macro-finance) control variables in our regressions, which we retrieve from various sources. Details on all these variables can be found in Appendix A.1.

3.4 Estimation 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 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

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

where $\mathrm{loans}_{c,t}^{\mathrm{USD}}$ denotes outstanding USD loans originated by non-US banks, and $\mathrm{loans}_{US,t}^{\mathrm{c}}$ 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 $\mathrm{NCCL}_{c,t}$ implies a *rise in* USD lending of banks from currency area c *relative to*

US bank lending denominated in currency c.

A key challenge in our estimation is the potential endogeneity of flows and exchange rates: global loan flows can affect exchange rates, but exchange rates can also influence 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.[16] This in turn would affect the flows which we observe and lead to a potential bias of our estimate of the effect of loan flows on the exchange rates.

To account for this issue, we devise an instrumental variable that leverages the granular micro-level information in syndicated lending. 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 approach, when deployed in our setting, rests on the idea that changes in flows can result from *common shocks* affecting all banks (and, plausibly, exchange rates directly) as well as *idiosyncratic shocks* affecting individual banks (but not exchange rates). Using a GIV approach allows us to construct an instrument that isolates idiosyncratic shocks to lending but is not driven by common shocks. Specifically, aggregate lending flows move more strongly when large banks are hit by idiosyncratic shocks compared to idiosyncratic shocks that only affect small banks. This differential effect on lending flows can be used to estimate the exchange rate elasticity.

Definition of the Instrument. To obtain a measure of the degree to which large banks are affected by idiosyncratic shocks, we follow Gabaix and Koijen (2021a) and use the difference of the value-weighted average lending flow (i.e. lending flows are weighted by market shares of banks) and the equally-weighted average lending flow across banks in a month. Gabaix and Koijen (2021b) use a similar instrument in the context of flows between equity and bond markets.

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

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

[16] For instance, Niepmann and Schmidt-Eisenlohr (2023) document a negative relation between a broad USD index and U.S. banks' corporate loan originations which they attribute to link to institutional investors' reduced demand for risky loans in the secondary market.

where $w^c_{j,USD,t-1}$ 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. $\Delta l^c_{j,USD,t}$ is 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 changes in outstanding loans, where N_{C_c} denotes the number of non-US 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:

$$\Delta^{\text{Outflow}}_{c,t} = \underbrace{\sum_{j\in C_{US}} \Delta l^{US}_{j,c,t} \times w^{US}_{j,c,t-1}}_{\text{Value-weighted average}} - \underbrace{\frac{1}{N_{C_{US}}} \sum_{j\in C_{US}.} \Delta l^c_{j,US,t}}_{\text{Equally-weighted average}} \tag{2}$$

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 (1) and (2), we use their net, defined as

$$z_{c,t} = \Delta^{\text{Inflow}}_{c,t} - \Delta^{\text{Outflow}}_{c,t}, \tag{3}$$

as our instrument for net currency lending flows in our micro-level panel regression section. The resulting instrument exhibits a high correlation with cross-currency loan flows, and, essentially no correlation with spot exchange rate changes. We provide further evidence on the validity of the instrument in Appendix A.2.[17]

Two-stage Panel IV Least Squares. With our main variable(s) and instrument at hand, we then estimate the following two-stage IV panel procedure

$$\begin{aligned} \text{First stage: } \Delta\text{NCCL}_{c,t} &= z_{c,t} + \text{Controls}_{c,t} + \varepsilon_{c,t}, \\ \text{Second stage: } \Delta s_{c,t} &= \phi\widehat{\Delta\text{NCCL}}_{c,t} + \text{Controls}_{c,t} + \vartheta_{c,t}, \end{aligned} \tag{4}$$

[17]The correlation between the GIV instrument and spot exchange rate changes is a mere 4% and also statistically insignificant. By contrast, the correlation with net cross-currency lending flows, $\Delta NCCL$, is 31%. Gabaix and Koijen (2021b) show that the GIV instrument is particularly efficient when the excess Herfindahl index defined as $h := \sqrt{-\frac{1}{N} + \sum_{i=1}^{N} \Psi_i^2}$, where Ψ_i is the share of bank i loans as a percentage of all syndicated loans within a currency area, is large. Figure IA.7 in the Internet 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). Results for the first-stage regression can be found in Table A.2 in the Appendix.

where $\Delta\text{NCCL}_{c,t}$ is the previously defined net cross-currency bank lending measure. An increase in this variable indicates 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. The variable $z_{c,t}$ denotes the GIV instrument as defined above. 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 currency 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 estimate the effect of changes in net lending flows on spot exchange rate changes.

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. Having established this core result which corroborates Implication 1 of Section 2, we then proceed by showing that the importance of lending flows for exchange rates only emerged after the great financial crisis (GFC). Guided by Implication 2 of the conceptual framework in Section 2, we then move on to empirically investigate the role of intermediary balance sheet constraints and conditions in dollar funding markets in shaping the elasticity of exchange rates to cross-border bank flows.

4.1 Cross-currency lending flows and exchange rate elasticity

We start by reporting full-sample estimates for our main specification in Eq. (4) 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 of the USD 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.[18]

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.[19] 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)—an economically meaningful magnitude. 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 conceptual motivation in Section 2, i.e. more net USD lending by foreign banks leads to an appreciation of the dollar.[20]

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\widehat{\Delta\text{NCCL}}_{c,t}$	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: The Table reports second-stage results of the two-step 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. $\widehat{\Delta\text{NCCL}}_{c,t}$ is the contemporaneous GIV-instrumented difference between the lending of foreign banks into the USD and US bank lending flow out of the USD (obtained from the first-stage regression). 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 basis points (p.a.). HAC-robust standard errors in parentheses. Pseudo-R^2 refers to the squared correlation between the second stage variables and the dependent variable here and in the henceforth.

[18] The Global Financial Cycle as proposed in Rey (2015) is unlikely to explain the observed effect, as we control for it in all our regressions by including the first difference of the VIX. Also including year-month fixed effects instead of year fixed effects does not materially alter our main findings.

[19] We report the results of the first-stage regression in Table A.2 of the Appendix.

[20] Table IA.3 in the Internet Appendix provides more evidence when we split the net flows into in-and outflows and their respective effect on spot exchange rates. Table IA.4 compares the effect on forward exchange rates with the baseline regression on spot rates.

Shifts in the relation pre- vs. post GFC

Economic intuition and the implications of our framework in Section 2, suggest that the elasticity of exchange rates with respect to global lending flows should have changed 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 reliance on FX swaps and non-bank funding sources. Both of these developments suggest tighter conditions in USD funding markets, which – in line with Implication 2 of the framework in Section 2 – should result in a higher elasticity of exchange rates.

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 statistically and economically significant only 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.

Overall, these findings suggest that structural developments in the financial system since the GFC have greatly increased the importance of cross-border banking flows for exchange rates. In line with Implication 2 derived in Section 2, this increased impact of flows can likely be traced to a tightening of intermediation capacity in the global financial system—an issue we turn to next.

4.2 The role of constrained intermediation capacity and tighter USD funding conditions

We now dig deeper into the economic mechanism that generates our main finding. In line with Implication 2 of the framework in Section 2, we study various factors that, by affecting intermediation capacity and the tightness of USD funding markets, should affect the link between lending flows and exchange rates. Specifically, we study the importance of broker-dealer constraints and US dollar funding market tightness (including in relation to the monetary

Table 3: Exchange rate elasticity before and after the GFC

	Pre-GFC			Post-GFC		
$\widehat{\Delta \text{NCCL}}_{c,t}$	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: The Table reports second-stage regression results of the two-step panel IV estimation with a granular instrument. Pre-GFC refers to the time period before 2009/01, post-GFC refers to the subsequent time period. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\widehat{\Delta \text{NCCL}}_{c,t}$ is the GIV-instrumented difference between the USD syndicated lending of foreign banks and the logarithm of foreign currency syndicated lending of US banks (obtained from the first-stage regression). 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 basis points (p.a.). HAC-robust standard errors in parentheses.

policy cycle),

The role of broker-dealer leverage

In the aftermath of the great financial crisis, several regulatory reforms have tightened capital constraints for broker-dealers significantly. It is thus natural that intermediary balance sheet constraints may be an important factor driving the change in the elasticity of exchange rates to lending flows.[21] To shed light on the possible impact of such constraints, we examine the role of broker-dealer leverage more explicitly in the following. Consequentially, we would expect the elasticity of exchange rates with respect to flows to be higher when broker-dealers are more constrained.

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

[21] In this context, for instance 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. In a similar vein, Du *et al.* (2018b) trace violations of the CIP (arbitrage) condition to balance sheet constraints while Cenedese *et al.* (2021) show that the Basel III leverage ratio constrained dealers charge customers a higher premium for synthetic dollar funding.

Adrian *et al.* (2014)–defined as the ratio of total financial assets to equity (with the latter being the difference between total financial assets and total liabilities in the broker-dealer sector).[22]

We compare time periods in which banks exhibit low leverage ratios (below average) to times when the leverage ratio is above average. Table 4 presents the results. It shows that exchange rates react more strongly to flows when leverage is low, that is in periods when broker-dealers have less ability to flexibly expand their balance sheet via leverage. Table 4 shows that such times go hand in hand with a higher exchange rate elasticity, which is conceptually in line with Gabaix and Maggiori (2015).

Table 4: Exchange rate elasticity and broker-dealer constraints

	Low Leverage	High Leverage
$\widehat{\Delta \text{NCCL}}_{c,t}$	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: The Table reports second-stage regression results of the two-step panel IV estimation with a granular instrument. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\widehat{\Delta \text{NCCL}}_{c,t}$ 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 (obtained from the first-stage regression). 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 remainder of the empirical setup resembles the one of our main analysis presented in Table 2. 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 basis points (p.a.). HAC-robust standard errors in parentheses.

