

Swiss Finance Institute

Research Paper Series

N°24-52

Hunting for Dollars



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September 10, 2025

Abstract

Deviations from covered interest rate parity (CIP) have been attributed to limits to arbitrage, but trading volumes surge during periods of no-arbitrage violations. We show that such distortions are caused by constraints on non-U.S. agents' access to wholesale U.S. dollar markets, and thus reflect a premium for obtaining unencumbered synthetic dollar funding. Three main findings emerge. First, non-U.S. banks substitute secured USD borrowing with foreign exchange swaps to comply with regulatory requirements. Second, the cross-currency basis reflects the shadow costs imposed on non-U.S. agents for borrowing in U.S. wholesale segments. Third, U.S. dealers extract rents on dollar provision; the costs are ultimately passed on to the real economy, with non-U.S. customers paying an additional \$10.4 billion in hedging costs. Our study highlights how intermediary constraints impact interconnected money markets and drive segmentation in global dollar funding.

Keywords: US Dollar, Global Banks, FX Swaps, Repos, Intermediary Constraints, Covered Interest Parity, Regulation.

JEL classification: F31, G12, G15

^{*} We thank Iñaki Aldasoro, Saleem Bahaj, Leonie Bräuer, Georgia Bush, Gino Cenedese, Anusha Chari, Ricardo Correa, Bart Denecker, Wenxin Du, Darrell Duffie, Gerardo Ferrara, Thierry Foucault, Nicole Hentschel, Sebastian Infante, Morten Jacobsen, Ralph Koijen, Ingomar Krohn, Christian Kubitza, Robert Mann, Jack McCoy, Omar Misuraca, Thomas Mosk, Benjamin Munyan, Dagfinn Rime, Andrew Rose, Jesse Schreger, Jule Schüttler, Fabricius Somoogyi, Suresh Sundaresan, Quentin Vandeweyer, Miklos Vari, Andrea Vedolin, Adrien Verdelhan, Jonathan Wallen, and Vincent Wolff as well as audiences at the 2025 EFA Annual Meeting, 2025 Cambridge Symposium on FX Markets, Bank of England, BI Oslo, Norges Bank, New York Fed, 2025 Day Ahead Conference on Financial Markets and Institutions, 14th BIS/Banca d'Italia/ECB/Bank of Slovenia Workshop on FX, 3rd CEMLA/Dallas Fed/IBEFA Financial Stability Workshop, EPFL, 19th Central Bank Conference on the Microstructure of Financial Markets, 2024 ECB Money Market Conference, ESSEC, BIS, Northeastern University, ESRB, 7th Short-Term Funding Markets Conference, 2024 SFI Research Days, EMMEC, University of St.Gallen, and the 3rd Conference on the International Roles of the U.S. Dollar. Finally, we thank Marco Gortan for excellent research assistance.

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1. Introduction

Constraints on bank balance sheets have become a defining feature of post-crisis financial markets (Duffie, 2017). This is particularly evident in foreign exchange (FX) markets, where the breakdown of covered interest rate parity (CIP) - a cornerstone of international finance - has been widely linked to such limits to arbitrage. Yet the underlying mechanism remains poorly understood. Prevailing supply-driven explanations attribute CIP deviations to a withdrawal of arbitrage capital, but we document that regulatory periods are marked by strong increases in trading activity. Puzzlingly, it is during these episodes that severe no-arbitrage violations emerge, as FX swap prices persistently embed a premium for synthetic U.S. dollar funding. This paper seeks to uncover the origins of these distortions and assess their implications for the global distribution of dollar liquidity.

Our paper shows that CIP deviations are caused by constraints on non-U.S. agents' access to wholesale *dollar* funding, which leads them to pay a premium for unencumbered synthetic U.S. dollar funding. While U.S. dealer-banks can source dollar liquidity through their domestic deposits and central bank reserves, non-U.S. banks usually rely on secured, wholesale funding, which requires valuable balance sheet space. On the other hand, FX swaps are an *off*-balance sheet item. When regulatory constraints bind, these agents turn to synthetic dollar borrowing as an imperfect substitute; we identify this mechanism by showing that Eurozone dealers replace roughly \$50 bn of secured dollar funding with synthetic borrowing during quarter-end reporting windows. This is precisely when CIP deviations spike, as U.S. dealer-banks charge prices reflecting the shadow cost of non-U.S. banks' constrained outside option. In aggregate, these dynamics result in a substantial welfare transfer: U.S. dealers capture an additional \$5.3 bn annually, and these costs are ultimately passed on to non-U.S. customers, who expend an extra \$10.4 bn per year for their currency hedging. Our results show that post-crisis balance sheet regulation has unintentionally segmented the global dollar funding network, leading to large cross-border transfers of economic rents and raising the cost of hedging for the real economy.

We structure our analysis in three parts. First, we develop a granular, bespoke dataset allowing us to analyze agents' gross and net positions and flows across dollar funding markets. For FX markets, we obtain data from Continuous Linked Settlement (CLS) and classify 4,169

banking entities and their customers by the *nationality* of their ultimate parent.¹ This allows us to match agents to the reporting currency of their consolidated balance sheet, which better reflects their regulatory framework and deposit base than their geographic location, which is usually concentrated in major financial centers (e.g. London).² Our data covers around 30%-50% of the total currency market; we complement it with bank-level observations from U.S. and European wholesale segments. Crucially, we show that global FX swap gross positions *surge* at quarter-end by \$200 bn, precisely when supply constraints are expected to bind.

Second, we show that when regulatory constraints tighten, non-U.S. agents, in particular Eurozone dealer-banks, substitute U.S. wholesale funding with increased synthetic dollar borrowing. While repurchase agreements (repos) and FX swaps serve the same economic function of providing dollar liquidity, they have markedly different impacts on a bank’s Basel III leverage ratio (LR). Dollar funding via repos expands the balance sheet and worsens the LR, whereas FX swaps are off-balance sheet instruments, with only 1% of their positions contributing to the LR calculation. This asymmetry particularly disadvantages non-U.S. institutions, which must rely on costly secured borrowing to access dollar funding, whereas U.S. banks can rely on their own deposit base and their central bank reserves. We identify regulatory-motivated repo–FX swap substitution by leveraging a key artifact of the Basel III implementation. In most jurisdictions, banks report regulatory ratios at quarter-end, prompting window-dressing. On these dates, Eurozone banks sharply reduce USD repo borrowing and instead convert euro liquidity into synthetic dollars by increasing FX swap borrowing (both gross and net) by about \$50 bn; this demand is met by increased dollar lending from U.S. dealer-banks. We leverage the fact that banks in the U.K. must instead report their LRs using an average of the quarter’s daily values to provide causal evidence that regulatory incentives are the driver of repo-FX swap substitution; only quarter-end reporting banks adhere to this practice. This substitution effect allows us to identify the overall regulatory pressures borne by non-U.S. institutions - both U.K., Eurozone, or oth-

¹ For example, an FX swap traded by J.P. Morgan in London identifies the party as a U.S. bank, despite its geographic location.

² We sort market participants into six regions: the U.S., the Eurozone, the U.K., Switzerland, Japan, and a residual group combining all other nationalities (ROW). We further classify agents as Global Systemically Important Banks (G-SIBs), regular banks, and non-banks, resulting in 18 distinct agent types.

erwise - who must expend crucial balance sheet space to acquire wholesale dollar funding (U.S. banks, on the other hand, are not active in non-U.S. money markets).

Finally, we consider whether the substitutability of wholesale and synthetic dollar funding has pricing implications through a simple analytical framework. For a bank to remain indifferent between funding sources, the price of synthetic dollar borrowing must equal the effective cost of its alternative: short-term funding in U.S. wholesale money markets. As a result, the market-wide basis reflects the increased shadow cost of borrowing U.S. dollars relative to raising domestic currency. The 2016 U.S. Money Market Reform likely intensified these dynamics by shifting wholesale USD markets from unsecured to secured borrowing, increasing the required balance sheet space. We corroborate our hypothesis by showing strong correlations between CIP deviations and various proxies for non-U.S. agents' wholesale USD shadow costs. U.S. banks are on the other side of this trade, and we provide evidence that they are able to extract rents on the provision of such dollar liquidity; U.S. G-SIBs charge higher prices for dollar funding when FX swap markets are more concentrated and when they hold a larger market share. Our findings explain the observed difference in magnitudes between the cross-currency basis and the GCF-IOER spread; that the former is far larger demonstrates that U.S. banks are able to charge prices above their marginal cost as they capitalize on non-U.S. institutions' willingness to pay for unencumbered dollar funding. We empirically validate our framework's implication that non-U.S. institutions, including dealer-banks, possess inelastic demand for the dollar through a granular instrumental variables (GIV) approach: a 1% increase in the basis results in only a 0.71% reduction in demand. Notably, the inverse price elasticity increases thirteen-fold at quarter-end relative to our whole-sample estimate, as the surge in the cross-currency basis outstrips that of the underlying flows, highlighting the role of shadow costs and pricing power.

Our findings imply that balance sheet regulation redistributes the gains and losses along global dollar funding chains. Intermediary constraints disproportionately affect non-U.S. institutions, who must either expend balance sheet space or pay a premium for synthetic dollar funding.³ Pricing dynamics go well beyond the quarter-end, as (i) many banks must

³ Note that dollar frictions are caused not by the structure of American money markets, which are deep, liquid, and easily accessible, but rather due to the fact that the secured standard of such markets is penalized

report daily averages of all trading days, not just the quarter-end figure, and (ii) the prices of all swaps with a maturity over 3 months - i.e., the entire currency hedging segment - are impacted by regulation. To quantify the total economic cost, we combine data on FX swap trading volumes with transaction prices obtained from the settlement data. We document an annual welfare transfer of \$5.3 bn from non-U.S. institutions to U.S. dealer-banks.⁴ Importantly, effective dollar borrowing costs increase for all agents; we do not find economically meaningful evidence of price discrimination. While non-U.S. dealer-banks pay over-the-odds to obtain dollar funding, they pass on these costs; our data reveals that non-U.S. customers are the single largest payers of the cross-currency basis, incurring an additional \$10.4 bn annually for their currency hedges, a significant cost for the real economy.

Our paper resolves a long-standing tension in the literature whereby deviations from CIP have been convincingly attributed to Basel III balance sheet regulation (Du et al., 2018; Cenedese et al., 2021), despite FX swaps being exempt from such provisions as off-balance sheet instruments. As a result, economists affiliated with the regulator have contested responsibility, concluding that “the existing literature has neglected this important fact and has thus misattributed quarter-end dynamics in FX swap markets to the impact of leverage regulation on CIP arbitrage” (Borio et al., 2018). A large literature has since sought to determine the precise origin of CIP deviations, yet an incomplete understanding of the structure of global dollar funding chains has kept a definitive resolution out of reach. In contrast to the aforementioned studies, we procure detailed volume and quantity data, allowing us to identify supply and demand shifts. In particular, our finding that FX swap *gross* positions increase systematically at quarter-end suggests that prevailing supply-driven explanations must be reconsidered.

Our work also disentangles whether Eurozone banks’ quarter-end behavior reflects a withdrawal from CIP arbitrage or a rise in synthetic dollar demand. Under the arbitrage view, Eurozone banks borrow dollars in repo and relend them synthetically to capture the CIP spread; when quarter-end balance sheet costs rise, they unwind such trades, reducing

by the regulatory framework.

⁴ We further show that U.S. G-SIBs’ share of the FX swap customer market dramatically increased from around 30% to 50% at the time of the Basel III implementation, to the detriment of Eurozone and U.K. banks.

both repo borrowing and synthetic dollar lending. The alternative demand-side view holds that Eurozone banks have a structural need for dollars, either to fund their own operations or to fulfill their obligations to clients as FX dealers. When balance sheet considerations require them to reduce wholesale borrowing, they turn to synthetic markets to make up the shortfall. To test this, we decompose net synthetic positions and find that gross lending does not decline at quarter-end; instead, gross borrowing surges to offset lost wholesale funding. The evidence thus indicates that Eurozone banks’ quarter-end behavior reflects their demand for unencumbered dollar funding, rather than a scaling back of arbitrage activity.

Our work contributes to the extant literature in several ways. First, while CIP violations have been attributed to limits on arbitrage capital, we instead demonstrate that the basis reflects the premium non-U.S. participants are willing to pay for unencumbered dollar funding. The cross-currency basis adjusts as such to respect the law of one price: the effective cost of dollar funding must remain equal across financial instruments. Second, while previous work has focused on supply mechanisms, we show that banking regulation causes increased inelastic demand for synthetic funding, thus explaining the observed volume surges during periods when trading was thought to be constrained. Third, our work highlights the interconnectedness of global funding markets, and shows that distortions in currency markets are due to spillovers from regulatory effects in wholesale segments. Fourth, we demonstrate that an unintended consequence of banking regulation is to counterintuitively penalize *secured* money market borrowing. Fifth, our results uncover segmentation between non-U.S. and U.S. agents in FX markets: banking regulation disproportionately constrains the former, which must expend balance sheet space to access the U.S. dollar, resulting in a substantial welfare transfer. In the absence of economically meaningful price discrimination, shadow costs are manifested in the market price, and all participants are affected. Future research will look to extrapolate the implications of this segmentation for other asset classes, in particular exchange rates.

Related Literature. We contribute to the broad literature describing how financial frictions and intermediary constraints influence market functioning ([Fleckenstein and Longstaff \(2020\)](#), [Du et al. \(2023a\)](#)). We focus on regulatory frictions and how non-U.S. institutions’

holding of USD assets and hedging demand causes global imbalances ([Bräuer and Hau \(2022\)](#), [Du et al. \(2023b\)](#), [Du and Huber \(2024\)](#), [Liao and Zhang \(2025\)](#)). We also add to the discussion of how cross-currency lending and international capital flows are linked to the basis ([Becker et al. \(2023\)](#), [Ben Zeev and Nathan \(2024\)](#)). [Kubitza et al. \(2024\)](#) document that persistent CIP deviations affect portfolio rebalancing by euro-area investors using FX forwards; our GIV analysis adds to this by demonstrating that even dealer-banks - those outside of the U.S. - display demand-side, price-taking behavior. U.S. banks' ability to extract rents on the provision of unencumbered dollar funding highlights the benefits associated with the dollar's central role in global financial markets ([Farhi and Maggiori \(2017\)](#), [Gourinchas et al. \(2019\)](#), [Gopinath and Stein \(2021\)](#)). Wholesale funding constraints represent intermediary frictions as in [Gabaix and Maggiori \(2015\)](#), and the cross-currency basis reflects Funding Valuation Adjustments ([Andersen et al. \(2019\)](#)) incorporating the shadow costs of direct U.S. money market funding. Our paper cleanly identifies an example of how segmentation within the intermediary sector affects asset pricing ([Siriwardane et al., 2025](#)).