The role of US dollar funding market tightness

The arguments laid out in Section 2 suggest that the tightness of conditions in USD markets and their accessibility for foreign banks is crucial in affecting the exchange rate response to cross-border lending flows. In the following, we investigate this channel from various angles.

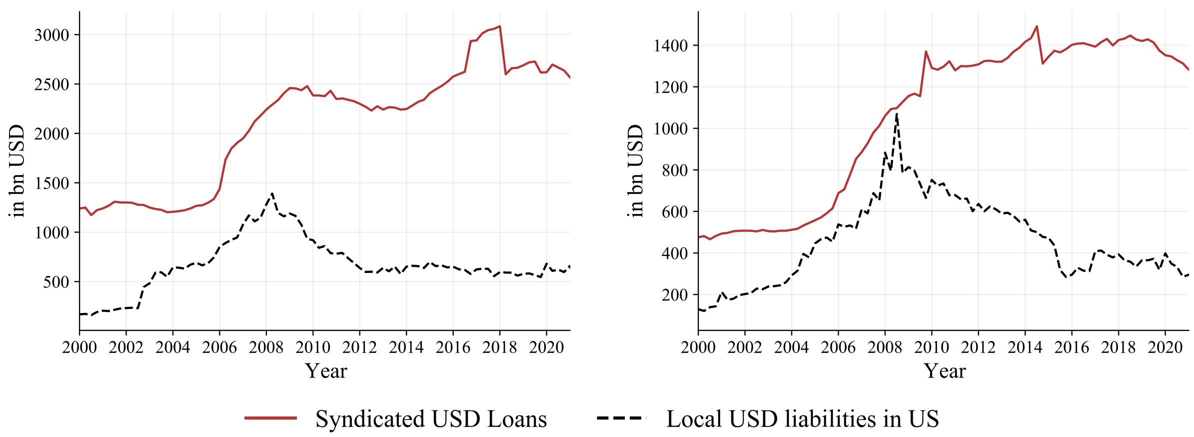
To further motivate the analysis, we start out with a brief discussion of the structural shifts in

[22] The measure is constructed from Federal Reserve Z.1 security brokers and dealers series: Total Financial Assets (FL664090 0 05) divided by Total Financial Assets (FL664090 0 05) less Total Liabilities (FL664190 0 05), see He *et al.* (2017).

USD funding markets that occurred after the GFC. 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.

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

(a) Euro Area banks **(b)** British 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 BIS Consolidated Banking Statistics 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.

As can be seen from Figure 3, conventional USD funding and syndicated lending steadily grew together from 2000 until 2008. Since the GFC, however, cross-currency syndicated lending in USD has continued to increase whereas local USD funding by non-US banks has dwindled. Taken together, these observations indicate that globally active banks may need to increasingly rely on funding sources other than local USD liabilities in the US to finance their dollar-denominated banking assets.[23] 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 USD liquidity.

We now proceed by exploring the impact of USD funding conditions in shaping the elasticity of exchange rates to banking flows more formally, in line with Implication 2. We do so in various ways, first examining the role of direct borrowing in USD as a source of funding for

[23]After origination, banks may also securitize part of the syndicated loans and sell them to (non-bank) investors. As these investors often reside in the same currency area as the originating bank, increased reliance on FX swaps for funding the origination of syndicated loans discussed in Section 2 could be an important contributing factor to the growing trend in off-balance sheet USD debt, as evidenced in Borio *et al.* (2022).

non-US banks. As previously discussed, if US banks have ample dollar liquidity and are able to easily provide funding to non-US banks, we would expect the exchange rate elasticity to be more subdued compared to 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 marginal reserve distributors to other (especially foreign) banks. Hence, we 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 dividing our sample into above and below average across the sample period.[24] Table 5 shows that when the share of reserves to total risk-weighted assets is low, the exchange rate elasticity is higher. In other words, when US banks have limited liquidity to distribute, the cost of providing USD funding rises, which induces a stronger appreciation of the USD.

To further analyze the role of USD funding market tightness, we examine the relationship between the share of loans granted to foreign banks and the exchange rate elasticity. The share of interbank loans granted to foreign banks, either in the US through a branch or abroad, is an important factor in determining the amount of USD liquidity supplied to non-US banks. When it is low, non-US banks will need to source USD liquidity synthetically from the FX swap market as opposed to borrow directly through interbank markets. We divide the sample in time periods when the shares of loans granted to foreign banks are below and above average. The results in Table 5 indeed confirm that, when the share of loans granted to foreign banks is low, the exchange rate elasticity is higher.

A third way of investigating the link of the exchange rate elasticity with USD funding market tightness is to consider the role of unevenness in the distribution of USD reserves in the banking system. 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 an important role as a driver of frictions that affect the ease with which dollar liquidity is redistributed in the system. Intuitively, for any given level of reserves, if only a few large banks hold most of the reserves and are unwilling to redistribute them, there might

[24] Figure IA.3 in Section IA.2.6 of the Internet Appendix defines periods of high and low shares of reserves relative to total risk-weighted assets.

Table 5: 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
$\widehat{\Delta \text{NCCL}}_{c,t}$	-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: The Table reports second-stage regression results of the two-step panel IV estimation with a granular instrument. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\widehat{\Delta \text{NCCL}}_{c,t}$ 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 (obtained from the first-stage regression). An increase in this measure implies that foreign banks lend more in USD than US banks lend in foreign currency. All high-low separations of the sample are based on the average across the sample, see Internet Appendix IA.2.6 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 basis points (p.a.). HAC-robust standard errors in parentheses.

be detrimental effects on smaller and/or foreign banks that cannot access (claims on) reserves other than through these large banks. We would therefore expect that a higher concentration of reserves among the major US banks implies greater re-distributional frictions hampering foreign banks' ability of obtaining USD funding. This will in turn manifest in a higher exchange rate elasticity with respect to cross-border banking flows.

To quantify the concentration of reserves among the top 30 largest US banks we compute the Herfindahl-Hirschman index of reserve holdings. Our findings in Table 5 indicate that a high concentration of reserves among the top 30 US banks is associated with a stronger response of exchange rates to cross-border lending flows. Together with the previous two findings (on the share of reserves and of loans to foreign banks), these results further strengthen our conclusion that tightness in USD finding markets amplifies the impact of flows on the exchange rate (Implication 2).

Phases of the monetary policy cycle and USD funding conditions

It is also well-known that funding conditions for banks change markedly over the monetary policy cycle. In periods when the Federal Open Market Committee (FOMC) tightens monetary conditions competition for funds in dollar markets tends to intensify. Drechsler *et al.* (2017) demonstrate that US banks hold a market power advantage over deposits which allows them to keep deposit rates subdued even if policy rates set by the central bank are rising. However, foreign banks face greater pressure to compete for alternative source of wholesale funding, such as the commercial paper/certificate of deposit market, leading to higher costs and a disadvantage relative to US banks.[25] According to Implication 2 in Section 2, tighter conditions in USD wholesale funding markets will likely result in a higher exchange rate elasticity in response to a rise in net cross-currency lending flows.

To test this hypothesis, we divide our sample into monetary policy cycles characterized as "hiking", "easing", or "no change" as depicted in Figure IA.6 in the Internet Appendix. Table 6 shows that the impact of flows on exchange rate tends to be particularly pronounced during Fed hiking cycles. In these periods funding conditions in USD markets tend to tighten, especially for foreign banks, which in turn leads to an increase in the exchange rate elasticity with respect to cross-currency lending flows.

To further assess the role of funding market conditions, we also study how the elasticity of exchange rates depends on dollar scarcity as captured via deviations from covered interest parity (CIP). This result – relegated to the Internet Appendix to conserve space – broadly confirms the previous findings that increased cross-currency USD lending leads to a larger USD appreciation in times of elevated USD funding scarcity.[26]

5 Global Bank Lending and USD Funding Markets

As discussed in Section 2, 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. As Implication

[25]This finding may be linked to the phenomenon that money market funds receive inflows during periods of monetary tightening while competitive pressures to retain deposits tend to increase, see e.g. Kacperczyk and Schnabl (2013).

[26]Details can be found in Internet Appendix, columns (4) and (5) of Table IA.5, which show that when USD funding markets are tight (i.e. CIP deviations are large), the exchange rate elasticity is higher.

Table 6: Exchange rate elasticity and the US monetary policy cycle

	Fed Cycle		
	Hike	No Change	Ease
$\widehat{\Delta\text{NCCL}}_{c,t}$	100.9	21.20	-22.38
	(18.87)	(49.83)	(144.7)
Observations	332	629	223
Macro-controls	Yes	Yes	Yes
Currency FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Currency Areas	11	13	10
Pseudo-R^2	0.06	0.10	0

Notes: The Table reports second-stage regression results of the two-step panel IV estimation with a granular instrument. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\widehat{\Delta\text{NCCL}}_{c,t}$ 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 (obtained from the first-stage regression). 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. 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 basis points (p.a.). HAC-robust standard errors in parentheses.

3 of our framework suggests, we would expect higher net lending flows to lead to larger CIP deviations. In the following, we show this prediction is borne out in the data (Subsection 5.1). In Subsection 5.2, we explore the response of issuance in the CP/CD market, which for certain banks may be a more attractive source of dollar funding compared to the practice of rolling over FX swap funding.

5.1 Lending flows and the term structure of CIP deviations

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

$$x_{t,t+n} = y^{\$}_{t,t+n} - \left(y_{t,t+n} - \rho_{t,t+n}\right), \tag{5}$$

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

Deviations of the cross-currency basis from zero are commonly interpreted as deviations from Covered Interest Parity Du *et al.* (2018b). A negative currency basis implies tightness of funding conditions in US dollar markets 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 – exceeds the direct USD borrowing cost. As a measure for risk-free interest rates ($y_{t,t+n}$), we use overnight index swap (OIS) rates. 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.

To test Implication 3, we analyze how changes in net cross-currency lending by global banks affect the CIP deviation across maturities from 1 month to 3 years. As in our empirical analyses before, there is a potential endogeneity issue in the sense that a larger CIP deviation itself might increase the cost of USD lending for and thus lower USD loan originations by foreign banks. To address this issue, we again rely on our GIV framework when estimating the effect of flows on CIP deviations. Specifically, the regression equations are

$$\begin{aligned} \Delta \text{NCCL}_{c,t} &= z_{c,t} + \text{Controls}_{c,t} + \varepsilon_{c,t}, \\ \text{CIP deviation}_{n,c,t} &= \phi \widehat{\Delta \text{NCCL}}_{c,t} + \text{Controls}_{c,t} + \vartheta_{c,t}, \end{aligned} \tag{6}$$

where the dependent variable, CIP deviation$_{n,c,t}$, is the cross currency basis for a contract with n months to maturity. ΔNCCL$_{c,t}$ is the previously defined net cross-border lending flow. $z_{c,t}$ is the GIV instrument defined in Equation (3). The remainder of our estimation approach follows the one used in Section 3.4 for the estimation of the effect on the spot exchange rate.

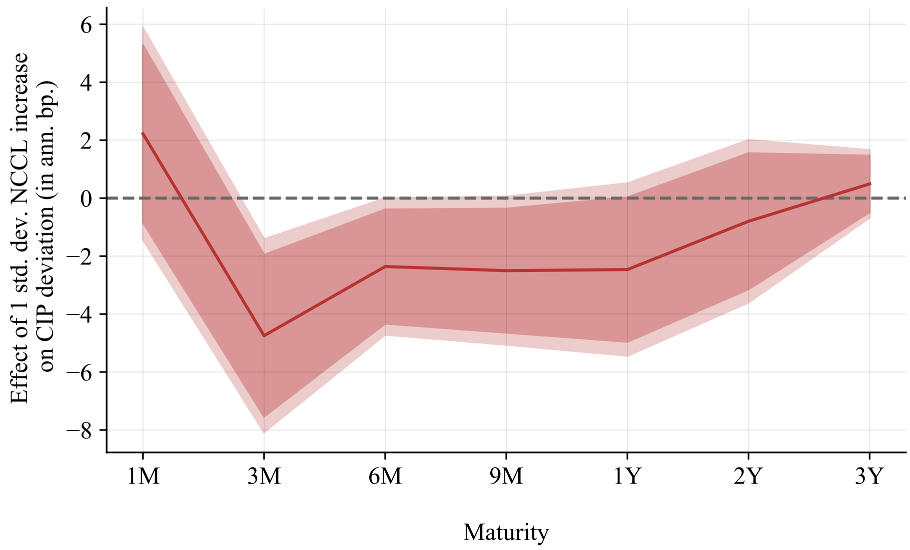
Figure 4 shows the effect of cross-border bank lending flows on the CIP deviation across different maturities. Most of the estimated coefficients are negative which implies that an increase in net USD cross-currency lending implies a larger (i.e. more negative) CIP deviation. In terms of economic significance, a one standard deviation increase in net USD lending flows, implies a 4.8 basis points more negative CIP deviation (at the three-month tenor). Turning to the results across maturities in Figure 4, we find that the effect is strongest at the three months tenor. This finding seems interesting, because banks that secure short-term USD liquidity via FX swaps commonly do so with contracts at a three months maturity.[27] 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 should thus be most pronounced at the this tenor and Figure 4 confirms this hypothesis. Overall, this finding lends credence to the view that cross-currency lending drives demand for USD liquidity via FX swaps and supports Implication 3 discussed in Section 2.

5.2 Cross-Currency Lending and USD Funding Markets

Non-US banks can acquire USD liquidity via a multitude of instruments and funding sources, with FX swaps being the most flexible (as discussed above). But banks can also place USD-denominated commercial paper (CP) and/or certificates of deposits (CD) with money market funds (MMFs). Compared to rolling over FX swaps to obtain USD liquidity, banks are less flexible in placing CP or CDs with longer maturities with investors. Moreover, this option is only available to banks with sufficiently high credit ratings or with an established investor base

[27] Based on our discussions with market participants in treasury and syndicated loan divisions at banks, the three months tenor was mentioned as the most common swap maturity by far.

Figure 4: 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.

willing to hold their debt instruments. If banks are indeed in a position to place their CP or CDs, though, the cost of obtaining USD liquidity tends to be lower, making this option preferable to FX swap funding.

To investigate whether banks rely on USD CP and CDs to (at least partially) fund USD denominated syndicated loans, we obtain information on all available active and inactive CP 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 to non-bank players such as MMFs, see e.g. Rime *et al.* (2022).

We analyze CP/CD issuance separately for banks with high and low credit quality (relative to the average rating across all banks) as USD money markets are known to exhibit a large degree of tiering, see e.g. Rime *et al.* (2022).[28] This tiering essentially makes it very costly for banks with lower credit ratings to place their CP/CDs with MMFs, which might prevent them from obtaining USD liquidity via the USD money market in the first place. We would thus expect these low-rated banks to rely more heavily on the FX swap market compared to banks with high ratings and access to short-term funding via CP/CDs. We thus analyze the effect of increases in USD outstanding loans in a given currency area on the issuance growth within the group of

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

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:

$$\Delta(\text{CP+CD})_{c,t+i} = \Delta\text{USD Lending}_{c,t} + \text{Controls}_{c,t} + \vartheta_{c,t}, \tag{7}$$

where $\Delta(\text{CP+CD})_{c,t}$ is the change in the logarithm of outstanding USD CP 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. The remainder of control variables remains the same compared to our previous setup in Section 3.4. Following Jordà (2005), we run this regression as a local linear projection where the dependent variable is the difference between the previous month's value and the value $i = 0, 1, ..., 18$ months ahead.

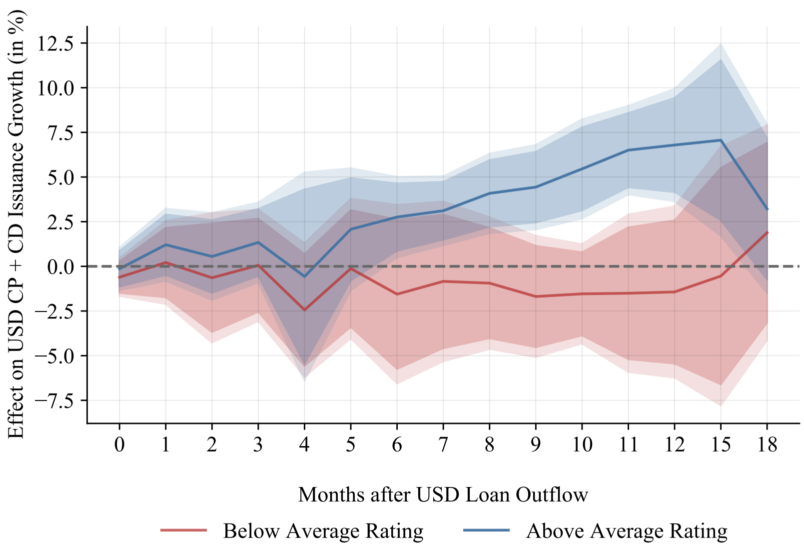
Figure 5 plots the results of this exercise. As expected, banks with below average credit ratings do not increase their USD CP and CD issuance following an increase in USD lending, presumably because their lower rating prevents them from tapping this market to substitute FX funding. Banks with above-average credit ratings, however, indeed significantly increase their USD CP and CD issuance starting around 6 months after the increase in USD denominated loans.

Banks appear to increase their CP and CD issuance volume with a significant time lag after large loan outflows into the USD from a particular currency area. 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 5 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 liquidity management practices.

6 Additional results and robustness

To further understand the economic drivers of cross-country variation in the importance of flows for exchange rates, we first investigate structural differences in USD funding across countries in Section 6.1. Next, we provide robustness of our main finding by utilizing an alternative

Figure 5: 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 CP 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.

instrument instead of the Granular IV we deployed in our main analysis in Section 6.2. We provide further robustness results in the Internet Appendix.

6.1 Impact of cross-country differences in USD funding

Different currency areas feature different degrees of reliance on USD-denominated assets and liabilities. For instance, Aldasoro *et al.* (2020) show that Australian banks have historically accumulated more USD liabilities than 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 originating from currency areas that face a dollar glut and can be net providers of USD in FX swap markets.

To determine whether these funding disparities between currency areas influence the exchange rate elasticity, we use data from the Locational Banking Statistics data base maintained by the Bank for International Settlements (BIS). We then split our sample into two groups. The first group comprises banks headquartered in a currency area that has high USD funding and a second group with banks in currency areas that have low USD funding. Specifically, we make use of the variable 'net USD claims' which is defined as the difference between outstanding USD claims (i.e. USD assets) and USD funding (i.e. USD liabilities) of banks from a specific currency area. A positive net claim means that a currency area has more USD assets than USD funding, i.e. such currency areas would be net receivers in in FX swap markets. Conversely, a negative net claim means an excess of USD funding over USD claims that need financing, so these currency areas would be net USD providers of USD in FX swap makets.[29]

Based on this distinction, we would expect that global bank lending flows originating from countries with positive net claims move the exchange rate more than lending flows coming from countries with negative net claims.