We further contribute to the literature on CIP deviations, which post-crisis have been explained through intermediary constraints ([Ivashina et al. \(2015\)](#), [Abbassi and Bräuning \(2020\)](#), [Krohn and Sushko \(2022\)](#)). [Rime et al. \(2022\)](#) show that low-credit quality banks struggling to obtain USD funding shift from wholesale to synthetic borrowing. Our paper instead focuses on quarter-ends, and shows that substitution is driven by Eurozone banks constrained by the high regulatory cost of secured wholesale funding. [Correa et al. \(2020\)](#) show that U.S. banks are reluctant to lend U.S. dollars due to reserve-draining limitations; we show that U.S. dealers charge dollar funding costs far in excess of their supply constraints. Our paper also relates to [Wallen \(2022\)](#), who documents evidence of market power in the pricing of the synthetic dollar rate when supply is reduced; our mechanism focuses instead on powerful dollar demand surges. Finally, [Khetan \(2024\)](#) studies how concentration limits cap Euro-area banks' borrowing from American money markets, driving them toward synthetic funding. In contrast, the dynamics we study occur as Eurozone banks voluntarily *reduce* their USD money market borrowing and crucially can explain the sizable quarter-end dislocations that are the salient feature of post-crisis CIP deviations. These effects are especially important as they intrinsically impact all long-term FX swaps, i.e., currency hedges.

2. Wholesale and Synthetic Funding: Conceptual Framework

This section outlines the regulatory landscape and its pricing implications for U.S. dollar funding, and establishes the hypotheses tested in subsequent sections.

2.1. Regulatory landscape

The first hypothesis we develop is that financial regulation incentivizes non-U.S. financial institutions to substitute U.S. dollar funding sourced from repos with synthetic dollar funding when constrained. Two mechanisms are at play. First, Basel III introduced the LR - a risk-*unweighted* capital requirement—which penalizes activities that expand the balance sheet, such as repo borrowing. Importantly, however, differences in the implementation of Basel III *across jurisdictions* imply that some banks, particularly those of the Eurozone, are required to report their LRs at the end of the quarter while others, such as those in the U.K. and the U.S., calculate it using the average of the quarter’s daily values. These regulatory differences have unintended consequences: they incentivize Eurozone banks to “window dress” their quarter-end reports, temporarily reducing exposures to present a stronger regulatory position than actually maintained throughout the quarter.⁵

A second artifact of banking regulation is its heterogeneous treatment *across financial instruments* that serve similar economic functions. Consider the two primary methods for sourcing U.S. dollar funding. The first is to directly borrow U.S. dollar liquidity in U.S. money markets via repo, while the second is to borrow it synthetically via the FX swap market by converting domestic currency into U.S. dollars. While economically similar, these two transactions have very different outcomes for a bank’s LR. Regulation mandates that banks shall maintain a ratio of Tier 1 capital to total exposures at a minimum threshold θ , with $\theta = 3\%$ for Eurozone banks at the group level:

$$\text{LR} = \frac{\text{Tier 1 Capital}}{\text{Total Exposure}} \geq \theta \quad (1)$$

⁵ In response to the window-dressing issues discussed in this paper, the Basel Committee on Banking Supervision (BCBS) has issued new guidance requesting that, as of January 2022 and for the purposes of Pillar 3 disclosure requirements, internationally active banks must disclose the LR based on both quarter-end and quarter-average values of their gross secured financing transaction (SFT) assets (BCBS, 2019). Banks located in the European Union have been subject to this more stringent disclosure as of 28 June 2021 (European Commission, 2021).

where Tier 1 Capital means capital instruments of the highest quality, and Total Exposure includes on-balance sheet assets and key off-balance sheet items such as derivatives. The simplified T-accounts in Figure 1 illustrate how a bank's LR responds to different funding choices. They depict a globally active Eurozone bank that holds 100 euros in local currency and a U.S. Treasury worth \$100 (assuming a 1:1 exchange rate for simplicity), with no debt.⁶ This implies Tier 1 capital and Total Exposure of 200 each, and an LR of 1.0. If the bank raises dollars via repo in U.S. money markets, it borrows \$100 in cash and lends a Treasury security as collateral. This expands the balance sheet, as a new position is created for borrowed cash, matched by a liability denoting the repayment obligation. Crucially, the pledged Treasury remains on the balance sheet of the cash borrower.⁷ Total exposure thus rises to 300, reducing the LR to 0.67.

<i>Balance sheet</i>	Assets	Liabilities
	Bond 100 \$	Equity 200 €
	Cash 100 €	Debt 100 \$
	Cash 100 \$	
<i>Off-balance sheet</i>		

(a) LR after repo: $200/300=0.67$.

<i>Balance sheet</i>	Assets	Liabilities
	Bond 100 \$	Equity 200 €
	Cash 100 \$	
<i>Off-balance sheet</i>		
	FX receivables 100 €	FX payables 100 \$

(b) LR after FX swap : $200/(200+0.01\cdot 100)=0.995$.

Fig. 1: Panel (a) depicts the evolution of the balance sheet after a repo transaction is conducted, and panel (b) does the same for an FX swap.

Consider now the alternative of sourcing U.S. dollar synthetically through an FX swap, as shown in panel (b). Unlike a repo, FX swaps are an off-balance sheet instrument, and as such only 1% of their positions count towards the exposure calculation (BCBS (2014); Borio et al. (2018)).⁸ Instead of expanding the balance sheet, FX swaps only change the currency composition of on-balance sheet assets (Borio et al., 2020).⁹ The near leg simply converts the

⁶ Note that whether the bank has a starting capital of U.S. Treasuries or of euro liquidity does not influence matters, as one can be converted to the other without affecting the LR.

⁷ See Ranaldo et al. (2021) for the balance sheet treatment of repo.

⁸ As off-balance sheet items, FX swaps contribute to the LR through the “add-on factor” for potential future exposure, which is 1%.

⁹ We focus solely on the impact of FX swaps’ and repos’ *notional* amounts on the balance sheet. FX

euro liquidity to USD, while the far leg increases both assets and liabilities, reflecting that the bank will have to repay the USD notional and will receive its original euro liquidity; however, this occurs *off*-balance sheet, and the LR becomes a mere $200/(200 + 0.01 \cdot 100) = 0.995$. The advantage of the FX swap over a repo is evident: while the latter reduces the LR from 1 to 0.67, an FX swap leaves it nearly unchanged.¹⁰

Note that it is the secured nature of repo contracts that creates additional regulatory costs relative to unsecured borrowing. Repo is balance-sheet intensive: both the borrowed cash and the pledged collateral remain on-balance sheet, disproportionately penalizing the LR. Borrowing \$100 via repo thus requires up to \$200 of balance sheet space. Accordingly, we document in sec. 4.3.5 that agents window-dress their secured borrowing, but leave unsecured positions relatively untouched. This distinction gained further importance after the 2016 U.S. Money Market Fund (MMF) reform, which triggered a large reallocation from unsecured to secured (repo) USD borrowing, thereby heightening the regulatory burden for non-U.S. banks (Choulet, 2018; Anderson et al., 2021; Aldasoro et al., 2022).¹¹ The reform thus effectively requires banks to keep sufficient appropriate collateral, i.e. U.S. Treasuries, on their balance sheets if they wish to fund themselves through U.S. MMFs. Munyan (2017) shows that banks reduce their Treasury holdings as well as their repo borrowing at quarter-end, suggesting that they are held specifically to facilitate USD funding.¹²

swaps' marked-to-market value will also be included in the P&L and thus impact the balance sheet through retained earnings; Borio et al. (2017) estimate that this value averages about 3% of the notional amount for FX forwards. These start at zero at contract initiation and vary afterwards relative to the current spot rate.

¹⁰ There is one important exception whereby FX swaps lose their attractiveness relative to repo: year-ends, when they are fully counted in the annual calculation of G-SIB capital surcharges (BCBS, 2013). When referring to quarter-ends in this paper, we are referring to the three non-year-end quarter-ends. We study the exceptional case of year-ends in section 4.3.3.

¹¹ Prime funds invest in primarily unsecured instruments such as commercial paper and certificates of deposit, issued particularly by the private sector and non-U.S. issuers. Government funds on the other hand largely invest in secured financing, including repo. Both operated on a constant net asset value (CNAV) model until the reform of October 10, 2016, which obliged private funds to instead adopt a floating net asset value (VNAV) model, leading to a large reallocation from private to government funds.

¹² Most Treasuries appear directly tied to repo funding needs, as banks do not hold much more Treasuries than what is required to pledge in repo. Data from the European Banking Authority's Transparency Exercise show that Eurozone banks hold on average \$161 bn in U.S. Treasuries while borrowing \$96 bn in Treasury-backed repo. See also Georgievska (2022) on how collateral scarcity exacerbates CIP deviations.

2.2. Pricing framework

Our second hypothesis is that the regulatory costs outlined in section 2.1 are priced. Specifically, market participants weigh the effective cost of borrowing between wholesale and synthetic funding, and substitute from one to the other until the price of an FX swap (i.e. the cross-currency basis) reflects the shadow cost differential between U.S. and domestic wholesale markets. At the quarter-end, a widespread rise in the effective U.S. repo borrowing cost transmits to a higher basis, consistent with the additional inelastic demand for FX swaps.

To illustrate this effect, consider the CIP condition, which states that the return from lending in domestic currency should equal that of lending in foreign currency on a fully hedged basis. Thus, for currency pair $x|y$, we have:

$$(1 + i_{t,t+n}^y) = (1 + i_{t,t+n}^x) \cdot \left(\frac{F_{t,t+n}^{x|y}}{S_t^{x|y}} \right) \quad (2)$$

where n is the maturity under consideration, S_t represents the spot rate at time t , $F_{t,t+n}$ is the forward rate agreed for a trade unwinding at time $t+n$, and $i_{t,t+n}^x$ and $i_{t,t+n}^y$ represent the interest earned in the base and quote currencies respectively.¹³ We refer to deviations from CIP as the cross-currency basis $\chi_{t,t+n}^{x|y}$;¹⁴ if substantial enough, these represent an arbitrage opportunity:

$$\chi_{t,t+n}^{x|y} = \left(\frac{F_{t,t+n}^{x|y}}{S_t^{x|y}} \right) \cdot (1 + i_{t,t+n}^x) - (1 + i_{t,t+n}^y) \quad (3)$$

The CIP condition held well empirically before the 2008 financial crisis (Akram et al., 2008), but it broke down during the recession, with deviations persisting ever since. This fundamental change has largely been attributed to intermediary constraints arising from a more stringent post-crisis regulatory landscape under Basel III. Du et al. (2018) show that CIP deviations are particularly high when an FX swap contract crosses the quarter-end, making USD borrowing via FX swaps more expensive (we replicate this effect in Appendix A). We argue that the observed rise in the basis is in fact consistent with no-arbitrage if one

¹³ The first three letters of a currency pair, e.g. EURUSD, are referred to as the base currency, and the last three as the quote currency.

¹⁴ We take an increase in the basis to mean that borrowing USD has become more expensive.

takes into account the increase in shadow cost of U.S. repo borrowing. Thus, intermediary constraints emerge in wholesale funding, but spill over to synthetic dollar funding markets.

We formalize this mechanism by augmenting the CIP no-arbitrage condition with shadow costs. Setting $y = \$$ in equation (2), the standard condition equates the cost of borrowing USD (left-hand side) to that of raising domestic currency and swapping it into USD (right-hand side), in line with the law of one price (Rime et al., 2022). Introducing shadow costs C for wholesale funding,¹⁵ the condition becomes:

$$\underbrace{(1 + i_{t,t+n}^{\$} + C_{t,t+n}^{\$})}_{\text{Cost of USD funding}} = \underbrace{(1 + i_{t,t+n}^x + C_{t,t+n}^x)}_{\text{Cost of domestic funding}} \cdot \underbrace{\left(\frac{F_{t,t+n}^{x|\$}}{S_t^{x|\$}}\right)}_{\text{Cost of FX swap}} \quad (4)$$

Re-arranging the above in log-terms yields:

$$\underbrace{(i_{t,t+n}^{*,\$} - i_{t,t+n}^{*,x})}_{\text{i-rate differential}} + \underbrace{(c_{t,t+n}^{\$} - c_{t,t+n}^x)}_{\text{shadow cost differential}} = \underbrace{(f_{t,t+n}^{x|\$} - s_t^{x|\$})}_{\text{forward premium}} \quad (5)$$

which states that the forward premium is determined by the differentials in interest rates and shadow costs. Inserting eq. (3) shows that the cross-currency basis rises with the differential in shadow costs of borrowing USD in U.S. money markets and that of raising domestic funding:

$$\chi_{t,t+n}^{*,x|\$} = c_{t,t+n}^{\$} - c_{t,t+n}^x \quad (6)$$

Our framework suggests that the basis will rise so as to make synthetic USD borrowing more expensive when there is an increase in the shadow cost differential, i.e. when USD repo borrowing becomes relatively costly w.r.t. non-USD borrowing. This is consistent with the surges in CIP deviations observed at quarter-end. Furthermore, when choosing their source of dollar funding, each agent j compares their own individual shadow costs relative to the market-wide price ($\bar{\chi}$) for synthetic funding, and will substitute to synthetic funding if $\bar{\chi}_{t,t+n}^{*,x|\$} < c_{t,t+n}^{j,\$} - c_{t,t+n}^{j,x}$.

While sourcing U.S. dollar funding via repo is constrained by its secured nature, non-U.S. agents can readily obtain unencumbered domestic currency. During our sample period,

¹⁵ We assume the shadow cost of FX swaps to be negligible, as only 1% of their notional values enters the LR calculation.

unconventional monetary policy provided non-U.S. institutions with abundant central bank reserves and excess liquidity, particularly for the euro, Swiss franc, and yen. This domestic funding can be readily converted into synthetic dollars through FX swaps. Likewise, U.S. banks held large excess reserves of U.S. dollar liquidity of around \$2 trillion during the period in question. Moreover, owing to the dollar’s special status, non-U.S. institutions actively borrow in U.S. money markets, whereas U.S. institutions are largely absent from non-U.S. money markets (Rime et al., 2022). Consequently, when regulation constrains secured borrowing, the effects asymmetrically impact non-U.S. and U.S. agents, thereby segmenting currency markets. This additional burden is further important as banks operate close to LR limits in order to optimize balance sheet utilization and profitability.

Figure 2 illustrates these dynamics in a supply-and-demand framework spanning both wholesale and synthetic funding markets. In the absence of frictions, CIP deviations are minimal. Once regulatory shadow costs are imposed, however, the effective borrowing rate rises to $(1 + i^{\$}) + C^{\$}$, leading to a reduction in the equilibrium quantity ($Q \rightarrow Q'$) at which the repo market clears. To cover the shortfall, constrained non-U.S. banks turn to FX swaps, shifting the synthetic demand curve outward. Having lost their outside option, these agents exhibit more inelastic demand. Supply shifts outward and becomes more inelastic, as the only provider of unencumbered dollar funding during regulatory periods are U.S. banks, who can leverage their deposit base and central bank reserves. These banks are able to charge agents their outside option, and to the extent that they do not face their own quarter-end supply-end constraints, extract rent on the provision of U.S. dollars. The determinants of demand and supply inelasticity are explored in greater detail in section 5.

While CIP deviations have been interpreted as a violation of no-arbitrage, we will see that quarter-end episodes are not due to a lack of arbitrage capital; to the contrary, trading volume is highest precisely during these episodes. Instead, the cross-currency basis surges to reflect that the cost of borrowing U.S. dollars must remain equal regardless of the underlying financial instrument; the cross-currency basis cannot simultaneously satisfy both the (nominal) CIP condition as well as the law of one price. Alternatively, our findings suggest that the CIP condition *does* hold, provided agents’ shadow costs are taken into account.