To provide context, Figure 6 plots net claims for six major currency areas. Australian banks consistently exhibit negative net claims, thereby indicating their USD funding surplus and potential role as net providers of USD swap funding. On the contrary, Japanese banks exhibit the largest and most persistently growing net claims (i.e. a USD funding deficit), which suggests that (some of) these claims need funding via FX swaps.

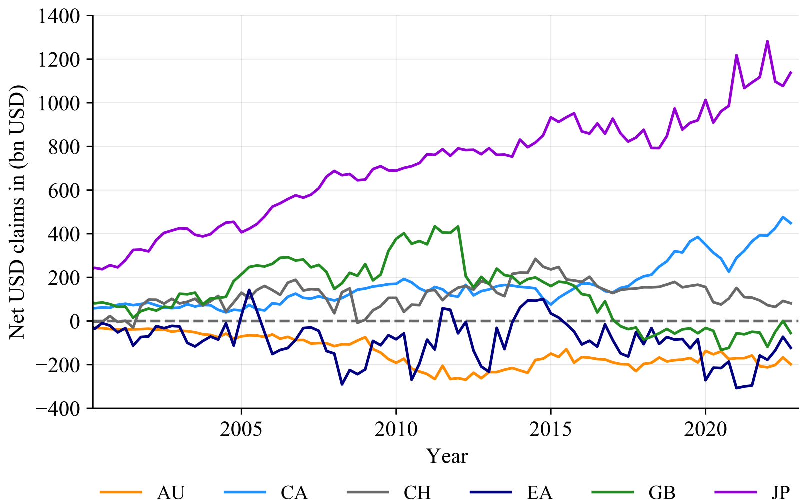
Table 7 reports estimates of the exchange rate elasticity with respect to flows for the two groups of countries. As expected, there is no significant effect of foreign currency lending on exchange rates for countries whose banking systems have negative net claims (USD funding surplus). Conversely, there is a notable effect of net foreign currency lending flows on exchange rates of countries with positive net claims (USD funding deficit). These results are intuitive, as the latter are required to resort to the FX swap market to fund their foreign currency lending, while the former do not or at least to a lesser degree. These findings also show that it is not only fluctuations in the USD *over time* that influences USD denominated cross-border lending (e.g. Avdjiev *et al.*, 2019) but that rather persistent features *across* countries' banking systems (here, USD funding) can also play an important role in this regard.

In the last column, we report results for an alternative specification which comprises all countries in the sample but has ΔNCCL as well as an interaction term of ΔNCCL and net claims as independent variables (in addition to controls and fixed effects). The third column of Table 7 report the coefficient on this interaction term, which we estimate to be positive and significantly different from zero. In sum, USD lending flows originating from countries with a structural

[29] Claims and liabilities are measured vis-à-vis the banking and non-bank sector. For non-US banks, we also include local claims and liabilities in the US with all sectors as counterparties.

USD funding deficit have a stronger effect on exchange rates than lending flows from countries with a structural USD funding surplus.

Figure 6: Evolution of net US dollar claims across major banking systems



Notes: This figure depicts the USD-denominated net claims for selected banking systems by nationality over time. Positive values mean that banks from this currency area have more USD claims than liabilities and thus indicate a USD funding deficit. Conversely, negative values correspond to the banking sector having more USD funding than acquired assets and thus indicate a USD funding surplus. The data are from the BIS LBSN and CBS/I database for the time period 2000/01-2022/12. Japanese values include trustee positions of Japanese banks that are held on behalf of customers.

6.2 Capital constrainedness as an alternative instrument

Finding an instrument that impacts cross-currency loan flows but not exchange rates is challenging because most candidate variables would affect not only lending flows but also overall economic conditions and thus exchange rates. Our GIV instrument in our baseline results addresses this main issue, allowing for a clean identification of the impact of cross-currency loan flows on exchange rates. That said, to strengthen the robustness of our main finding, we also construct an alternative instrument that is based on a shift in credit lending conditions but plausibly uncorrelated with exchange rate changes. This alternative instrument, makes use of a change in regulations in the Eurozone, allowing for a clear economic interpretation. A drawback though is that it has limitations in terms of the sample of countries and the time period that can be covered in our estimation (06/2011 until 12/2013). We hence prefer the GIV approach for our baseline.

Specifically, we utilize the European Banking Authority (EBA) capital exercise as a quasi-natural experiment. The EBA capital exercise, conducted in 2011/2012, mandated the largest

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

	Sample split		
	Negative net claims ("USD surplus")	Positive net claims ("USD deficit")	Regression with Interaction Term
$\widehat{\Delta \text{NCCL}}_{c,t}$	73.00	82.08	
	(64.46)	(18.44)	
$\widehat{\text{Net claims} \times \Delta NCCL_{c,t}}$			0.131
			(0.026)
Observations	487	555	1042
Macro-controls	Yes	Yes	Yes
Currency FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Currency Areas	4	5	6
Pseudo-R^2	0.110	0.100	0.180

Notes: The Table reports the results of two-stage panel IV estimation with a granular instrument. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\widehat{\Delta \text{NCCL}}_{c,t}$ 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 (obtained from the first-stage regression). 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. 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. The coefficient describes the effect of a 100 bp increase in the lending measure on the spot exchange rate in basis points (p.a.). HAC-robust standard errors in parentheses.

European banks to raise their Core Tier 1 capital ratios to 9% 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.[30]

The first instrument we use considers the interaction of the (log of the) Tier 1 capital and an indicator variable indicating the post-EBA period.

$$\text{Instrument}^{(1)}_{c,t} = \text{Tier 1 capital}_{c,t} \times \mathbb{1}^{EBA}_{c,t}.$$

High levels of Tier 1 capital allow banks to be less affected by the EBA capital exercise in their lending business. This is in line with Gropp *et al.* (2019), who find that banks that needed to raise capital during the capital exercise reduced their lending. The last factor takes on the value 1 if the currency area is subject to the EBA capital exercise. Thus, we expect this measure to correlate positively with inflows into the country, as tighter regulatory scrutiny in the home country makes lending by foreign banks relatively more attractive compared to local banks.

We also gather data on the anticipated lending conditions for banks in the respective currency areas. For this purpose we use surveys (Bank Lending Survey for the Euro area, Senior Loan Officer Survey for Canada, and Credit Conditions Survey for the UK) which capture how senior loan officers evaluate lending conditions going forward. We use the respective proxies for the expected lending demand to capture banks' anticipated loan demand over the near future. Additionally, we obtain information on the Tier 1 capital banks from the respective currency areas hold on average in a given month. The source here is Bank Focus. We then consider a second variant of our alternative instrument where we further interact the instrument with the anticipated lending conditions:

$$\text{Instrument}^{(2)}_{c,t} = \text{Tier 1 capital}_{c,t} \times \mathbb{1}^{EBA}_{c,t} \times \text{lending conditions}_{c,t-3}.$$

Higher values in the lending conditions variable reflect an improving of expected lending conditions in the home country going forward. Thus, we should observe less cross-border lending activity. We would overall expect a negative effect of the second variant of the instrument

[30] 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. We include banks from the UK in the control group despite the largest banks having been part of the EBA capital exercise, as the four banking groups already considerably exceeded the regulatory threshold prior to the EBA capital exercise following prior scrutiny by local regulators.

on cross-border lending in the first stage of our estimation, as better lending conditions at home and higher regulatory scrutiny negatively should affect lending abroad negatively.

Notably, the EBA capital exercise is unlikely to have affected exchange rates directly, which makes the lending tightness measure a suitable instrument for net cross-currency lending. This is supported by a negligible correlation between our lending tightness measures and spot exchange rate changes.

Table 8 reports estimation results using the two types of lending tightness instruments. The first instrument exhibits a positive correlation with the cross-border loan measure in the first-stage regression. This is intuitive as higher capitalized banking systems are less affected by the EBA capital exercise. In the second stage, we find a positive and significant effect of cross-currency lending flows on exchange rates. The effect turns out to be somewhat larger in magnitude than our baseline estimate (see Table 2 for comparison). These results support the notion that differences between countries in the ease of originating new syndicated loans have a bearing on the exchange rate via a decline in cross-currency loan flows. The right-hand panel of Table 8 reports estimation results for the second instrument. Intuitively, the first stage shows a negative correlation as a deterioration in lending conditions at home, in conjunction with better capitalized banks, leads to more lending abroad. In the second stage, we can also observe a significant positive effect on the US dollar exchange rate when foreign banks grant more USD loans.[31].

7 Conclusion

We examine the impact of flows on exchange rates through the lens of granular information on cross-currency lending in the syndicated loan market. We find that exchanges rates respond significantly to net cross-currency lending flows: A net increase in US dollar lending by foreign banks (relative to that in foreign currency by US banks) implies that the dollar appreciates against 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. We corroborate this main finding based on an alternative instrument for lending constructed from regulatory changes to capital requirements by European banks.

[31] To account for differences in this small time frame in the lending condition expectations, we control for the current value of lending expectations in the respective home countries throughout all our specifications.

Table 8: Baseline regression with alternative instrument

	$\text{Instrument}^{(1)}_{c,t}$		$\text{Instrument}^{(2)}_{c,t}$	
Instrument:	$\text{Tier 1 capital}_{c,t} \times \mathbb{1}^{EBA}_{c,t}$		$\text{Tier 1 capital}_{c,t} \times \text{Lend. cond.}_{c,t-3} \times \mathbb{1}^{EBA}_{c,t}$	
	First Stage	Second Stage	First Stage	Second Stage
Dependent variable:	$\Delta\text{NCCL}_{c,t}$	$\Delta s_{c,t}$	$\text{NCCL}_{c,t}$	$\Delta s_{c,t}$
Instrument	0.234		-0.010	
	(0.064)		(0.003)	
$\widehat{\Delta\text{NCCL}}_{c,t}$		245.7		329.0
		(97.75)		(133.8)
Observations	93	93	93	93
Macro-controls	Yes	Yes	Yes	Yes
Currency FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Currency Areas	3	3	3	3
Pseudo – R^2		0.142		0.136
First stage F-test		19		17

Notes: The Table reports the results of two-stage panel IV estimation with a granular instrument. Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\widehat{\Delta\text{NCCL}}_{c,t}$ 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 (log of) Tier 1 capital holdings, and a binary variable indicating European banks under effect of the EBA capital exercise (07/2012-03/2013) (columns (1) and (2)), which we further interact with the lending conditions reported by the largest banks (obtained from central bank surveys; lagged by one quarter) in columns (3) and (4). The first difference of the end of month VIX index as well as the current lending condition expectation 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 basis points (p.a.). HAC-robust standard errors in parentheses.

We show that the impact of lending flows on exchange rates only emerged after the GFC and that it is stronger when dealers' capacity to flexibly expand their balance sheet by taking on greater leverage is more constrained. It is also stronger when funding conditions in the US dollar tighten, e.g., during the hiking phase of the monetary policy cycle or when USD reserve holdings in the banking system are more concentrated. All in all, these findings point to an important role for intermediation and funding frictions in affecting exchange rates.

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", *CEPR Discussion Paper No. DP14437*.

Aldasoro, Iñaki, Beltrán, Paula, Grinberg, Federico, and Mancini-Griffoli, Tommaso, 2022a, "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, 2022b, "Global Banks, Dollar Funding, and Regulation", *Journal of International Economics*, *137*, Article 103609.

Aldasoro, Iñaki, Ehlers, Torsten, McGuire, Patrick, and von Peter, Goetz, 2020, "Global Banks' Dollar Funding Needs and Central Bank Swap Lines", *BIS Bulletin No. 27*.

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.

Bippus, Balduin, Lloyd, Simon, and Ostry, Daniel, 2023, "Granular Banking Flows and Exchange-Rate Dynamics", *Bank of England Staff Working Paper No. 1043*, *September 2023*.

Borio, Claudio, McCauley, Robert, and McGuire, Patrick, 2022, "Dollar Debt in FX Swaps: Huge, Missing and Growing", *BIS Quarterly Review, December 2022*.

Borio, Claudio, McCauley, Robert, McGuire, Patrick, and Sushko, Vladyslav, 2016, "Covered Interest Parity Lost: Understanding the Cross-currency Basis", *BIS Quarterly Review, September 2016*.

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.

Cenedese, Gino, Della Corte, Pasquale, and Wang, Tianyu, 2021, "Currency Mispricing and Dealer Balance Sheets", *The Journal of Finance*, *76*(6), 2763–2803.

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, 2023, "Intermediary Balance Sheets and the Treasury Yield Curve", *Journal of Financial Economics*, *150(3)*, Article 103722.

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

Engel, Charles and Wu, Steve Pak Yeung, 2018, "Liquidity and Exchange Rates: An Empirical Investigation", *NBER Working Paper No. 25397*.

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", *International Finance Discussion Papers Board of Governors of the Federal Reserve System, Number 1283*.

Lilley, Andrew, Maggiori, Matteo, Neiman, Brent, and Schreger, Jesse, 2022, "Exchange Rate Reconnect", *The Review of Economics and Statistics*, *104*, 845–855.

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*.

McGuire, Patrick and von Peter, Goetz, 2009, "The US dollar shortage in global banking", *BIS Quarterly Review, March 2009*.

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

Niepmann, Friederike, 2023, "Banking Across Borders with Heterogeneous Banks", *Journal of International Economics*, *142*, Article 103748.

Niepmann, Friederike and Schmidt-Eisenlohr, Tim, 2023, "Institutional Investors, the Dollar, and U.S. Credit Conditions", *Journal of Financial Economics*, *147*(1), 198–220.

Rey, Hélène, 2015, "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence", *NBER Working Paper No. 21162*.

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.

Appendix

This Appendix provides additional information on data sources and tickers, as well as additional information on the granular instrumental variable approach underlying our empirical results.

A.1 Additional Information on Data

Table A.1: Data Sources

Variable Name	Description	Data Source	Mnemonic/Link
Spot exchange rate	FC/USD (ann. bp.)	BIS	Link
Forward rates	FC/USD (ann. bp.)	Refinitiv Eikon	USD+**X**+1M=R, **X**=3 digit currency code
Loan volume	Volume of outstanding loans	Refinitiv DealScan	Link
VIX index	CBOE Volatility Index	Federal Reserve Bank of St. Louis	VIXCLS (Monthly, Average)
3 month interbank	90-day interbank rates and yields	Federal Reserve Bank of St. Louis	IR3TIB01+**X**+M156N, **X**=2 digit country code
CPI inflation	Core CPI, Standardized, SA, Chg P/P	Refinitiv Eikon	a+**X**+CCORPE/A, **X**=2 digit country code
5y and 10y gov. bond yields		Refinitiv Eikon	**X**+5YT=RR/**X**+10YT=RR, **X**=2 digit country code
OIS rates	1 Month Overnight Index Swap	Refinitiv Eikon	**X**+1MOIS= with **X**=['JPY', 'CHF', 'USD', 'GBP', 'AUD', 'CAD', 'NZD'], 'EUREON1M=', 'KRW1MOIS=KMBC', 'CNYAMOS1M=CFIC', 'INRAMONMI1M=', 'NOK1MOIS=TDS'
CP/CD Issuance	USD CP/CD Issuance volume	Refinitiv Eikon	Manual download of issued CP/CDs
CP/CD Rating	CP/CD Issuer Rating	Refinitiv Eikon	TR.IssuerRating of ISINs
Net USD positions within country	USD claims - liab. positions	BIS LBS	
Lending conditions	Exp. lending cond. 3 months ahead	ECB Canada UK	BLS.Q.U2.ALL.LE.E.Z.F3.ST.S.WFNET SLOS Credit Conditions Survey
Tier 1 capital holdings of banks	Tier 1 capital holdings of banks	BankFocus	

Notes: This table summarizes the data sources used to obtain the information we deploy in our empirical analysis.

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:

$$\Delta l_{ict} = -\alpha \Delta s_{ct} + f^{v}_{ict}, \tag{8}$$

$$\text{where } f_{ict} = \lambda_i' \eta_t + u_{ict}, \tag{9}$$

where c denotes the currency area and t the given month. Δl_{ict} denotes the change in lending flow of bank i in currency area c at time t. Δs_{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, λ_i', and an idiosyncratic shock, u_{ict}. Our estimation equation of interest is given by

$$\Delta s_{ct} = \kappa \Delta l_{ict} + \varepsilon_{ct}, \tag{10}$$

In a simple regression of Δl_{ict} on Δs_{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 Δl_{Sct} and Δl_{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[32]

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

The key assumption in GIV frameworks is that the common shock and the idiosyncratic shock 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 ε_{ct}.

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

Table A.2: First Stage Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GIV instrument	0.688	0.710	0.680	0.702	0.613	0.626	0.614	0.620
	(0.0859)	(0.0530)	(0.0844)	(0.0530)	(0.0381)	(0.0451)	(0.0385)	(0.0429)
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

Notes: This table presents the results of the first stage regression corresponding to Table 2. The effect of the GIV instrument is scaled by 1000 for better readability. Overall, the instrument achieves values above the rule of thumb of 10 suggested by Stock and Yogo (2005).

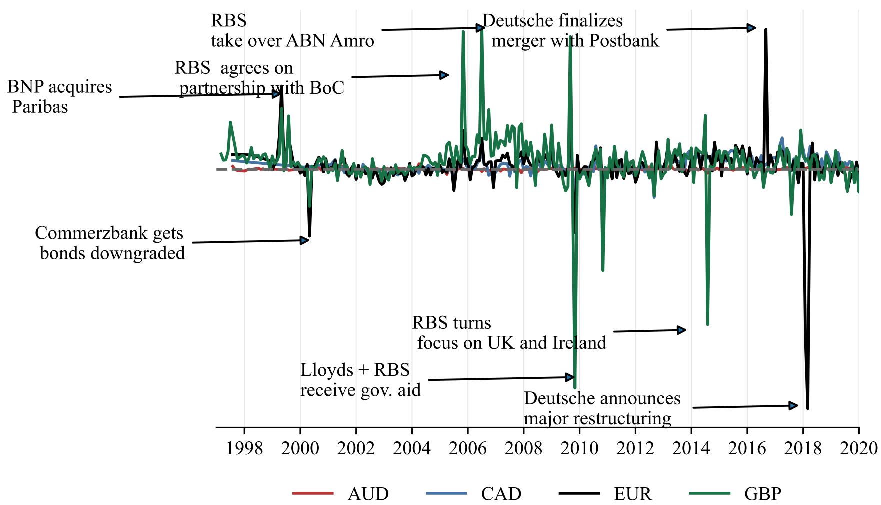
The instrument is relevant for our endogenous measure of cross-currency lending trivially, as

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

It exhibits a correlation of 0.31 with the net cross-currency lending measure.

To provide a more comprehensive understanding of the GIV instrument's dynamics, we examine significant fluctuations and relate them to key corporate events involving major contributors to respective value of instrument. In Figure A.1, we depict the temporal evolution of the GIV instrument. Notably, many of the substantial fluctuations can be attributed to events such as bank mergers, unanticipated profit spikes or drops, and significant shifts in a bank's strategy - often developed in collaboration with government authorities.