An important consideration is whether quarter-end dynamics could be explained by Eu-

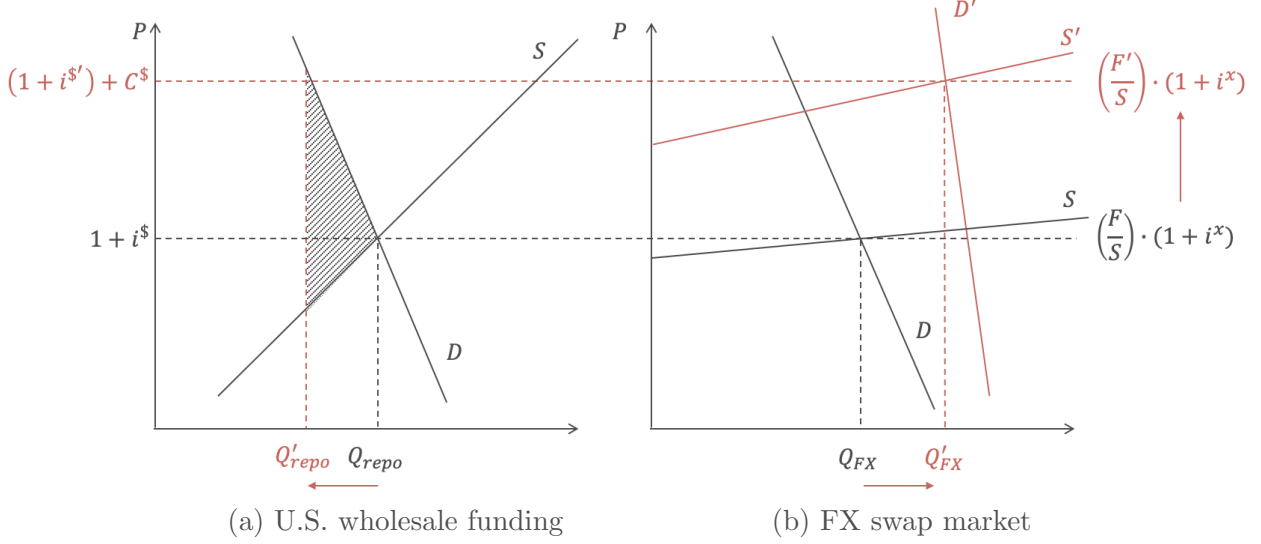


Fig. 2: Supply and demand in wholesale and synthetic dollar funding markets.

rozone banks acting as arbitrageurs. Given that these banks have privileged access to U.S. MMFs, one could hypothesize that they raise funding there, and lend within-quarter to e.g. European investment funds in synthetic markets, only to unwind this trade when reporting at the quarter-end. Alternatively, one can suppose that Eurozone banks have a persistent need for dollars, either to fund their own operations or to fulfill their obligations to clients as FX dealers. They thus depend on U.S. MMFs and must replace the dollar funding lost to quarter-end window-dressing. Both hypotheses propose that Eurozone banks' net dollar position will increase at quarter-end. However, were Eurozone banks to reduce their arbitrage operations, one would expect them to decrease their gross synthetic dollar lending. On the other hand, if they require dollar funding themselves, they would instead increase their gross synthetic dollar borrowing. We will test these hypotheses in sec. 4.

3. Mapping the Market for U.S. Dollar Funding

This paper sheds light on the global U.S. dollar funding chain through the lens of its two crucial segments: FX swap and repo markets. We source novel settlement data on volumes and prices to map banks' global synthetic funding positions, and complement this with data on banks' positions in wholesale money markets.

3.1. Data on the global FX swap market

With their sheer size of around \$3.8 trillion of global daily turnover ([Bank for International Settlements, 2022](#)), FX swaps represent the largest market in the world. However, obtaining data on this segment is notoriously difficult given its fragmented, over-the-counter nature. Trading occurs bilaterally and is dispersed throughout many exchanges, and relying on observations from a single source may not be representative of the global landscape. To address this, we use data from CLS, the world’s largest multi-currency cash settlement system.¹⁶ Most if not all trades require settlement, and CLS allows us to observe trades regardless of the platform on which they were executed, if any.¹⁷

We obtain a bespoke dataset from CLS on quantities and prices allowing us to identify the agents active in FX swap markets. First, we manually classify participants as G-SIBs, regular banks, or non-banks. This allows us to study the role of the large dealers which dominate the FX market; Appendix [IA.A](#) lists the G-SIBs in our data.¹⁸ Second, we hand-sort the 4,169 banking entities in our data set based on the *nationality* of their ultimate parent (i.e. the ‘home’ as opposed to the ‘host’ principle) and divide them into six regions: the U.S., the Eurozone, the U.K., Switzerland, Japan, and the rest of the world (ROW).¹⁹ To give an example, J.P. Morgan’s London branch is classified as a U.S. rather than a U.K. firm (and is further denoted as a G-SIB). Additionally, we classify non-bank customers per geography.²⁰

¹⁶ CLS FX spot data has been studied in inter alia [Hasbrouck and Levich \(2019\)](#), [Ranaldo and Somogyi \(2021\)](#), and [Cespa et al. \(2022\)](#), and CLS FX swap data has been analyzed in [Bräuer and Hau \(2022\)](#) and [Kloks et al. \(2023a\)](#).

¹⁷ There are some exceptions: for instance, CLS does not perform settlement for overnight swaps, the Chinese renminbi, or the Russian ruble. Moreover, a bank will not use CLS settlement when a customer has a deposit account with it (e.g., a retail investor using the banks’ wealth management services). Furthermore, institutions (e.g., hedge funds) with a prime brokerage arrangement with a dealer-bank are not settled through CLS.

¹⁸ We classified banks as G-SIBs if they were designated as such at least 7 times during the years 2012-2021 according to the List of Global Systemically Important Banks published annually by the Financial Stability Board (FSB) in consultation with the BCBS and national authorities. Given their role in FX markets, we use the terms “dealer-banks” and “G-SIBs” interchangeably throughout the paper.

¹⁹ A welcome consequence of our classification is that all ROW G-SIBs are Chinese (CN). This does not hold true for non-G-SIB entities.

²⁰ Funds were assigned to regions based on the physical location of the fund’s management personnel, which avoids assigning them to the legal domicile of their headquarters, which may have little economic significance. Finally, corporates and non-bank financial institutions were assigned according to a location principle based on information observed in CLS. Note that, in total, we have 6 currency blocks and 3 institution types, thus meaning that we have 18 distinct counterparties in our data set. We observe 138 directional flows (as non-banks cannot trade with each other in CLS) and further observe intra-sectoral gross positions.

The intuition behind the classification is to link banking groups with the currency of their consolidated balance sheet (the dollar, the euro, the pound, the Swiss franc, and the yen) and to better identify the regulatory framework to which the ultimate parent is subject. In Appendix B, we test the representativeness of our data by sourcing a sample based on the *locational* principle and comparing it to the similarly-delineated BIS Triennial Central Bank Survey on FX and OTC derivatives (BIS, 2016); our results confirm that BIS and CLS locational shares match closely. We furthermore observe that due to London’s role as a global hub for FX trading, the location principle severely underestimates the importance of U.S. banks, who account for 47% of the market, whereas only 19% of their trading occurs within the U.S. itself. Eurozone and U.K. G-SIBs are the other major banking sectors, with 23% and 16% market share, respectively. We are the first to study CLS FX swap data based on nationality and institution type in a global context.²¹ Our data runs from September 3rd, 2012 to June 30th, 2022 and is available at daily frequency. It covers 40 currency pairs (including 17 USD pairs) and 8 tenors²² and captures at least 30% of the FX market according to BIS estimates.²³ Table IA.B1 provides further summary statistics.

Fig. 3 visualizes the global market for U.S. dollar borrowing and lending in FX swaps through a network of outstanding positions.²⁴ For simplicity, we group our data into two main institution types: G-SIBs and customers, with the latter group including both regular banks and non-banks. We consider the net U.S. dollar position between agents in *domestic* currency pairs.²⁵ Several key insights emerge. First, the market is dominated by G-SIBs,

²¹ Kloks et al. (2023b) use this data to analyze how banks’ FX swap positions compare with their balance sheet currency mismatches. Hacıoğlu-Hoke et al. (2024) study the topography of FX derivatives; their EMIR data provides firm-level insights but is constrained to U.K. and EU agents trading on U.K. platforms.

²² We assign swaps to a total of 8 tenor buckets designed to represent tom-next (TN), spot-next (SN), 1-week (1W), 2-week (2W), 1-month (1M), 2-month (2M), 3-month (3M), and longer (1Y) maturities.

²³ For further analysis of the representativeness of CLS data, see Kloks et al. (2023a).

²⁴ The arrows represent the direction of the U.S. dollar flow, with larger arrows representing greater net amounts of dollars being loaned. The color of the nodes sums up these positions to indicate an overall position in domestic currencies, with green (red) representing dollar lending (borrowing). Finally, the size of the nodes is determined by agents’ trading volume in all dollar pairs. For simplicity, we do not include intra-customer flows in this analysis.

²⁵ That is, when considering a Japanese or a Swiss customer trading with a G-SIB, we calculate the dollar position based on USDJPY and USDCHF respectively. When a Eurozone G-SIB trades with e.g. a U.K. G-SIB, we consider the net dollar flow resulting from combining EURUSD and GBPUSD pairs. Focusing on domestic pairs allows us to parse out the effect of agents’ using the dollar as a vehicle currency, and instead focus on fundamental flows.

with U.S. G-SIBs playing the most prominent role. Second, customers (i.e. non-G-SIBs and non-banks) are clear net dollar borrowers, regardless of their nationality. Third, U.S. G-SIBs are the most prolific dollar lenders, with large flows to all other agent types. Appendix [IA.C](#) provides a further volume breakdown per party, currency, and tenor and further quantifies the flows shown in Fig. [3](#) as a share of the underlying volume.

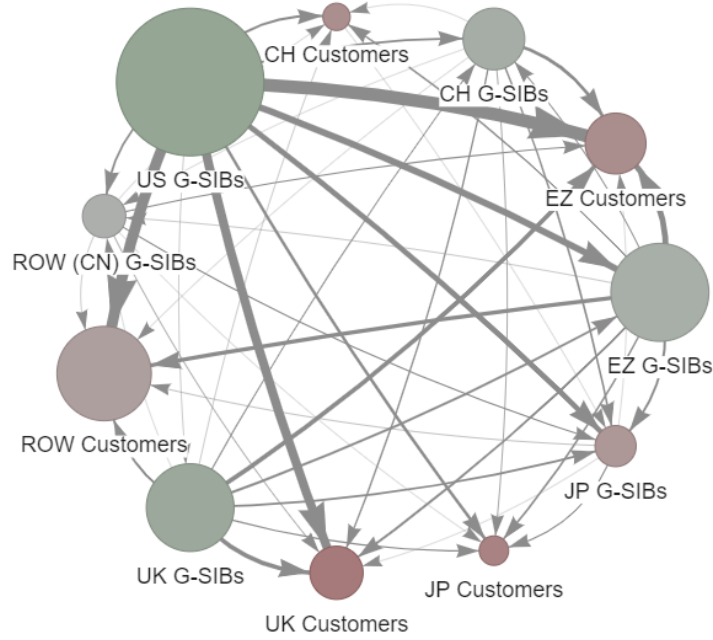


Fig. 3: The edges of the network show absolute net U.S. dollar positions in participants' domestic currency pairs. The nodes' colors represent the extent to which they are an overall dollar lender (green) or borrower (red) in their domestic currency pairs. Size of the nodes is determined by participants' trading volume in all dollar pairs. Data is daily average positions and volumes for the 2012-2022 period.

Fig. [4](#) supports our narrative and provides initial evidence of regulatory-driven demand effects. It depicts an event study around quarter-ends for short-term *outstanding* FX swap positions and shows that the total amount of active FX swap positions spikes exactly at the end of the quarter, i.e. on the day t when the balance sheet is reported. That is, an FX swap is included at date t if its near-leg settlement date $\leq t$ and its far-leg settlement date is $> t$.^{[26](#)} Thus, the swap volumes appearing on date t are those volumes which would be shown

²⁶ The data set defines a business day as rolling over at 5 p.m. New York time, in line with FX convention.

on a bank’s balance sheet for that quarter.²⁷ The plot depicts gross total global volumes and hence does not attempt to indicate a net borrowing pressure (which is investigated in-depth in the next section); instead, it simply demonstrates that banks use FX swaps *intentionally* to target the reporting date itself. Across all currency pairs, an extra \$200 bn worth of short-term FX swap trades is conducted on average, representing a 10% surge. The effect is substantial even when considering all FX swap tenors (not just the short-term segment); Appendix C shows that the spike in activity remains considerable and represents a 3% increase of total volume. Appendix IA.D formalizes our findings in a regression setting.

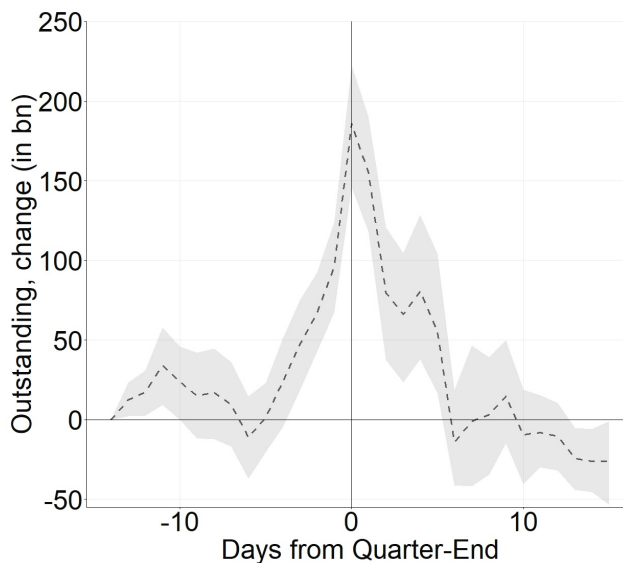


Fig. 4: Regulatory quarter-ends serve as the basis of the event study. Year-ends are not included. Short-term maturities means tenors between spot-next to 1W. All volumes are in USD. Dotted lines represent the 95% confidence interval with bootstrapped standard errors.

We further complement our data on synthetic funding flows with observations of FX swap prices, following the structure of our nationality dataset. We obtain measurements of swap points $F - S$, as this represents the *traded* price of an FX swap contract and reflects the conventional method by which prices are quoted and exchanged. The implied rates of the near (S) and far (F) legs of each contract were carefully manually matched. Then, daily volume-weighted average prices were calculated for each currency pair, tenor, party, and counterparty. Appendix IA.E shows the actual prices charged by U.S. banks based on

²⁷ We consider regulatory quarter-ends, i.e. post-2015 quarter-ends (as public disclosure of the LR started in 2015 for European banks) and do not include year-ends.

CLS data, compared to indicative quotes from Bloomberg. It confirms that CLS rates, while inherently slightly noisier, are well-behaved and highly correlated with Bloomberg prices. To our knowledge, this is the first study to analyze FX swap prices using settlement data. To obtain the cross-currency basis from FX swap points, we match traded CLS rates with daily overnight interest rate swap (OIS) and LIBOR interest rates from Bloomberg.