Figure A.1: GIV instrument over Time



Notes: This figure illustrates time-series variation in the GIV instrument. Large spikes in the instrument can be linked to corporate events. Notably, most of the substantial fluctuations can be linked to idiosyncratic events such as bank mergers, unanticipated spikes or decreases in profits, or announcements of significant shifts in a bank's corporate strategy.

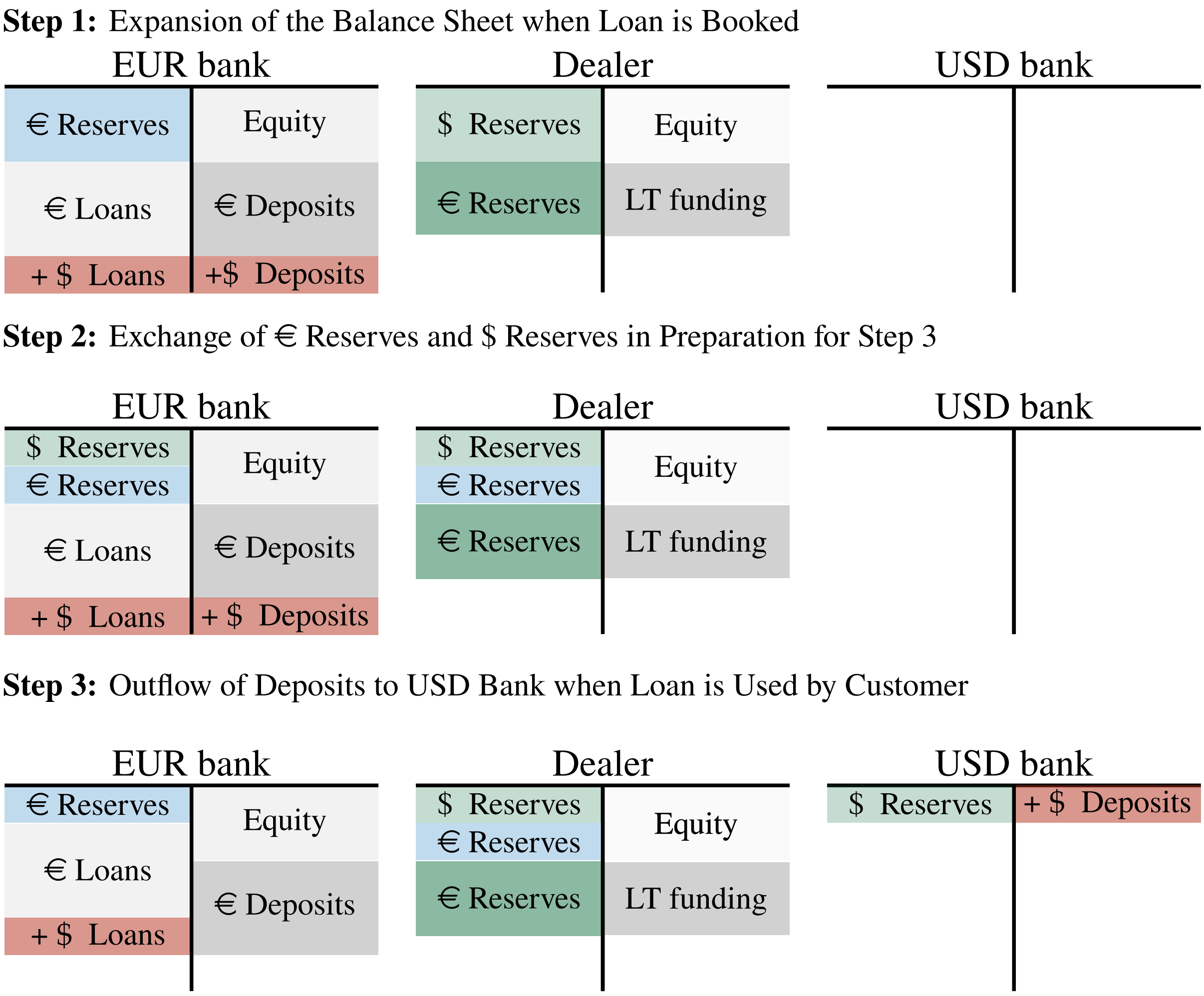
Internet Appendix to accompany

Global Bank Lending and Exchange Rates

(Not for publication)

IA.1 Additional details on the funding mechanism

Figure IA.1: 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 IA.1 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.[33]

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.

IA.2 Additional data, descriptive statistics, and results

IA.2.1 Sectoral composition of syndicated loan data

Table IA.1 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.

Table IA.1: Borrower Sector Distribution

Industry	**Percentage (%)**
Services	17.11
Natural Resources	14.96
Telecommunications	9.02
Manufacturing	8.54
Utilities	7.83
Others	7.62
Automotive & Transportation	7.61
Construction	7.46
Wholesale & Retail	7.38
Healthcare	4.89
Beverages	3.98
Technology	3.6

Notes: This table 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 telecommunication sector.

[33]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.

IA.2.2 Where Global Banks Originate USD Loans

Global USD syndicated lending is not confined to the US, or countries that use the USD as payment currency. Table IA.2 shows a large fraction of USD lending occurring from non-US lenders to borrowers outside the US. 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 from 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.

Table IA.2: Where Global Banks Originate USD Loans

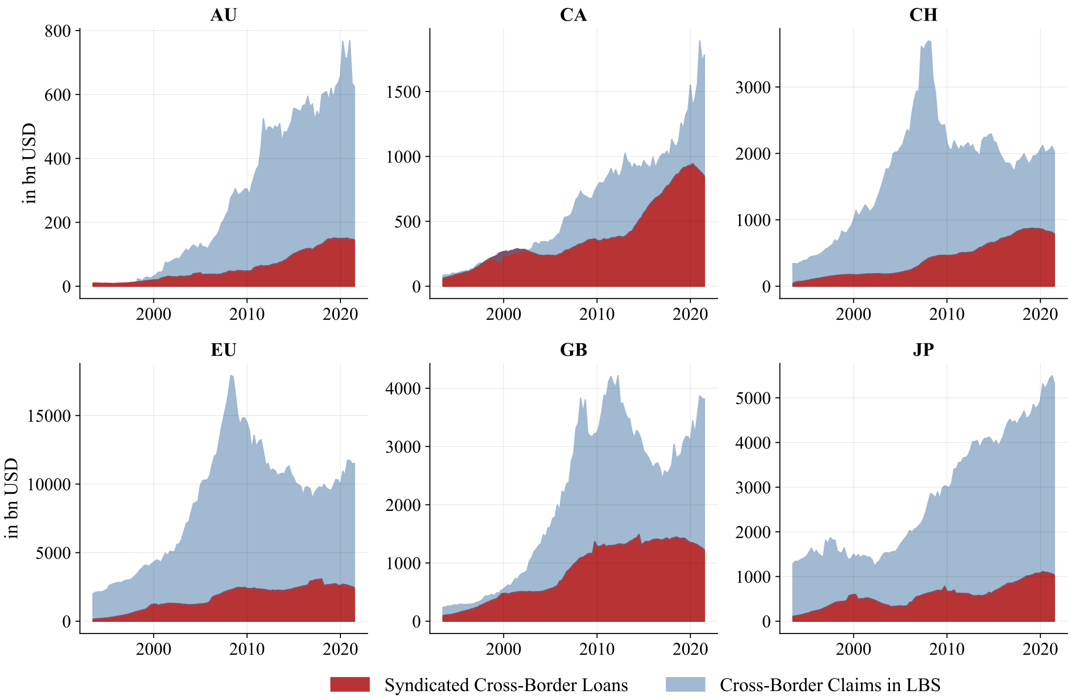
	Borrower Origin Country											Share of
Bank Origin Country	AU	CA	CH	CN	EU	GB	JP	OTH	SE	SG	US	Total
AU	10.20	3.10	4.16	1.34	3.24	10.55	1.91	12.83	0.31	3.90	48.46	0.90
CA	0.35	12.67	0.90	0.02	2.48	2.72	0.29	3.69	0.12	0.31	76.44	5.14
CH	1.08	2.06	2.30	0.21	4.15	3.48	0.06	3.97	0.19	0.45	82.05	4.48
CN	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: Country codes in the rows refer to the lending bank's parent country. Country codes in columns denote the country of the borrower (for USD loans). For example, the entry 3.10 in cell AU–CA indicates that out of all loans that Australian banks extend in USD (of which Australian banks originate 0.9% of the global market, see entry in the last column), 3.1% flow to Canadian borrowers. Conversely, Canadian banks extend 0.35% of their USD loans to Australian borrowers. Each row adds up to 100%, with each entry denoting the likelihood of a given country's banking system to lend to a borrower of a specific country. The last line denotes the share of borrowers from that country among all USD borrowers globally. The last column denotes the share of the bank origin country among the global USD lending market. All shares are calculated based on the volume of the extended loan.

IA.2.3 Benchmarking syndicated loans to toal claims from the Locational Banking Statistics

Figure IA.2 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.

Figure IA.2: Cross-Currency Syndicated Loan Claims Compared to Total Claims against RoW



Notes: This Figure compares total outstanding cross-currency syndicated loan volumes (red areas) to *total claims* of banks headquartered, the latter being more broadly defined and including syndicated loans as one component. Each subfigure compares syndicated cross-currency loans and total claims for banks quartered in a particular currency area (as indicated by currency codes at the top of each sunfigure). Total claims are based on data from the BIS Locational Banking Statistics.