3.2. Data on U.S. and European repo markets

We source data on U.S. wholesale funding from reports on MMF portfolio holdings, i.e. U.S. Securities and Exchange Commission (SEC) form N-MFP (obtained from Crane data). The tri-party repo market contained therein is where large global banks, including non-U.S. banks, obtain U.S. dollars from MMFs, who are the largest primary cash lenders in this market. The data set includes outstanding repo volumes for U.S. and non-U.S. banks at an individual entity level and is available as a snapshot at each month-end from 2012 onwards. We further obtain data on Eurozone banks' activity in euro markets from BrokerTec, the largest repo electronic exchange in Europe.²⁸ Our data allows us to obtain a representative picture of Eurozone banks' trading activity in their home repo markets.²⁹

4. Repo-FX Swap Substitution

In section 2.1, we explained how the two main money market instruments, i.e. repos and FX swaps, heterogeneously impact banks' balance sheets, and emphasized how the latter avoids hindering banks' regulatory ratios. This section provides empirical evidence that constrained banks substitute from repo to FX swaps when sourcing U.S. dollar funding.

4.1. Empirical evidence of substitution

Figure 5 provides visual evidence supporting the substitution hypothesis by showing Eurozone G-SIBs' activity across various money markets. The blue line depicts their repo

²⁸ Note that the European market structure is different than the tri-party U.S. repo market; the dominant segment in Europe is the central (clearing) counterparty (CCP)-based interbank market.

²⁹ Two other electronic trading platforms are prominent in Europe, namely Eurex Repo and MTS. Only MTS is comparable in size to BrokerTec, but it does not have market participant identifiers. Regardless, it covers Italian banks, which do not play a large role in global U.S. dollar funding markets.

Eurozone G-SIB positions in global money markets

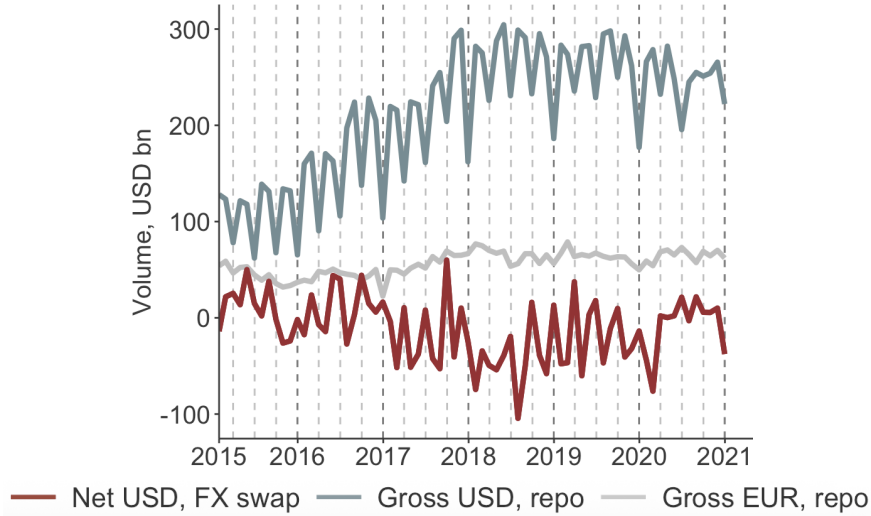


Fig. 5: This figure shows the behavior of Eurozone G-SIBs in wholesale and synthetic funding markets. The red line shows Eurozone G-SIBs’ net position in short-term FX swaps (dollar borrowing net of dollar lending for maturities one week and under). The blue line shows their gross dollar borrowing from U.S. MMFs; as MMFs only lend cash, this is also a net position. In grey, we plot gross euro currency borrowing in their domestic money market (as observed in BrokerTec). The time period runs from January 2015 to December 2020.

borrowing from U.S. MMFs.³⁰ The red line represents their net dollar position in short-term FX swaps, that is, USD borrowing net of dollar lending. Evidently, Eurozone G-SIBs systematically reduce (increase) their borrowing in repo (FX swaps) at quarter-ends (indicated by dotted vertical lines). The decline in repo of around \$50 bn closely mirrors the corresponding rise in synthetic borrowing. Furthermore, the grey line represents Eurozone G-SIBs’ domestic euro currency borrowing in European repo; this shows that repo window-dressing dynamics are largely driven by withdrawals from U.S. money markets, while domestic borrowing remains relatively constant.³¹ We will observe in the following figure that FX swap operations are equally dollar-focused.

Our granular data allows us to observe who demands and supplies the dollar at quarter-

³⁰ Note that this borrowing is intrinsically one-directional as U.S. MMFs only lend cash; they do not borrow. That is, they only perform reverse repo and do not incur repo liabilities (Baklanova et al., 2021). Therefore, borrowing from MMFs is both a gross and a net position.

³¹ While CCP-based euro repo can be window-dressed through netting, borrowing from U.S. MMFs is solely one-directional, implying that window-dressing is only possible through a complete exit of the position.

Synthetic (FX swap) activity at the quarter-end

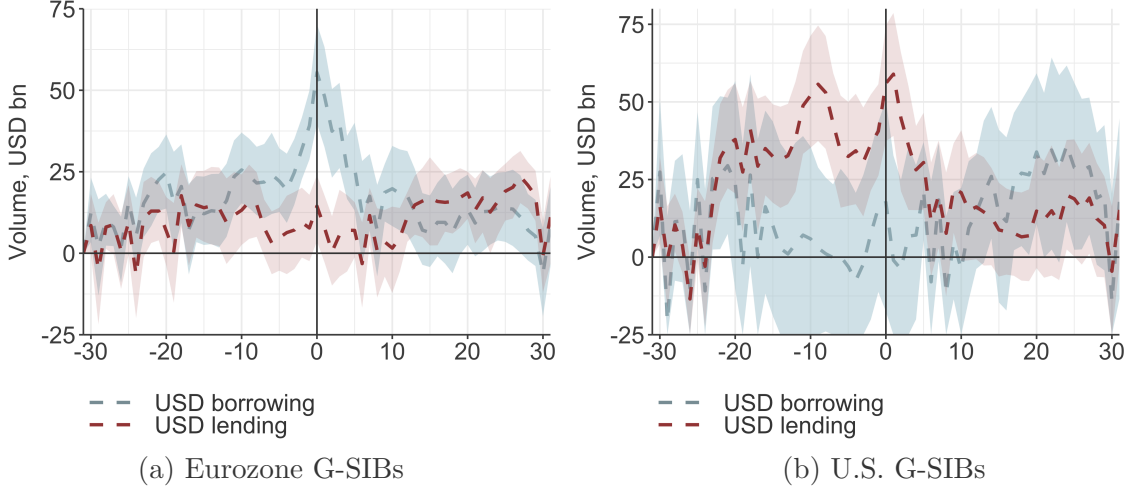


Fig. 6: We conduct an event study around quarter-ends (excluding year-ends) of outstanding short-term FX swap positions (i.e. gross dollar borrowing and lending). The study spans 31 days before and after the quarter-end (as a quarter spans 62 business days). Panel (a) shows Eurozone G-SIB positions and panel (b) shows those of U.S. G-SIBs. Bootstrapped standard errors are depicted as a shaded area around the point estimates. The time period for all panels runs from January 2015 to December 2020.

end. Panel (a) presents an event study around the the quarter-end, and shows that Eurozone G-SIBs’ net synthetic dollar position increases by around \$50 bn. The surge in gross synthetic dollar borrowing is implemented so as to target the quarter-end reporting date itself.³² Panel (b) shows that U.S. G-SIBs provide this incremental liquidity with a corresponding \$50 bn increase in dollar lending, which is consistent with the notion that they can provide dollar liquidity from their reserves.³³ Prior research in [Correa et al. \(2020\)](#) has estimated the U.S. G-SIB synthetic dollar funding surge at around \$20 bn using a shorter time-frame around the quarter-end; we replicate this result in [Appendix IA.F](#) and show that one reaches the higher estimate when considering the pre-IMM trend in dollar lending. [Appendix D](#) repeats the event study exercise for all agents in the dataset, showing their quarter-end activity. In

³² Furthermore, non-dollar borrowing (i.e. dollar lending) remains constant, showing that synthetic dynamics are unique to the dollar, as was the case for repo movements.

³³ A second surge in U.S. bank lending is identifiable around 10 days before the quarter-end; these are International Monetary Market (IMM) dates when U.S. G-SIBs provide bridge USD funding to market participants rolling over their positions. For historical reasons, many FX and money market options and futures have these standardized maturity dates, which fall on the third Wednesday of each quarter-end month.

Appendix [IA.G](#), we provide further summary statistics on the surge of flows and quantities per nationality.

4.2. Identification: heterogeneous regulatory reporting

To further test our hypothesis that repo-FX swap substitution is regulatory-driven, we refine our identification strategy by comparing those G-SIBs which report their regulatory ratios as a quarter-end snapshot with those which report daily averages of the quarter’s values. As discussed in section [2.1](#), banking regulation in most jurisdictions mandates that ratios are calculated using the balance sheet as it stands on the last day of the quarter. Two jurisdictions, the U.K. and the U.S., are an exception. In the U.K., banks first reported their quarterly ratios as an average of the three intervening month-ends during a transition phase from January to December 2016 ([Cenedese et al., 2021](#)); subsequently, they moved to a daily averaging scheme ([Bank of England, 2015](#)). The Supplementary Leverage Ratio (SLR) in the U.S. has been based on daily averages since its inception.

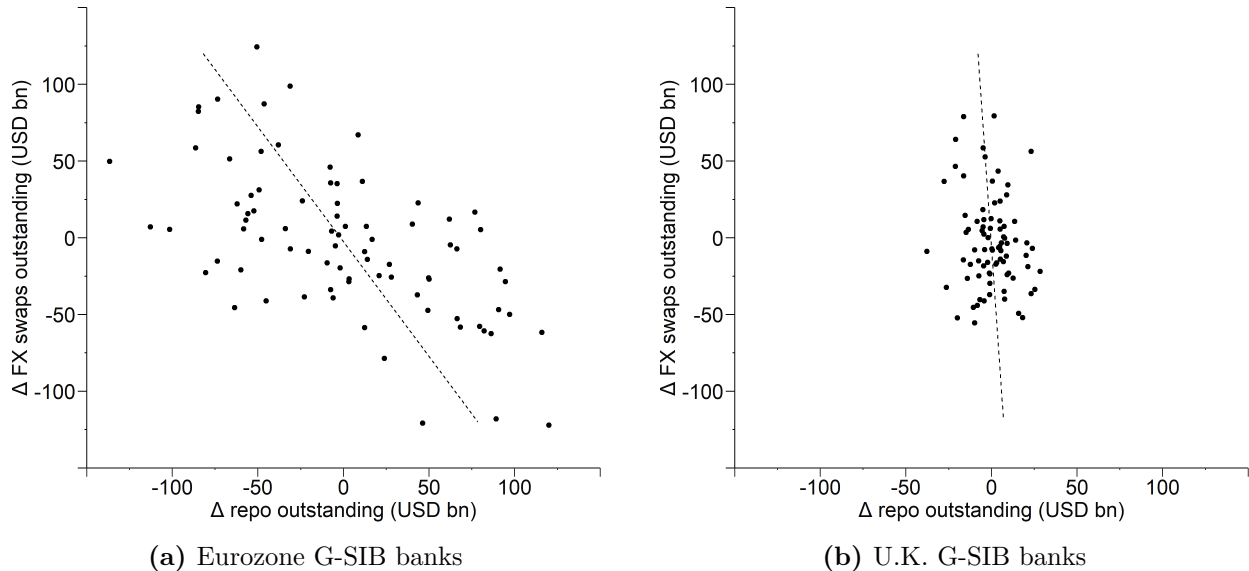


Fig. 7: The figure displays monthly *changes* in Eurozone (panel a) and U.K. (panel b) net USD FX swap positions in all U.S. dollar currency pairs vis-à-vis the monthly *change* in their borrowing from U.S. MMFs. Values combine all maturities and are measured in billions of USD. The sample runs from January 2015 to September 2021.

Figure [7](#) shows prima facie evidence that repo-FX swap substitution is an activity pursued by Eurozone G-SIBs (panel a) but not their U.K. counterparts (panel b). While a

clear negative association is visible between (changes in) net USD FX swap positions and borrowing from U.S. MMFs in U.S. dollars for Eurozone banks, this relationship applies less, if at all, to U.K. banks.

We use G-SIBs from snapshot-reporting jurisdictions as a treatment group - in that they are strongly incentivized to adapt their quarter-end results - and G-SIBs from jurisdictions on averaging schemes as a control group.³⁴ This approach is likely to lead to an under-estimation of the average treatment effect for the treated, given that “averaging” G-SIBs arguably still face some minor incentive to window-dress at the quarter-end. Note that whether averaging was taken using daily values or monthly figures (as in the U.K. transition period) does not matter for our identification given our regression model, which is as follows:

$$Y_{i,t} = \beta_1 \cdot Q_t^{end} + \beta_2 \cdot Snapshot_i + \beta_3 \cdot Q_t^{end} \cdot Snapshot_i + \beta_4 \cdot Q_t^{end} \cdot Y_t^{end} + \beta_5 \cdot Q_t^{end} \cdot Y_t^{end} \cdot Snapshot_i + \alpha_i + u_{i,t} \quad (7)$$

where Q_t^{end} (Y_t^{end}) is a dummy indicating a quarter-end (year-end), α_i are ultimate parent nationality fixed effects, and $Snapshot_i$ is unity for snapshot-reporting bank nationalities and 0 for “averaging” banking jurisdictions. β_3 is the difference-in-differences estimator and the coefficient of interest, while the year-end variables serve only as controls. Regarding the dependent variable $Y_{i,t}$, we separately regress agents’ gross and net FX swap dollar positions, as well as their repo borrowing (all in logs). We further calculate the share of net USD borrowing which occurs through FX swaps as opposed to repo as follows:

$$SwapShare_{i,t}^{\$} := 100 \cdot \left(\frac{SwapBorrowing_{i,t}^{\$} - SwapLending_{i,t}^{\$}}{SwapBorrowing_{i,t}^{\$} - SwapLending_{i,t}^{\$} + RepoBorrowing_{i,t}^{\$}} \right) \quad (8)$$

The results in Table 1 provide support for our hypothesis. Column (1) first considers *gross* synthetic dollar borrowing; when crossing the quarter-end, snapshot-reporting G-SIBs show a 14%³⁵ higher outstanding position in FX swap dollar borrowing than G-SIBs on an averaging scheme. Column (2) performs the same for gross synthetic dollar lending, and finds

³⁴ U.K. G-SIBs are classified as snapshot reporters for the duration of 2015, and thereafter are labeled as “averagers.”

³⁵ As the model is in log-linear form, a unit increase in the regressor causes a $100 \cdot (e^{\beta} - 1)$ percent increase in the dependent variable.

	Snapshot vs. Daily Average Reporters				
	FX Swap (logs)		Net	Repo (logs)	FX Swap
	Borrowing	Lending		Net	Share (%)
	(1)	(2)	(3)	(4)	(5)
Q^{end}	−0.01 (0.06)	0.07 (0.04)	−0.20 (0.42)	−0.09 (0.10)	−16.22* (9.84)
$Snapshot$	−0.27*** (0.09)	−0.61*** (0.07)	4.03*** (0.69)	−0.79*** (0.16)	50.47*** (16.26)
$Q^{end} \times Snapshot$	0.13** (0.07)	−0.02 (0.05)	1.21** (0.50)	−0.36*** (0.12)	40.64*** (12.40)
<i>Controls</i>					
$Q^{end} \times Y^{end}$	−0.51*** (0.10)	−0.39*** (0.08)	−1.05 (0.73)	−0.02 (0.17)	−17.93 (17.21)
$Q^{end} \times Y^{end} \times Snapshot$	0.15 (0.11)	−0.05 (0.09)	0.83 (0.87)	0.01 (0.21)	10.33 (21.34)
Observations	492	492	492	411	411
Adjusted R^2	0.91	0.90	0.59	0.83	0.24

Table 1: All models are panel regressions with bank nationality fixed effects. The dependent variable is (i) gross dollar borrowing in FX swaps, (ii) gross dollar lending in FX swaps, (iii) net dollar borrowing in FX swaps, (iv) USD repo net borrowing (which is also a gross position, given borrowing from U.S. MMFs is one-directional), and (v) the share of dollars sourced through net synthetic funding as defined in eq. (8). All positions are outstanding. “Snapshot” is a dummy variable comparing banking nationalities that report their regulatory ratios as a quarter-end snapshot (i.e. the Eurozone, Switzerland, Japan, and ROW) as opposed to G-SIBs which report averages (i.e. the U.K. and the U.S.). Q_t^{end} (Y_t^{end}) is a dummy indicating a quarter-end (year-end). Frequency is monthly; the sample starts at the 2015 year-end and ends in September 2021. ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

no significant change relative to the control group. Column (3) considers *net* synthetic dollar borrowing, and confirms that snapshot reporters dramatically increase their dollar borrowing at quarter-end, relative to averaging reporters.³⁶ Column (4) considers net repo borrowing from U.S. MMFs (this is both a gross and a net position, as these flows are one-directional); constrained bank positions drop by a significant 30% when crossing the regulatory period relative to the control group. When considering net synthetic dollars as a share of total

³⁶ The coefficient value is very large as the net dollar position for these institutions is often close to zero, thus the percentage increase is disproportionately high; see Figure 5. Eurozone G-SIBs’ dollar position is positive once we consider long-term swaps and/or wholesale borrowing.

dollar borrowing in column (5), i.e., swaps and repos combined, we see a statistically and economically significant surge of 40.6% relative to G-SIBs on an averaging scheme.

Our results support the notion that the opposite dynamics observed in repo and FX swap markets are driven by a common factor, namely, regulatory reporting. Furthermore, these results point to Eurozone banks demanding dollars themselves, rather than withdrawing from arbitrage strategies, as discussed in sec. 2.2. That is, one can observe in columns (1)-(2) that these agents increased their gross dollar borrowing while keeping their gross dollar lending constant.³⁷ If these institutions were winding down arbitrage operations, one would expect them to reduce their gross dollar lending; the results point to their instead using synthetic funding to maintain their dollar borrowing levels during constrained periods. We consider these dynamics further in sec. 4.3.8.

4.3. *Additional Considerations and Robustness Checks*

To further validate our hypothesis, we analyze substitution patterns across several dimensions: (i) nationalities, (ii) currencies, (iii) year-ends, and (iv) secured versus unsecured funding. Additionally, we explore the potential role of other regulatory ratios, the impact of netting in repo markets, and the role of clients in FX swap markets. Finally, we consider whether Eurozone banks conduct within-quarter arbitrage of the cross-currency basis.

4.3.1. *Breakdown by Jurisdiction*

The fact that those *same* nationalities which decrease their wholesale funding also increase their synthetic borrowing, as shown in Appendix E, is further evidence for repo-FX swap substitution. The dynamic is strongest for Eurozone and Swiss G-SIBs, and less pronounced for Japanese banks.³⁸ This pattern is confirmed in Appendix IA.H using a difference-in-differences specification with alternate U.K. and U.S. control groups; that is, we estimate the model in eq. (7) for each nationality separately. Compared to U.K. peers, Eurozone banks increase their synthetic funding share by 45%. U.S. banks supply that synthetic dol-

³⁷ We confirm this result for Eurozone G-SIBs specifically in Appendix IA.H. Note that this analysis, pooled over all G-SIB banking groups in our sample, hides a degree of heterogeneity across jurisdictions, which we will clarify in the next section.

³⁸ [Aldasoro et al. \(2022\)](#) suggest that repo window-dressing is prevalent among European banks specifically because French banks are large repo intermediaries.

lar funding, but do not do so through increased U.S. MMF borrowing. This suggests they rely instead on their excess reserves instead, see [Correa et al. \(2020\)](#).

4.3.2. *Uniqueness of the Dollar*

We confirm that the observed substitution is unique to the U.S. dollar. As regards FX swap dynamics, USD purchases dominate quarter-end activity (see Appendix [D](#) and Appendix [IA.I](#)). Correspondingly, Eurozone banks withdraw sharply from U.S. dollar repo at quarter-end, but show little change in domestic European repo markets. Figure [5](#) illustrates this divergence, and Appendix [IA.J](#) confirms it using a difference-in-differences approach. Eurozone banks are able to net their domestic positions, but cannot do so with U.S. MMFs, which are intrinsically one-directional and whose structure does not allow netting with any other repo segment. Furthermore, since the purpose of such borrowing is to acquire USD liquidity, netting would be counterproductive. Finally, while non-U.S. institutions use U.S. money markets to obtain dollar liquidity, U.S. institutions are not active in wholesale money markets outside of the U.S. ([Rime et al., 2022](#)).

4.3.3. *Year-Ends*

At year-end, FX swaps lose their attractiveness relative to repos as their positions are fully included in the annual snapshot calculation of G-SIB capital surcharges ([BCBS \(2013\)](#), [Krohn and Sushko \(2022\)](#)).³⁹ We thus test whether the share of synthetic USD funding decreases at year-end relative to other quarter-ends:

$$SwapShare_{i,t} = \beta_0 + \beta_1 \cdot Q_t^{end} + \beta_2 \cdot Q_t^{end} \cdot Y_t^{end} + u_{i,t}. \quad (9)$$

Table [F1](#) shows that while quarter-end funding shifts toward FX swaps, this reverses at year-end. For example, Eurozone G-SIBs increase their synthetic funding share by 17% during (all) quarter-ends, but this reverses by 13% at year-end, in line with our hypothesis.

³⁹ As FX swaps contribute to the complexity score, a large swap position could result in a bank crossing into the next G-SIB bucket, which would result in additional capital buffer requirements.

4.3.4. Role of Liquidity Coverage Ratio and HQLA Requirements

We consider whether other regulatory requirements such as the liquidity coverage ratio (LCR) could explain the observed dynamics. While the LCR requires banks to hold high-quality liquid assets (HQLA), it is reported at *monthly* frequency in Europe,⁴⁰ unlike the LR. The distinct quarter-end patterns we observe are therefore more consistent with LR-related window-dressing. This aligns with [Cenedese et al. \(2021\)](#), who find no results when considering the LCR introduction date in the U.K.

4.3.5. Secured vs. Unsecured Funding

Quarter-end substitution is concentrated in secured borrowing, and we find no significant reduction of unsecured USD borrowing by G-SIBs, as shown in Appendix G. That window-dressing targets secured funding highlights that it is the collateralized nature of wholesale borrowing which penalizes the LR. In contrast, unsecured funding - though subject to other regulatory frictions like LCR and XVA - consumes half as much balance sheet space. Basel III regulation thus counterintuitively penalizes secured borrowing in favor of unsecured funding. However, as a result of the 2016 U.S. MMF Reform, unsecured borrowing collapsed by roughly \$600 bn in favor of secured means, increasing the burden on non-U.S. institutions (as displayed in Appendix H).

4.3.6. Effects on U.S. Repo Markets

Our analysis of the cross-currency basis is unaffected by repo rate movements, as CIP deviations are inherently net of interest rate changes. As far as repo markets themselves, reduced quarter-end borrowing by Eurozone banks would suggest downward pressure on U.S. MMF rates, but these funds instead place excess cash at the Fed's overnight reverse repo (ON RRP) facility (see Fig. [IA.K1](#) and [Egelhof et al. \(2017\)](#); [Correa et al. \(2020\)](#)). That the U.S. MMF repo rate does not significantly decrease indicates that its supply is relatively elastic w.r.t. its demand. Instead, dollar demand is inelastic, the repo rate remains relatively unchanged, and regulatory shadow costs are passed on the repo borrower, not the lender (see Fig. [IA.K2](#)). Outside of U.S. MMFs, [Egelhof et al. \(2017\)](#) find that banks attempt to balance

⁴⁰ See Article 2(1)(a) of the Commission Implementing Regulation (EU) No 680/2014 of 16 April 2014.

their positions in the nettable General Collateral Finance (GCF) segment by reducing dollar lending, thereby increasing rates (see Fig. [IA.K3](#)). However, they confirm that, in total, Eurozone banks reduce their overall repo dollar borrowing at quarter-end; our paper shows that the shortfall is made up through synthetic funding.

4.3.7. *Role of End-Customers*

Non-U.S. banks appear to use FX swaps at quarter-end to manage the regulatory cost of meeting continual USD demand from their non-bank clients, rather than in response to an increase in that demand. First, we find no evidence of quarter-end surges in non-bank USD borrowing. Second, Appendix [I](#) shows that non-U.S. dealers' positions with U.S. G-SIBs are positively correlated with their customers' USD flows with their respective selves, suggesting dealers replenish inventory based on client activity. Dealer-banks must continually service customer demand or face losing client relationships. Thus dealer-banks can only optimize their regulatory ratios through their choice of funding instrument, not by how they lend to counterparties.^{[41](#)}

4.3.8. *Do Eurozone banks arbitrage the basis outside of the quarter-end?*

Since Eurozone dealer-banks only report their regulatory ratios at quarter-end, they could in principle arbitrage the cross-currency basis during the quarter. That is, they could borrow wholesale dollar funding and lend to agents without U.S. MMF access (i.e., non-bank customers) or to banks constrained by daily-average reporting. With respect to the former, Eurozone banks indeed provide synthetic dollars to non-bank customers and, when this activity is backed by wholesale funding, capture the CIP basis as a spread.^{[42](#)} However, we find no evidence that they scale back such client lending at quarter-end: customer gross and net positions remain stable. This suggests that within-quarter profits primarily reflect Eurozone dealer-banks' role as financial intermediaries, rather than an explicit arbitrage

⁴¹ Furthermore, given that *reverse repo* - i.e. the lending of liquidity - does not expand the balance sheet, client lending should regardless leave the LR unaffected.

⁴² It is important to distinguish between active arbitrage of the CIP basis and the servicing of customer order flow as part of market-making and financial intermediation. While both involve lending synthetic dollars to customers, the former represents a profit opportunity to be exited when convenient, while the latter obliges Eurozone dealer-banks to source and maintain the appropriate dollar funding inventory. This imposes a *burden* from a balance sheet perspective, thus intensifying their demand for synthetic dollars.

strategy to be unwound when no longer profitable.

As for arbitrage vis-à-vis U.S. and U.K. banks, we test this in two ways. First, if Eurozone banks exploited within-quarter dynamics, one would expect them to have increased their short-term dollar positions with U.S. banks after the 2015 Basel III implementation. By contrast, U.K. banks - subject to similar constraints - could not have done so. Our results (not shown) reveal no such structural shift in market dynamics, nor do we observe a post-2015 surge in net synthetic dollar lending from Eurozone to U.K. banks.

Second, if Eurozone G-SIBs' within-quarter activity had meaningfully involved the arbitrage provision of dollars to U.S. or U.K. banks, one would expect gross synthetic lending volumes to contract at quarter-end as these positions were unwound. We find no such pattern; instead, Eurozone G-SIBs expand their gross (and net) dollar borrowing from both U.S. and U.K. peers at quarter-end, while gross lending remains constant. We thus find no evidence that Eurozone banks arbitrage within-quarter dollar funding to constrained counterparties as a result of the Basel III reform.

5. Pricing Analysis

In the previous section, we established empirically that balance sheet regulation constrains non-U.S. banks' access to U.S. wholesale funding, causing them to substitute to synthetic dollar funding. Here, we test whether wholesale shadow costs and non-U.S. agents' demand for FX swaps have price effects which manifest through the cross-currency basis. We first show that the variation in quarter-end CIP deviations can be explained by the severity of shadow costs in U.S. secured markets. We then examine whether U.S. banks are able to extract rents from the provision of synthetic dollars - that is, whether they exploit the constrained position of non-U.S. banks to charge prices above their own marginal cost. In sec. 5.2, we consider FX swap market dynamics more broadly, and show that non-U.S. institutions, including dealer-banks, display inelastic demand. In sec. 5.3, we test whether U.S. dealer-banks are able to price-discriminate in FX swap markets, thereby capturing the full opportunity cost from constrained counterparties.

5.1. The cross-currency basis at the quarter-end

5.1.1. Shadow costs and demand-side effects

According to the conceptual framework in section 2.2, the cross-currency basis should increase as the shadow cost of sourcing dollars from U.S. MMFs rises. We consider two proxies for shadow costs in U.S. repo markets: (i) Eurozone G-SIB repo withdrawals, and (ii) the share of U.S. MMF borrowing performed on a secured relative to an unsecured basis. Proxy (i) indicates the severity with which Eurozone G-SIBs need to window-dress their LR. Panel (a) of Figure 8 plots changes in the cross-currency basis versus changes in outstanding Eurozone G-SIB repo positions with U.S. MMFs; it shows a powerful link between the basis and Eurozone G-SIBs’ monthly positions. The intuition is that the higher the shadow costs faced by these banks at quarter-end, the more they will withdraw from repo markets, and the basis accordingly adjusts to reflect their shadow costs.⁴³ With regard to (ii), one of the factors making U.S. wholesale funding *relatively* costly is the extent to which balance sheet-intensive collateral is required for such operations. We consider Eurozone and Swiss G-SIBs’ wholesale funding and derive the share of their secured wholesale funding as $\Delta_t^{Secured} := \frac{\sum_{j=1}^J (\mathcal{O}_{j,t}^{Secured})}{\sum_{j=1}^J (\mathcal{O}_{j,t}^{Secured} + \mathcal{O}_{j,t}^{Unsecured})}$, where $\mathcal{O}$ denotes an outstanding quantity of U.S. dollar borrowing from U.S. MMFs. Secured borrowing consists of repo while unsecured borrowing includes commercial paper (CP) and certificates of deposit (CD).⁴⁴ Panel (b) of Figure 8 shows that the share of secured borrowing heavily coincides with spikes in the cross-currency basis, both during and outside the quarter-end reporting period.⁴⁵

A causal linkage of wholesale shadow costs to the cross-currency basis can be performed by revisiting the results of Du et al. (2018), which show that deviations from CIP emerge when swap contracts cross regulatory quarter-ends (see Appendix A). The key is understanding that the quarter-end variable does not represent a shock to the supply of synthetic dollar

⁴³ A similar correlation has been documented in Aldasoro et al. (2022).

⁴⁴ These G-SIBs’ wholesale funding consists of the following sources: repo (67.8%), CP (13.1%), CD (12.6%), and “Other” (6.5%). The results we show below are robust when including other sources of financing in the denominator.