IA.2.4 Disaggregating netflows into in- and outflows

To see the differential effect of the loan flows flowing out of the country (into the US) compared to the inflows flowing into the country (out of the US), we consider the loan flows separately instead of evaluating the impact of their ratio as in the $\text{NCCL}_{c,t}$ measure.

In reality, FX dealers strategically manage their exposure by balancing net flows in opposite directions. Consequently, examining the impact of flows in isolation without accounting for counterbalancing flows can result in more pronounced effects on the spot rate, as opposed to a more realistic assessment considering the net flows.

In light of this, we repeat the baseline regression as specified in equation (4), where we use the respective instruments for the in- and outflow instead of the net measure. Table IA.3 shows that the outflow of loans – out of the foreign country and into the US – leads to a significant appreciation of the USD visà-vis the foreign currency. A one standard deviation increase of loan outflows leads to an appreciation of the USD of around 200 basis points (annualized).

Column (3) includes the respective inflow measure, which intuitively leads to a depreciation of the USD visà-vis the foreign currency. In terms of economic magnitude, a one standard deviation increase in inflows depreciates the USD by around 365 basis points (annualized). Thus, when the ratio between the two increases, e.g. outflows increase relative to inflows, the USD appreciates, as we established in Section 4.

IA.2.5 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.[34] 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 IA.4 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

[34]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.

Table IA.3: Disaggregating Net Flows into Inflows and Outflow

	$\Delta s_{c,t}$			
	(1)	(2)	(3)	(4)
$\widehat{\Delta \text{NCCL}}_{c,t}$	72.33			
	(13.20)			
$\Delta\log(\text{outflow})_{c,t}$		9211.6		9128.9
		(3527.9)		(3149.9)
$\Delta\log(\text{inflow})_{c,t}$			-5867.6	-5920.3
			(2125.5)	(2134.7)
Observations	1184	1184	1184	1184
Macro-controls	Yes	Yes	Yes	Yes
Currency FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Currency Areas	14	14	14	14
Pseudo-R^2	0.150	0.160	0.160	0.150

Notes: The Table reports the results of two-stage panel IV estimation with a granular instrument. $\widehat{\Delta \text{NCCL}}_{c,t}$ 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. $\Delta\log(\text{outflow})_{c,t}$(Std.) and $\Delta\log(\text{inflow})_{c,t}$(Std.) denote first difference of the log of the (by country) standardized out (foreign country to US) and inflows (US to foreign country) loan flows. 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 basis points (p.a.). HAC-robust standard errors in parentheses. Column (1) shows the baseline result. Column (2) uses the GIV instrument for the outflows instead of the net measure of in- and outflows. Column (3) uses both GIV instruments for the two endogenous variables.

when the spot exchange rate is used as dependent variable.

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.

Table IA.4: Elasticity of Spot and Forward Exchange Rates

	Spot rate	Forward rate	Forward – Spot rate
$\Delta\widehat{\text{NCCL}}_{c,t}$	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

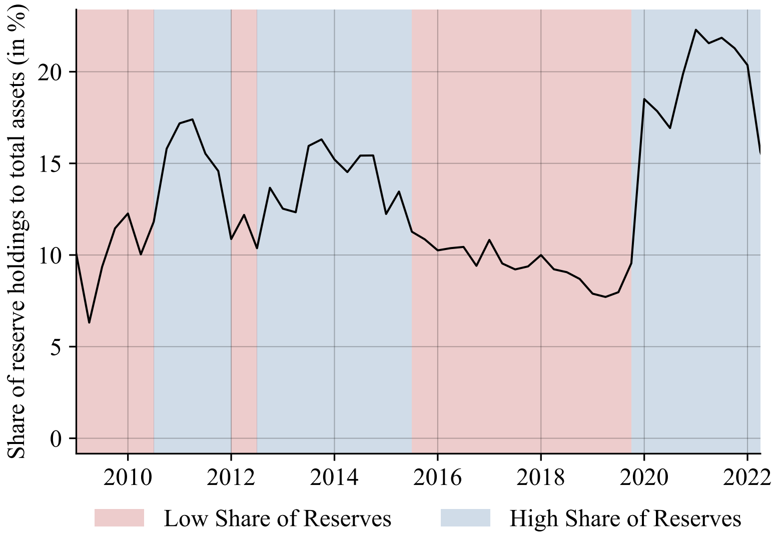
Notes: We compare the baseline regression of the first difference of the logarithm of the spot exchange rate vis-à-vis the USD on net cross-currency loan flows ($\Delta NCCL$) with analogous regressions for forward exchange rate (log) changes and forward points as dependent variables. The dependent variable for each regressions is indicated in the top row. $\Delta\widehat{\text{NCCL}}_{c,t}$ 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 basis points (p.a.). HAC-robust standard errors in parentheses.

IA.2.6 Definition of sample splits

We define in Figure IA.5 periods of reserve scarcity and abundance based on the share of reserve holdings to total assets among the top 30 US banks. If a value is above the sample average, we consider this a period of 'reserve abundance' and conversely below the average as 'reserve scarce'.

IA.5 shows evolution and definition over time. Figure IA.4 defines the level of high and low shares of loans to foreign banks. As US banks could provide USD liquidity in the inter-bank market, we study the effect in periods when there is 'high credit provision' (above average share of loans to foreign banks in relation to risk-weighted assets) or 'low credit provision' (below

Figure IA.3: 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) where high and low refers to values above/below the average share of reserves.

average).

Similarly, we define periods of high and low reserve concentration based on values of the Herfindahl-Hirschman Index of reserve holdings among the top 30 US banks being above or below the sample average. Figure IA.5 shows evolution and definition over time.

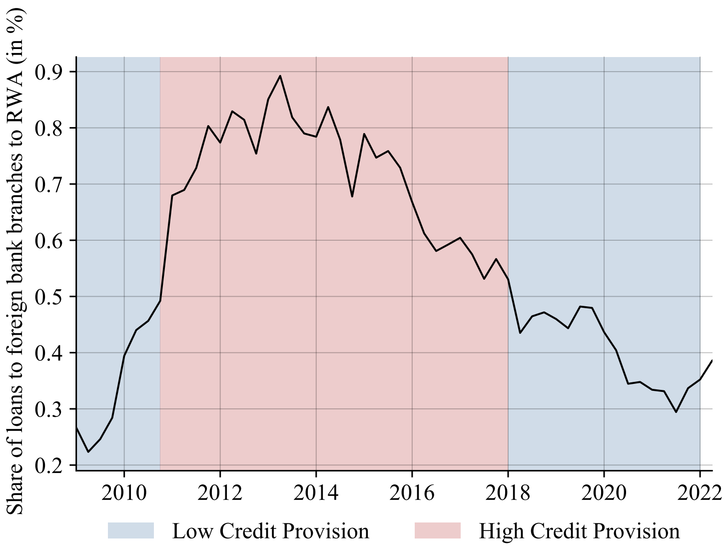
Figure IA.6 illustrates the hiking and easing cycles underlying our results in Table 6. Light blue indicates easing cycles, whereas red areas indicate tightening cycles. Areas that are not marked are defined as "No Change" in Table 6. Easing and hiking cycles refer to periods of subsequent rate cuts and hikes as shown in the figure.

IA.2.7 Additional GIV diagnostics

If the concentration within a country's banking sector is high, deploying the GIV estimation approach might lead to a bias given that the estimate looses precision when estimated with few very large banks. Conversely, if banks are similar in size, the proposed instrument, which makes use of the differential effect between large and small entities, might lead to an imprecise estimate.

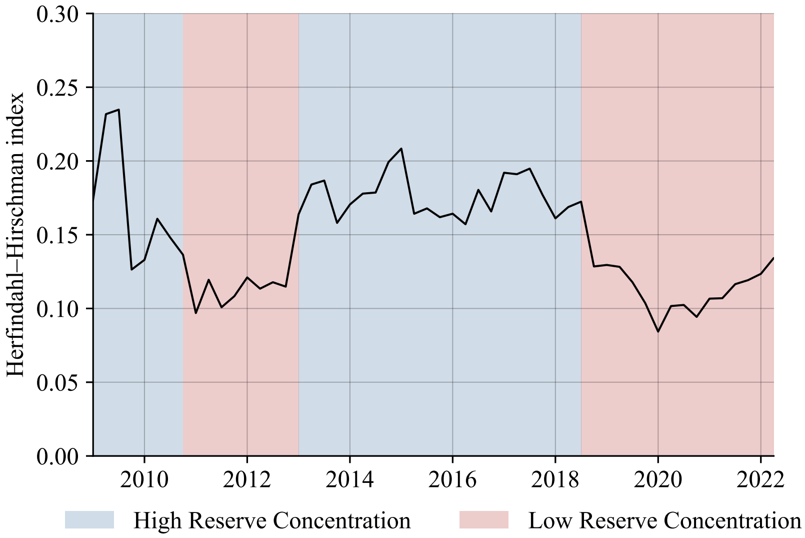
Therefore, we calculate the excess Herfindahl Index over time. Figure IA.7 shows the evolution of the excess Herfindahl Index over time. The excess Herfindahl index is defined as $h := \sqrt{-\frac{1}{N} + \sum_{i=1}^{N} \Psi_i^2}$, where Ψ_i is the share of a bank among the total syndicated loan market within a currency area. Across all countries, the values of the Herfindahl index indicate a level

Figure IA.4: Definition of High and Low Share of Loans to Foreign Banks



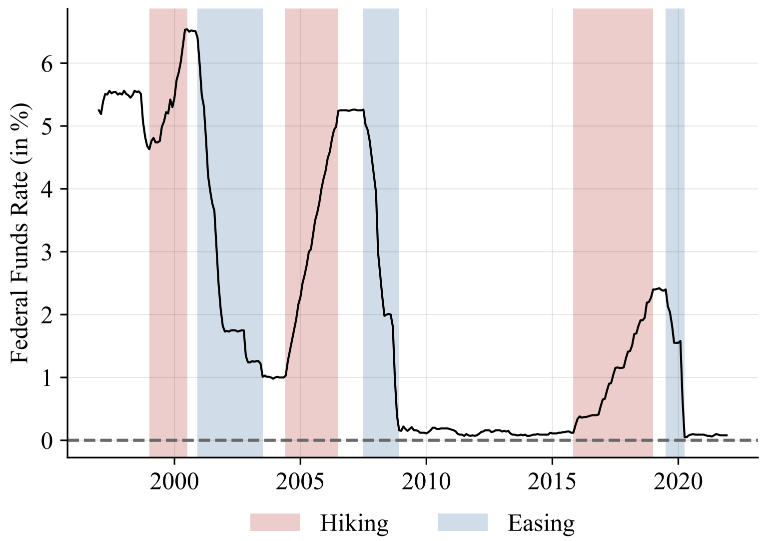
Notes: This figure defines periods of high (red) and low (blue) credit provision defined as high share of loans to US subsidiaries of foreign banks. High and low refers to above and below the average value of credit provision.