⁴⁵ We consider lagged values of the secured funding share to consider banks’ balance sheet shadow cost before they window-dress it away; considering contemporaneous values does not change results. Furthermore, there interestingly remains a strong correlation between the basis and the share of secured borrowing even outside of the quarter-end. This suggests that non-regulatory relative costs also play a role; a plausible explanation is that difficulties in sourcing the requisite collateral increase banks’ synthetic reservation price.

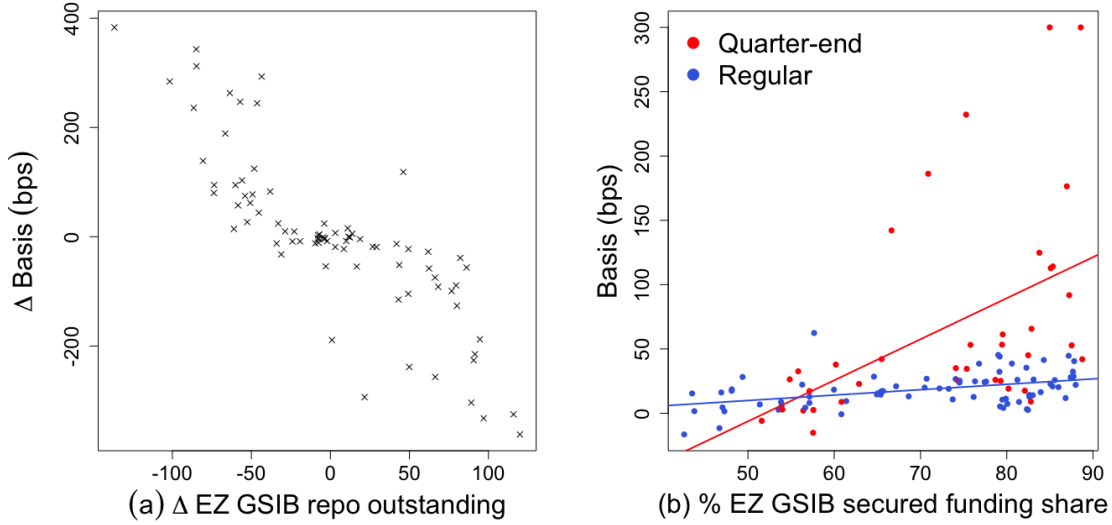


Fig. 8: Panel (a) depicts a scatterplot of changes in the cross-currency basis (USDJPY 1W) versus changes in outstanding Eurozone G-SIB repo positions with U.S. MMFs. Panel (b) depicts a scatterplot of the share of secured borrowing by European G-SIBs versus the level of the cross-currency basis (EURUSD 1W). The secured borrowing share is a lagged value from the previous month. Basis values are capped at 300 basis points for visualization purposes. Red (blue) dots denote values during (outside of) the quarter-end. Frequency is monthly for both panels.

funding, but rather the imposition of shadow costs on Eurozone (and other non-U.S.) banks' access to wholesale dollars. As FX swaps are exempt from the LR and U.S. banks do not report quarter-end snapshots, the significance of the quarter-end variable is through its impact on Eurozone banks' wholesale borrowing. The cross-currency basis then rises to reflect these banks' constrained outside option and inelastic demand for the dollar.

5.1.2. Supply-side determinants

Synthetic dollar funding markets are thus affected by sizable demand shocks from non-U.S. banks willing to pay an elevated cross-currency basis, provided it remains below their wholesale shadow costs. To the extent U.S. G-SIBs do not face their own supply constraints, they may charge prices in excess of their marginal cost, and thereby extract rent on the provision of dollar funding. This section provides evidence on the determinants of supply.

As U.S. G-SIBs report their regulatory metrics such as the SLR and the LCR as daily values averaged over the quarter, it is unlikely that Basel III concerns are an important

quarter-end supply constraint.⁴⁶ On the other hand, limits to reserve-draining intermediation are a potential friction: as documented by [Correa et al. \(2020\)](#) and [Copeland et al. \(2025\)](#), banks are often reluctant to decrease their level of reserves with the Fed. This effect results in the GCF repo rate often drifting above the interest rate on excess reserves (IOER), in particular during periods of quantitative tightening. As U.S. banks could easily arbitrage GCF rates back to parity with IOER by draining reserves and lending in repo, the GCF-IOER spread is a measure of their reluctance to lend out dollars. Thus, even in the absence of the demand-side effects documented in this paper, the cross-currency basis has the GCF-IOER spread as a lower bound (and the cost of non-U.S. institutions' outside option as an upper bound).

We test which determinants of supply can explain the cross-currency basis at quarter-end. To capture supply constraints, we consider several measures of dealer health: (i) the intermediary ratios of [He et al. \(2017\)](#), (ii) the average credit default swap (CDS) spreads of U.S. and Eurozone G-SIBs (separately), and (iii) the GCF-IOER spread. To measure U.S. G-SIBs' pricing power - their ability to charge a premium for supplying dollars - we use (iv) their market share in synthetic funding trading and (v) the excess Herfindahl index in FX swaps, both calculated at the currency-tenor level. Since U.S. G-SIBs dominate FX markets (see [Fig. 3](#)), the Herfindahl index largely reflects their hold on market-making.

Our results are reported in [Appendix J](#). Neither dealer health measures nor the GCF-IOER spread show a significant relationship with the cross-currency basis at quarter-end, suggesting that U.S. dealers are not constrained in their liquidity provision. By contrast, both proxies for U.S. G-SIBs' pricing power in FX swap markets are strongly correlated with quarter-end CIP deviations: the greater their share of FX swap markets, the higher the prices they charge. If the deviations were instead driven by supply constraints, one could expect a negative correlation. Instead, a strong positive relationship is visible in panel (a) of [Fig. 9](#) (additional results are reported in [Appendix IA.L](#)). These findings suggest that the high cross-currency basis charged by U.S. banks reflect their ability to extract the full reservation price from non-U.S. institutions reliant on them for dollar funding, rather than any

⁴⁶ With the exception of year-ends, as explained in [sec. 4.3.3](#).

constraints on their liquidity provision. Further evidence of U.S. dealer-banks' dominance is shown in sec. 6, where we show their customer market share greatly increased as a result of the Basel III reform.

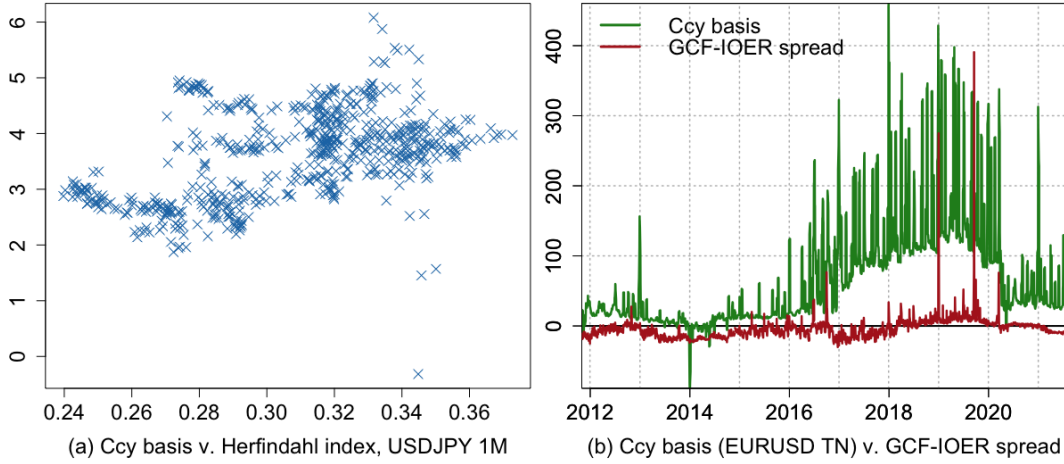


Fig. 9: Panel (a) plots quarter-end CIP deviations (USDJPY 1M, in logs) vs. the excess Herfindahl index. Panel (b) depicts the GCF-IOER spread alongside the EURUSD tom-next cross-currency basis.

Panel (b) plots the GCF-IOER spread against the cross-currency basis. This comparison highlights the premium U.S. G-SIBs charge for providing dollars through repo versus FX swaps. The GCF-IOER spread reflects their marginal cost when providing dollar funding, as it captures the opportunity cost of holding excess reserves at the Fed. Ceteris paribus, one would expect U.S. G-SIBs' returns from lending a dollar in wholesale and synthetic funding markets to be equal. Instead, as shown in panel (b) and documented elsewhere, CIP deviations far exceed this proxy for supply constraints - often by hundreds of basis points. That U.S. G-SIBs charge significantly higher prices for lending dollars through FX swaps than in repo implies that they charge prices above their marginal cost; in that sense, they extract rents. They may do so as Eurozone G-SIBs are willing to pay a premium for unencumbered synthetic funding; this inelastic demand further explains the stark differential between GCF-IOER and CIP spreads noted in the literature.

5.2. Non-U.S. bank demand and the basis

The previous section explained quarter-end CIP deviations as arising from shadow costs on non-U.S. institutions' wholesale borrowing. Here, we consider unconditional dynamics over the whole sample, and whether non-U.S. institutions' demand shocks impact the cross-currency basis. Notably, we include non-U.S. G-SIBs as demand-side agents - such dealer-banks would usually be considered market-makers - and test whether they possess inelastic dollar demand. We compute the daily *net* open position for each institution type i (excluding U.S. G-SIBs g) per currency x relative to the dollar, with maturity m and trade date t by aggregating across all settled outstanding FX swap trades T as follows:

$$\mathcal{O}_{i,t,x,m}^{Net} = \sum_{k=t}^{t+1} \mathbb{1}[T_{k,i,x,m} = B] \cdot Q_T - \mathbb{1}[T_{k,i,x,m} = S] \cdot Q_T, \quad (10)$$

where B and S indicate a dollar inflow or outflow at the near leg. The aggregate net position across non-U.S.-dealer agents is then given by $\mathcal{O}_{t,x,m}^{Net} = \sum_{i \neq g} \mathcal{O}_{i,t,x,m}^{Net}$.

Our first goal is to measure the price sensitivity of the cross-currency basis in response to changes in agents' synthetic dollar funding positions, i.e., shifts in their net FX swap holdings. We thus wish to estimate:

$$\Delta \chi_{t,x,m} = \beta \cdot \Delta \mathcal{O}_{t,x,m}^{Net} + \gamma \cdot \mathbf{X}_{t,x,m} + \alpha_{x,m} + \tau_t + \epsilon_{t,x,m} \quad (11)$$

where $\mathcal{O}_t^{Net}$ is the net outstanding dollar borrowing of all institutions in our sample other than U.S. G-SIBs ("non-U.S.-GSIBs"),⁴⁷ $\mathbf{X}$ is a vector of controls, and $\alpha_{x,m}, \tau_t$ are currency-tenor and trade date fixed effects. To address endogeneity concerns, we use the granular instrumental variables (GIV) approach of [Gabaix and Koijen \(2024\)](#) which extracts idiosyncratic shocks from flow data; the underlying intuition is that idiosyncratic shocks to large agents are severe enough to affect the market price (relevance condition) but by their idiosyncrasy not otherwise linked to price or e.g. macroeconomic variables (exclusion restriction).

For brevity, we describe the technical details of the GIV implementation in Appendix [K](#). In summary, we create a GIV based on agents' synthetic dollar flows in 20 currency pair-

⁴⁷ U.S. G-SIBs serve as the supply-side in our framework. Note that their inclusion in $\sum_{i \neq g} \mathcal{O}_{i,t,x,m}^{Net}$ would result in $\mathcal{O}_{t,x,m}^{Net} = 0$.

tenor combinations, and require the economic relationships to hold over the entire panel. We extract large idiosyncratic shocks by removing common latent factors through residualizing regressions and principal component analyses. Eq. (11) is thus estimated through two-stage IV, instrumenting $\mathcal{O}_{t,x,m}^{Net}$ with our GIV.

Table 2 presents the results. Panel A reports the first-stage regression with Montiel Olea and Pflueger (2013) (MOP) effective F-statistics and shows a strong relationship between net dollar flows and our GIV instrument, allowing us to reject the null of weak instruments. Panel B regresses the cross-currency basis on agents' net positions. Columns (1) and (4) report OLS results for the full and post-2015 samples, respectively, showing no significant relationship. Columns (2)–(3) and (5)–(6) use GIV estimation. The results uncover a significantly positive link: across our specifications, a 1% increase in non-U.S.-G-SIB agents' flow results in a 0.52% to 1.1% increase in the basis. We are thus able support the notion that non-U.S. institutions, including dealer-banks, act as the demand side w.r.t. to synthetic U.S. dollar funding, as their flows have a significant price impact. This relationship grew stronger during the post-2015 period when the basis fluctuated more freely.

We now turn our attention to supply and demand elasticities. Here, a stronger relevance condition is required, chiefly that $E[\Delta\chi_{t,x,m}Z_{t,x,m}^{GIV}] \neq 0$, i.e. demand shocks can impact the price. Panel (a) of Table K1 presents results; significance is achieved for all specifications of our GIV. In the second stage, we extract the supply and demand elasticities ψ and ϕ :

$$\check{Y}_{t,x,m}^S = \psi \cdot \widehat{\Delta\chi}_{t,x,m} + \gamma^S \cdot \mathbf{X}_{t,x,m} + \alpha_{x,m} + \tau_t + \epsilon_{t,x,m}^S, \quad (12)$$

$$\check{Y}_{t,x,m}^E = \phi \cdot \widehat{\Delta\chi}_{t,x,m} + \gamma^E \cdot \mathbf{X}_{t,x,m} + \alpha_{x,m} + \tau_t + \epsilon_{t,x,m}^E \quad (13)$$

Panels (b) and (c) in Table K1 display results for the supply and demand elasticities, respectively. In response to a 1% increase in the basis, U.S. G-SIB dealers increase their provision of synthetic dollar funding by approximately 3-4% while non-U.S.-G-SIB institutions decrease their dollar demand by 0.15% to 0.95%. Furthermore, we observe that both supply and demand became more inelastic in the post-2015 period. Note that in accordance with theory, the first-stage price sensitivity corresponds to the second-stage elasticities, i.e. $\beta = \frac{1}{\psi - \phi}$. Finally, as a robustness check, we perform a thresholded/narrative GIV analysis in Appendix IA.M; our results are validated.

Panel A: First stage		Dep. variable: $\Delta\mathcal{O}_{t,x,m}$				
		Full sample		Post-2015 period		
		Z^{preci}	Z^{equi}	Z^{preci}	Z^{equi}	
	(1)	(2)	(3)	(4)	(5)	(6)
Z^{GIV}		0.39*** (0.03)	0.33*** (0.03)		0.35*** (0.03)	0.30*** (0.03)
Panel B: Second stage		Dep. variable: $\Delta\chi_{x y,m,t}, \%$				
		Full sample		Post-2015 period		
	OLS	Z^{preci}	Z^{equi}	OLS	Z^{preci}	Z^{equi}
$\Delta\mathcal{O}_{t,x,m}$	-0.05 (0.03)			-0.06 (0.04)		
$\widehat{\Delta\mathcal{O}}_{t,x,m}$		0.52*** (0.18)	0.72** (0.28)		0.78*** (0.26)	1.10** (0.39)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$
Clustering	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$
Observations	48,740	48,740	48,740	36,900	36,900	36,900
R ²	0.17	0.16	0.16	0.17	0.16	0.16
MOP effective F-statistic	-	185	177	-	141	141

Table 2: Columns (1) and (4) estimate a direct regression of the cross-currency basis on non-U.S.-G-SIB agents’ outstanding synthetic positions. Other columns perform GIV estimation of eq. (11). The specifications are panel regressions over 4 currency pairs and 5 tenors, with currency pair-tenor (α) and date (τ) fixed effects and clustering. Controls are $\mathbf{X} = \{\mathcal{A}_{t,x,m}, s_{t,x}, Q_{t,m}^{end}, Y_{t,m}^{end}, PCA_1, PCA_2, PCA_3\}$ where $\mathcal{A}_{t,x,m}$ is the currency-tenor specific realized illiquidity measure of Klops et al. (2023a), $s_{t,x}$ are log spot returns, $Q_{t,m}^{end}$ ($Y_{t,m}^{end}$) refers to whether the underlying swap contract of that maturity crossed a quarter-end (year-end), and PCA are the aforementioned principal components. MOP denotes the Montiel Olea-Pflueger effective F-statistic. Columns (1)–(3) use the full sample (Sept. 2012 – Mar. 2022); columns (4)–(6) use the subsample from Jan. 1, 2015 onwards. ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

Our analysis yields two key implications. First, non-U.S. institutions exhibit highly inelastic demand and price-taker behavior, consistent with our intuition. Notably, this includes non-U.S. G-SIBs, whereas dealer-banks are usually viewed uniformly as market-makers. Second, the synthetic price elasticity increases thirteen-fold at quarter-end, which points to the role of shadow costs and pricing power. On average, 1-week non-U.S. demand rises by 40% at quarter-end, while the basis increases by 200% (from 31 to 93 basis points), implying

an inverse price elasticity of 5, magnitudes higher than the baseline of 0.39 from our full-sample GIV estimates.⁴⁸ The price movement far outstrips that warranted by underlying flows, as the quarter-end cross-currency basis immediately incorporates the premium for regulatory-advantageous synthetic funding.

5.3. U.S. banks' price setting

Our framework suggests that U.S. banks may extract rents on synthetic dollar provision, as their prices reflect the premium non-U.S. banks are willing to pay for unencumbered funding, rather than their own marginal cost. We test whether U.S. banks are capable of meaningfully price discriminating between agents at quarter-end, which would allow them to extract further rents from those most constrained actors. As shown in section 4, snapshot reporters (e.g., Eurozone banks) face steeper rises in shadow costs than averaging reporters (e.g., U.K. banks) at quarter-end. Full rent extraction would imply higher quarter-end prices charged to the former.

We proceed by first calculating market participant i 's effective USD borrowing cost on a trading day t as the volume-weighted average cross-currency basis paid for new USD purchases across all contracts of currency x and maturity m .⁴⁹ Columns (1) and (2) of Table 3 compare the effective borrowing cost outside and during the quarter-end periods across market participants. The measure consolidates USD borrowing costs across the G7 currencies and short-term maturities into a single figure, providing a useful gauge of market participants' costs incurred. Outside of the quarter-end, effective borrowing costs are broadly similar across agents. In contrast, the quarter-end sees a sharp rise in costs and much greater dispersion. Japanese banks face the highest per-dollar costs, consistent with their heavy exposure to the yen-dollar pair, where the basis is most expensive.

We then assess how much of the quarter-end surge in borrowing costs (column 3) reflects U.S. dealers charging different FX swap prices to different counterparties. Systematic dif-

⁴⁸ A lack of observations prevents us from directly estimating elasticities inside the quarter-end; for example, tom-next FX swaps cross the quarter-end one day per quarter.

⁴⁹ The effective USD borrowing cost is expressed as: $\gamma_{t,i} = \frac{\sum_x \sum_m Q_{i,t,x,m}^b \chi_{i,t,x,m}^{q,b}}{\sum_x \sum_m Q_{i,t,x,m}^b}$ for contracts b that result in a USD inflow at the near leg of the swap. The basis χ is calculated using actual traded swap points obtained from settlement data and market-wide OIS interest rates obtained from Bloomberg.

	Effective CIP cost, short-term tenors (bps)				
	Does not cross Q^{end} (1)	Crosses Q^{end} (2)	Δ change at Q^{end} (3)	Of which due to p.d. (4)	p.d. coef. p-value (5)
Non-U.S. G-SIB banks	31	98	67	0.0	0.99
Eurozone	31	93	62	-1.6	0.68
Swiss	31	146	115	1.2	0.89
Japan	23	146	123	5.5	0.55
U.K.	32	100	68	1.2	0.77
China	17	110	93	-7.7	0.26
Other non-U.S. banks	22	85	63	0.3	0.95
Non-Banks	30	75	45	-6.2	0.26
U.S. G-SIB banks	29	99	70	-	-

Table 3: Effective CIP cost for one-day to one-week FX swaps in G7 currencies. Columns (1) and (2) calculate the volume-weighted average basis incurred for borrowing USD outside and inside the quarter-end, while column (3) reports the difference. Column (4) reports the beta coefficient of the regression: $\chi_{i,t,x,m}^g = \beta \cdot isNonUS + \alpha_{x,m} + \tau_t + u_{t,i,x,m}$ and column (5) reports its p-value. Data spans 2015 to 2022.

ferences in average borrowing costs can reveal the extent of price discrimination.⁵⁰ To test this, we compare the basis U.S. G-SIBs set when trading with other U.S. G-SIBs as opposed to other participants, estimating the following panel regression coefficient β_i :

$$\chi_{i,t,x,m}^g = \beta_i \cdot isNonUS_i + \alpha_{x,m} + \tau_t + u_{t,i,x,m} \quad (14)$$

where $\chi_{t,i,x,m}$ is the daily volume-weighted average cross-currency basis charged by U.S. banks to counterparty i for USD purchases, $isNonUS_i$ equals 1 for trades between a U.S. G-SIB and counterparty i and 0 for trades between U.S. G-SIBs, and $\alpha_{x,m}$ and τ_t are currency-tenor and date fixed effects respectively. Column (4) of Table 3 reports the β_i coefficient estimate; column (5) the corresponding p-value. Our results indicate that heterogeneity in FX swap pricing is, by and large, economically small and that pricing differences across counterparties have a limited economic impact at the quarter-end. There is no evidence that Eurozone banks suffer worse prices than U.K. banks; Appendix IA.N formalizes these results in a difference-in-differences setting. This implies that any pricing power is primarily exercised through

⁵⁰ Hau et al. (2021), for example, find price discrimination against unsophisticated customers in FX derivatives.

uniform markups rather than discriminatory pricing. Short-term FX swaps have a large share of electronic trading; in such settings, the FX swap rate reflects the market-clearing price, which incorporates all agents’ shadow costs. While U.S. dealers do indeed extract large rents (as we shall see in the next section), they do not necessarily capture the full opportunity cost from the most constrained counterparties, such as Eurozone banks, which may partly explain the persistence of demand substitution patterns.

6. Economic Costs and Policy Implications

6.1. Quantifying regulatory shadow costs

This section analyzes the distribution of gains and losses among market participants arising from regulatory shadow cost dynamics. In particular, we seek to quantify (i) any economic costs borne by the “real” economy, and (ii) the welfare transfer which occurs between non-U.S. and U.S. institutions as a result of the need to source unencumbered dollar funding. To do so, we calculate the share of the cross-currency basis which can be attributed to shadow costs, and use this to compute agents’ profits and losses (in mn of USD) due to regulation. Table L1 reports the results for all tenors and currency pairs combined, with values aggregated at the yearly level. In column (1), we consider the costs associated with repo-FX swap substitution;⁵¹ each year, Eurozone G-SIBs expend around \$63 mn, to the benefit of U.S. dealer-banks.

The gains/losses from substitution are not especially large; repo-FX swap substitution rather serves as our *identification* of the regulatory shadow costs borne by U.S. dollar borrowers. Such costs are impounded in the price of all long-term swaps (i.e. currency hedges),⁵² and are borne by all non-U.S. participants, whether on a “snapshot” or an averaging regulatory regime. To estimate the annual regulatory shadow costs borne by participants, we first take the spread between the average effective annualized basis paid/earned by agents before

⁵¹ We proceed by multiplying the quarter-end surge in volume as in Appendix IA.G by the unannualized effective cost attributed to quarter-end dynamics (shown in annualized form in column (3) of Table 3) and multiplying by the number of yearly quarter-ends. We further scale our CLS data to the size of the global FX market according to BIS estimates.

⁵² FX swaps with maturity less than (more than) one week tend to be driven by currency funding (hedging) needs.

and after the 2015 Basel III implementation. As this is an annualized figure, we multiply it by agents' average *daily* post-reform net position to obtain their actual yearly revenue/loss in synthetic trading. We scale our results using CLS data to match the size of the global FX market as reported by BIS estimates.⁵³

Each year, non-U.S. G-SIBs pay an extra \$1.8 bn to U.S. dealer-banks as a premium for unencumbered synthetic dollar funding. They pass on these costs to non-U.S. non-bank customers, who incur losses of \$10.4 bn annually.⁵⁴ These results suggest that the shadow costs associated with Basel III are ultimately borne by non-U.S. end-customers and the real economy.⁵⁵ On average across participants, 76% of cross-currency basis profits/losses are attributable to regulatory shadow costs. A clear policy implication is that non-banks could avoid part of the economic cost were it not for restrictions preventing them from borrowing directly from U.S. MMFs, which oblige them to rely on intermediary dealer-banks instead.

A further implication of our results is that balance sheet regulation leads to an annual welfare transfer of \$5.3 bn from non-U.S. institutions to U.S. dealer-banks. This represents the premium non-U.S. agents are willing to pay to source dollar funding without consuming further balance sheet space. U.S. dealer-banks can provide this funding by leveraging their deposit base and central bank reserves, but extract rents on dollar provision. Thus, balance sheet constraints exacerbate the segmentation in FX markets between those agents with unfettered dollar access and those without. Further proof of this can be observed through studying dealer-banks' customer market share, as illustrated in Appendix M: Basel III implementation coincided with a significant decline in Eurozone G-SIBs' FX swap market share, while US G-SIBs' customer share correspondingly increased from around 30% to 50%. Note that our paper only documents the costs borne by agents in currency hedging markets; this ignores costs in other important segments, in particular the market for dollar-

⁵³ CLS data covers around 30% of the global FX market. Customer trades generally do not require CLS settlement, since clients frequently hold accounts with their FX dealers and transactions are settled internally. We therefore adjust our results to reflect the actual market size.

⁵⁴ Note that we are considering only the regulatory shadow costs stemming from quarter-end repo-FX swap substitution and impounded in the price of long-term swaps. We do not include the gains/losses arising from within-quarter short-term swaps. These are relatively small and do not significantly change our results.

⁵⁵ Non-U.S. customers are specifically penalized not because they are regulated differently than their U.S. counterparts, but because they borrow synthetic dollars on average.

denominated bank credit (Ivashina et al. (2015) and Eguren-Martin et al. (2023)).

6.2. Policy implications

Policymakers have made efforts to harmonize Basel III reporting standards across jurisdictions and to curtail window-dressing activities, though these issues persist.⁵⁶ Transparent regulatory reporting is an important consideration, but our paper highlights more fundamental issues. First, while post-crisis lending standards have moved towards secured borrowing, we show that LR stipulations counterintuitively penalize this practice relative to unsecured or synthetic means, as the requisite collateral remains on borrowers' balance sheets. Note that dollar constraints are caused not by the structure of American money markets, which are deep, liquid, and easily accessible, but rather due to the regulatory framework's treatment of secured borrowing. Such constraints asymmetrically impact agents, and segment currency markets into those who can access U.S. dollar funding without expending balance sheet space, and those who cannot. As a result, a substantial and persistent welfare transfer occurs from non-U.S. agents to U.S. dealer-banks, and will continue to do so regardless of how regulatory ratios are reported.

Our paper highlights that focusing on the mechanics of regulatory reporting does not resolve the fundamental issue of the LR's catch-all nature, which penalizes practices otherwise considered desirable. The unintended consequences of balance sheet constraints further spill over into currency markets, and disproportionately penalize non-U.S. banks who pay extra for U.S. dollar funding, and pass on these costs to the real economy. Policymakers must consider whether the benefits of blanket balance sheet regulation surpass its ramifications. More expensive FX swaps, as in the current regime, may discourage investors from appropriately hedging themselves. On the other hand, were repo collateral exempt from LR calculations, non-U.S. agents would likely shift their funding back into American money markets, which would reduce the need for central bank swap lines, but put upward pressure on U.S. interest rates.⁵⁷ Overall, our research highlights the unexpected scale and complexity

⁵⁶ As of June 2021, Eurozone banks have had to report their LR ratios as an average of daily values in addition to the snapshot measurement. Interestingly, however, they continue to report a lower snapshot LR relative to the average value (Bassi et al., 2024). This is because the snapshot LR still remains the decisive value for regulatory purposes, suggesting that banks fear dropping below the official minimum requirement.

⁵⁷ Central bank swap line agreements were originally instituted by the Fed in 2007 to alleviate borrowing

of these consequences as they impact interconnected financial markets.

7. Conclusion

Our research sheds new light on global dollar funding chains and the interplay between wholesale and synthetic markets. Using a novel, granular dataset to track supply and demand forces across global funding segments, we show that wholesale money and global currency markets are deeply interconnected due to non-U.S. institutions treating them as imperfect substitutes for accessing U.S. dollar liquidity. When these agents' access to wholesale dollars is hindered by balance sheet constraints, they turn to synthetic funding instead. There, U.S. institutions charge them a premium for the provision of unencumbered dollar funding and thus extract rents; these costs are then passed on to end-customers. Our paper provides a definitive explanation as to why CIP deviations respond powerfully to balance sheet constraints, despite FX swaps being off-balance sheet instruments. While the extant literature has attributed CIP breakdowns to a withdrawal of arbitrage capital, we instead demonstrate that they reflect the premium non-U.S. institutions pay to maintain dollar funding during constrained periods. In doing so, our paper uncovers how intermediary balance sheet constraints cause segmentation between agents in global currency markets, with the costs ultimately borne by the real economy.

pressure from non-U.S. agents on interest rates in U.S. money markets; Basel III regulation unintentionally incentivizes these agents to source funding outside of U.S. wholesale avenues.

References

- Abbassi, P., and F. Bräuning (2020): “Demand Effects in the FX Forward Market: Micro Evidence from Banks’ Dollar Hedging,” *Review of Financial Studies* 34(9), 4177–4215.
- Akram, F. Q., D. Rime, and L. Sarno (2008): “Arbitrage in the foreign exchange market: Turning on the microscope,” *Journal of International Economics* 76(2), 237–253.
- Aldasoro, I., T. Ehlers, and E. Eren (2022): “Global Banks, Dollar Funding, and Regulation,” *Journal of International Economics* 137, 103609.
- Andersen, L., D. Duffie, and Y. Song (2019): “Funding Value Adjustments,” *Journal of Finance* 74(1), 145–192.
- Anderson, A., W. Du, and B. Schlusche (2021): “Arbitrage Capital of Global Banks,” *Journal of Finance*, forthcoming.
- Baklanova, V., I. Kuznits, and T. Tatum (2021): “Primer: Money Market Funds and the Repo Market.” Staff article of the Division of Investment Managements Analytics Office of the U.S. Securities and Exchange Commission.
- Bank of England (2015): “Implementing a UK leverage ratio framework.” Prudential Regulatory Authority, Policy Statement, PS27/15, December.
- Bassi, C., M. Behn, M. Grill, M. Libertucci, P. Torstensson, and P. Welz (2024): “Closing the blinds on banks window dressing,” ECB Blog.
- BCBS (2013): “Global systemically important banks: Updated assessment methodology and the higher loss absorbency requirement.” Basel Committee on Banking Supervision. Available at: <https://www.bis.org/publ/bcbs255.htm>.
- BCBS (2014): “Basel III leverage ratio framework and disclosure requirements.” Basel Committee on Banking Supervision.
- BCBS (2019): “Revisions to leverage ratio disclosure requirements.” Basel Committee on Banking Supervision. Available at: <https://www.bis.org/bcbs/publ/d468.pdf>.
- Becker, J., M. Schmeling, and A. Schrimpf (2023): “Global Bank Lending and Exchange Rates.” BIS Working Papers No. 1161.