Figure IA.5: Definition of High and Low concentration of reserves



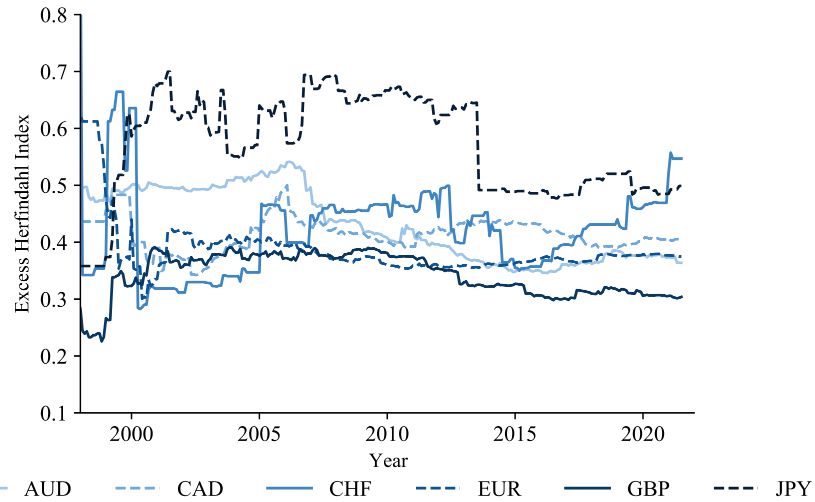
Notes: This figure defines periods of high and low concentration of reserves among the top 30 banks in the US. The figure depicts the Herfindahl-Hirschman index of the reserve holdings over time. High reserve concentration (above average) periods are marked in blue. Low concentration (below average)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

Figure IA.6: Definition of Monetary Policy Cycles



Notes: This figure defines US monetary policy hiking (red) and easing (blue) cycles, where each cycle comprise a series of subsequent rate cuts/hikes from top to bottom and vice versa. Periods with no rate changes are not highlighted in this figure and correspond to the "No Change" category in Table 6.

Figure IA.7: Excess Herfindahl Index Over Time



Notes: This figure depicts the excess Herfindahl index defined as $h := \sqrt{-\frac{1}{N} + \sum_{i=1}^{N} \Psi_i^2}$, where Ψ_i is the share of bank i as a percentage of all syndicated loans within a given currency area. For each currency area, the index is between 0.2 and 0.7 over time. This implies that the GIV instrument should have sufficient precision as discussed in Gabaix and Koijen (2021b).

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).

IA.3 Additional information on CIP deviations and global bank lending

IA.3.1 CIP deviations as a measure of USD funding tightness

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. We also dig deeper into the relation between funding costs, net cross-currency loan growth, and CIP deviations in Section 5 below.

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

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

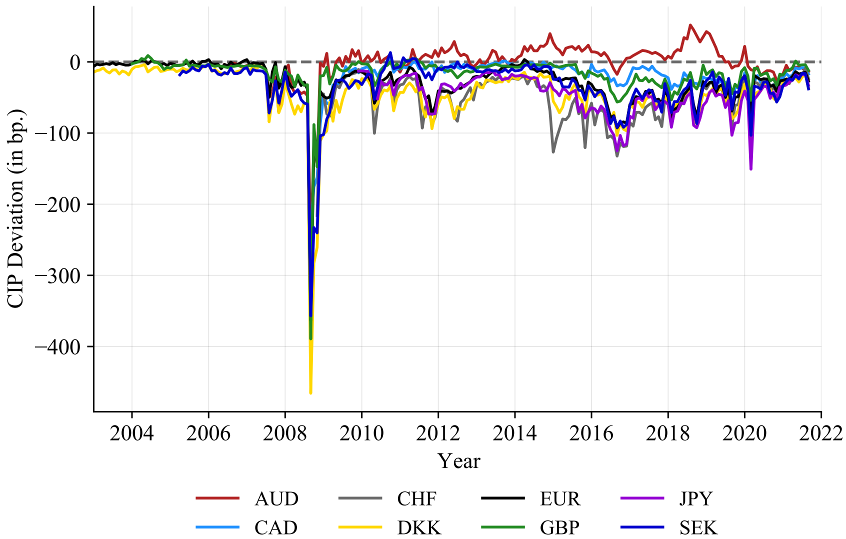
where the basis $x_{t,t+n}$ is the difference between the *direct* USD borrowing cost, $y^{\$}_{t,t+n}$, and the *synthetic* USD borrowing cost, $\left(y_{t,t+n} - \rho_{t,t+n}\right)$. The forward premium $\rho_{t,t+n}$, is defined as

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

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

Figure IA.8 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 IA.8: CIP Deviations at Three Month Term



Notes: This figure depicts the deviations from the CIP condition as defined in equation (5) at 3 month term. The data is obtained from Refinitiv Eikon. Large negative CIP deviations persist since the 2009.

Table IA.5 shows that in periods of large (negative) CIP deviations, the effect on the exchange rate is more pronounced.

IA.3.2 Global loan flows and CIP deviations

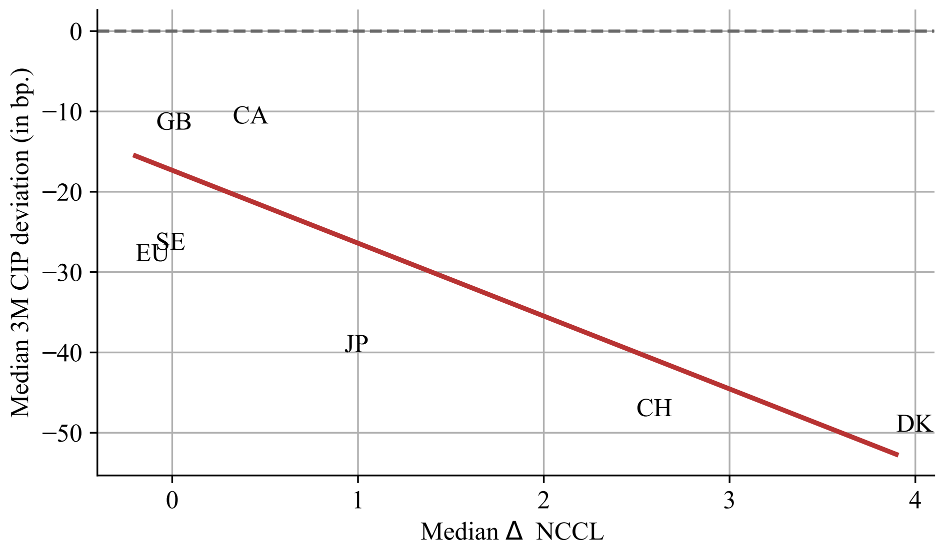
Figure IA.9 illustrates the median 3 month CIP deviation of a currency area after the financial crisis and the median value of the net lending flow measure $\Delta \text{NCCL}_{c,t}$. There is a clear negative relation between the lending flows and CIP deviations, indicating that greater outflows correspond to more substantial negative CIP deviations across different currency areas in a cross-sectional context.

Table IA.5: Exchange rate elasticity and USD funding conditions

	CIP deviation (3M)	
	Small	Large
$\Delta\widehat{\text{NCCL}}_{c,t}$	33.60	112.7
	(53.93)	(51.93)
Observations	189	73
Macro-controls	Yes	Yes
Currency FE	Yes	Yes
Year FE	Yes	Yes
Currency Areas	7	8
Pseudo-R^2	0.02	0.05

Notes: Dependent variable is the first difference of the logarithm of the spot exchange rate vis-à-vis the USD in the dimension FC/USD. $\Delta\widehat{\text{NCCL}}_{c,t}$ 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. Small CIP deviations refer to the CIP deviation being below 25 bp, whereas large referes to CIP deviations above 25 bp. 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, DKK, EUR, GBP, JPY, SEK. The coefficient describes the effect of a 100 bp increase in the lending measure on the spot exchange rate in basis points (p.a.). HAC-robust standard errors in parentheses.

Figure IA.9: Global Loan Flows and CIP deviations in the cross section



Notes: This figure shows medians of CIP deviations (at the three-month maturity) and medians of changes in net cross-currency lending $\Delta\text{NCCL}_{c,t}$ over the sample period from 1997 - 2021. The data on CIP deviations are obtained from Refinitiv Eikon.

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