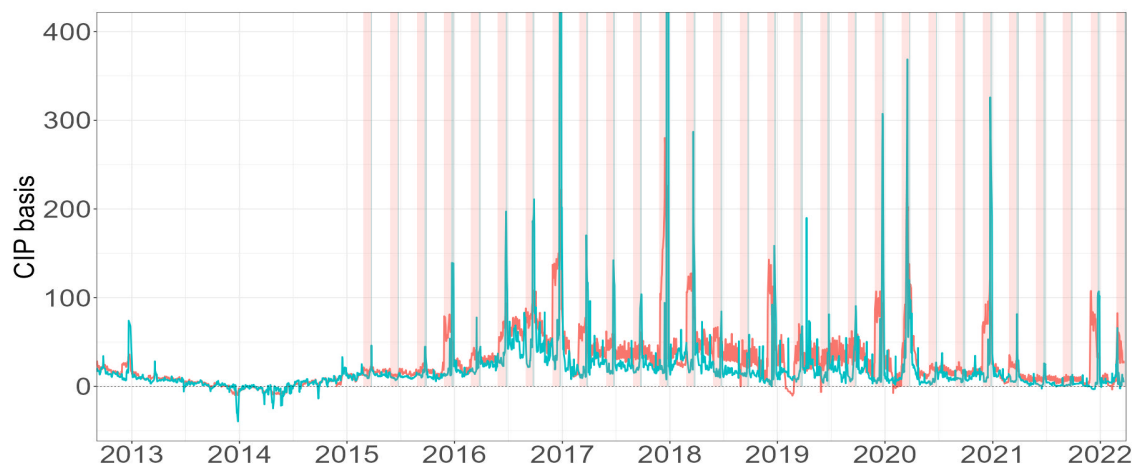
- Ben Zeev, N., and D. Nathan (2024): “The widening of cross-currency basis: When increased FX swap demand meets limits of arbitrage,” *Journal of International Economics* 152, 103984.
- BIS (2016): “Triennial Central Bank Survey of foreign exchange and OTC derivatives markets in 2016.” Bank for International Settlements. Available at: <https://www.bis.org/publ/rpfx16.htm>.
- BIS (2022): “Triennial Central Bank Survey of foreign exchange and Over-the-counter (OTC) derivatives markets in 2022.” Bank for International Settlements. Available at: <https://www.bis.org/statistics/rpfx22.htm>.
- Borio, C., R. Iqbal, R. McCauley, P. McGuire, and V. Sushko (2018): “The failure of covered interest parity: FX hedging demand and costly balance sheets,” BIS Working Papers No 590.
- Borio, C., R. McCauley, and P. McGuire (2017): “FX swaps and forwards: missing global debt?” *BIS Quarterly Review* September 2017, 37–54.
- Borio, C., R. McCauley, and P. McGuire (2020): “Foreign exchange swaps: Hidden debt, lurking vulnerability.” VoxEU column.
- Bräuer, L., and H. Hau (2022): “Can Time-Varying Currency Risk Hedging Explain Exchange Rates?” Swiss Finance Institute Research Paper No. 22-77.
- Cenedese, G., P. Della Corte, and T. Wang (2021): “Currency Mispricing and Dealer Balance Sheets,” *Journal of Finance* 76(6), 2763–2803.
- Cespa, G., A. Gargano, S. Riddiough, and L. Sarno (2022): “Foreign Exchange Volume,” *Review of Financial Studies* 35(5), 2386–2427.
- Choulet, C. (2018): “US money market funds and US dollar funding.” BNP Paribas Economic Research Department, Eco Flash note.
- Copeland, A., D. Duffie, and Y. Yang (2025): “Reserves were not so ample after all,” *Quarterly Journal of Economics*, pp. 239–281.
- Correa, R., W. Du, and G. Liao (2020): “U.S. Banks and Global Liquidity.” NBER Working Paper No. 27491.

- Du, W., and A. Huber (2024): “Dollar Asset Holding and Hedging Around the Globe.” Jacobs Levy Equity Management Center for Quantitative Financial Research Paper.
- Du, W., B. Hébert, and A. Huber (2023): “Are intermediary constraints priced?” *Review of Financial Studies* 36(4), 1464–1507.
- Du, W., B. Hébert, and W. Li (2023): “Intermediary Balance Sheets and the Treasury Yield Curve,” *Journal of Financial Economics* 153(3), 103722.
- Du, W., A. Tepper, and A. Verdelhan (2018): “Deviations from covered interest rate parity,” *Journal of Finance* 73(3), 915–957.
- Duffie, D. (2017): “Post-crisis bank regulations and financial market liquidity.” Banca d’Italia.
- Egelhof, J., A. Martin, and N. Zinsmeister (2017): “Regulatory Incentives and Quarter-End Dynamics in the Repo Market.” Federal Reserve Bank of New York Liberty Street Economics (blog).
- Eguren-Martin, F., M. Ossandon Busch, and D. Reinhardt (2023): “Global Banks and Synthetic Funding: The Benefits of Foreign Relatives,” *Journal of Money, Credit and Banking* Vol. 56, No. 1.
- European Commission (2021): “Commission Implementing Regulation (EU) 2021/637 of 15 March 2021.” Official Journal of the European Union.
- Farhi, E., and M. Maggiori (2017): “A model of the international monetary system,” *Quarterly Journal of Economics*, 133(1), 295355.
- Fleckenstein, M., and F. Longstaff (2020): “Renting Balance Sheet Space: Intermediary Balance Sheet Rental Costs and the Valuation of Derivatives,” *Review of Financial Studies* 33(11), 50515091.
- Gabaix, X., and R. Koijen (2024): “Granular Instrumental Variables,” *Journal of Political Economy* 132(7).
- Gabaix, X., and M. Maggiori (2015): “International Liquidity and Exchange Rate Dynamics,” *Quarterly Journal of Economics* 130(3), 1369-1420.
- Georgievska, L. (2022): “Covered Interest Rate Parity with Collateral,” working paper.

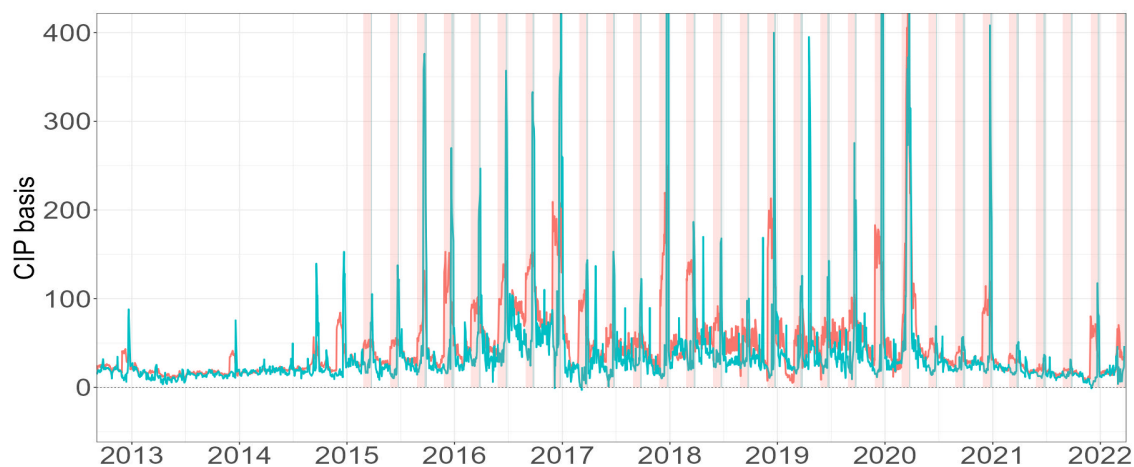
- Gopinath, G., and J. Stein (2021): “Banking, trade, and the making of a dominant currency” *Quarterly Journal of Economics*, 136, 783–830.
- Gourinchas, P.-O., H. Rey, and M. Sauzet (2019): “The International Monetary and Financial System” *Annual Review of Economics*, 11, 859–93.
- Hacıoğlu-Hoke, S., D. Ostry, H. Rey, A. Rousset Planat, V. Stavrakeva, and J. Tang (2024): “Topography of the FX derivatives market: A view from London,” Bank of England Staff Working Paper No. 1103.
- Hasbrouck, J., and R. M. Levich (2019): “FX Market Metrics: New Findings Based on CLS Bank Settlement Data.” NBER Working Paper No. 23206.
- Hau, H., P. Hoffmann, S. Langfield, and Y. Timmer (2021): “Discriminatory Pricing of Over-The-Counter Derivatives,” *Management Science*, Vol. 67(11), 6660–6677.
- He, Z., B. Kelly, and A. Manela (2017): “Intermediary asset pricing: New evidence from many asset classes,” *Journal of Financial Economics* 126(1), 1–35.
- Ivashina, V., D. Scharfstein, and J. Stein (2015): “Dollar funding and the lending behavior of global banks” *Quarterly Journal of Economics*, 130(2), 1241–1282.
- Khetan, U. (2024): “Synthetic Dollar Funding,” working paper.
- Kloks, P., E. Mattille, and A. Ranaldo (2023): “Foreign Exchange Swap Liquidity,” Swiss Finance Institute Research Paper No. 23-22.
- Kloks, P., P. McGuire, A. Ranaldo, and V. Sushko (2023): “Bank positions in FX swaps: Insights from CLS,” *BIS Quarterly Review* (September), 17–31.
- Krohn, I., and V. Sushko (2022): “FX spot and swap market liquidity spillovers,” *Journal of International Money and Finance* 120 (February), 102476.
- Kubitza, C., J.-D. Sigaux, and Q. Vandeweyer (2024): “The Implications of CIP Deviations for International Capital Flows.” Fama-Miller Working Paper, Chicago Booth Research Paper 24-18.
- Liao, G., and T. Zhang (2025): “The Hedging Channel of Exchange Rate Determination.” *Review of Financial Studies*, 38, 1–38.
- Montiel Olea, J., and C. Pflueger (2013): “A Robust Test for Weak Instruments,” *Journal of Business & Economic Statistics* 31, 358–369.

- Munyan, B. (2017): “Regulatory Arbitrage in Repo Markets.” Office of Financial Research Working Paper No 15-22.
- Ranaldo, A., P. Schaffner, and M. Vasios (2021): “Regulatory effects on short-term interest rates,” *Journal of Financial Economics* 141(2), 750–770.
- Ranaldo, A., and F. Somogyi (2021): “Asymmetric information risk in FX markets,” *Journal of Financial Economics* 140(2), 391–411.
- Rime, D., A. Schrimpf, and O. Syrstad (2022): “Covered Interest Parity Arbitrage,” *Review of Financial Studies* 35(11), 5185–5227.
- Siriwardane, E., A. Sunderam, and J. Wallen (2025): “Segmented Arbitrage,” *Journal of Finance*, July.
- Wallen, J. (2022): “Markups to Financial Intermediation in Foreign Exchange Markets,” working paper.

Appendix A



(a) EURUSD



(b) USDJPY

Fig. A1: Charts of the CIP basis for EURUSD and USDJPY. Red (blue) lines refer to the 1M (1W) basis. Red (blue) rectangles denote the business days when 1M (1W) repo contracts cross a quarter-end, starting from Q1 2015 until Q1 2022. Values are capped for presentational purposes.

Appendix B

Region	Location		Nationality
	BIS	CLS	CLS
U.K.	54	54	16
U.S.	19	19	47
Eurozone	13	14	23
Japan	7	2	5
Switzerland	5	4	7
Other	3	6	2
Total (%)	100	100	100

Table B1: CLS and BIS coverage comparison. CLS data is based on a sample from 2016 and is benchmarked against the BIS Triennial Central Bank Survey of foreign exchange and OTC derivatives of that year.

Appendix C

Figure C1 shows event studies of outstanding volume around quarter-ends for all tenors combined. In the l.h.s. graphic, we observe a remarkable drop in volume several days before the quarter-end; this occurs during the International Monetary Market (IMM) dates when many swaps expire. Money market instruments and currency / interest rate futures and options traded at the Chicago Mercantile Exchange have standardized expiration dates set as the third Wednesday of the month ending a quarter. As many medium-term (e.g. 3-month) FX swaps are used to access these products, we see a very strong decrease on those particular dates. Because of their timing, the number of days between an IMM date and a quarter-end date differs; the blue shading in the l.h.s. figure highlights the set of IMM days. This movement is not evidence of any window-dressing and instead is an artifact of the common expiry date applied to many swaps. The r.h.s. image shows the same with a reduced window (7 days before/after the quarter-end) to remove the effect of the IMM period; we observe a \$500 billion surge, representing 3% of the outstanding market. Note that this surge is not a reversal of the IMM decrease, but rather an increase for the quarter as a whole.

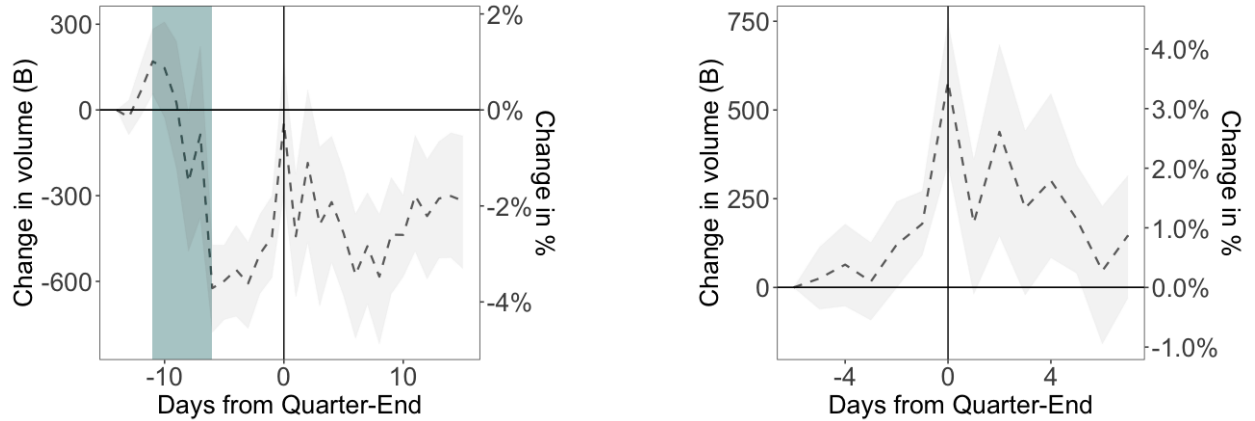
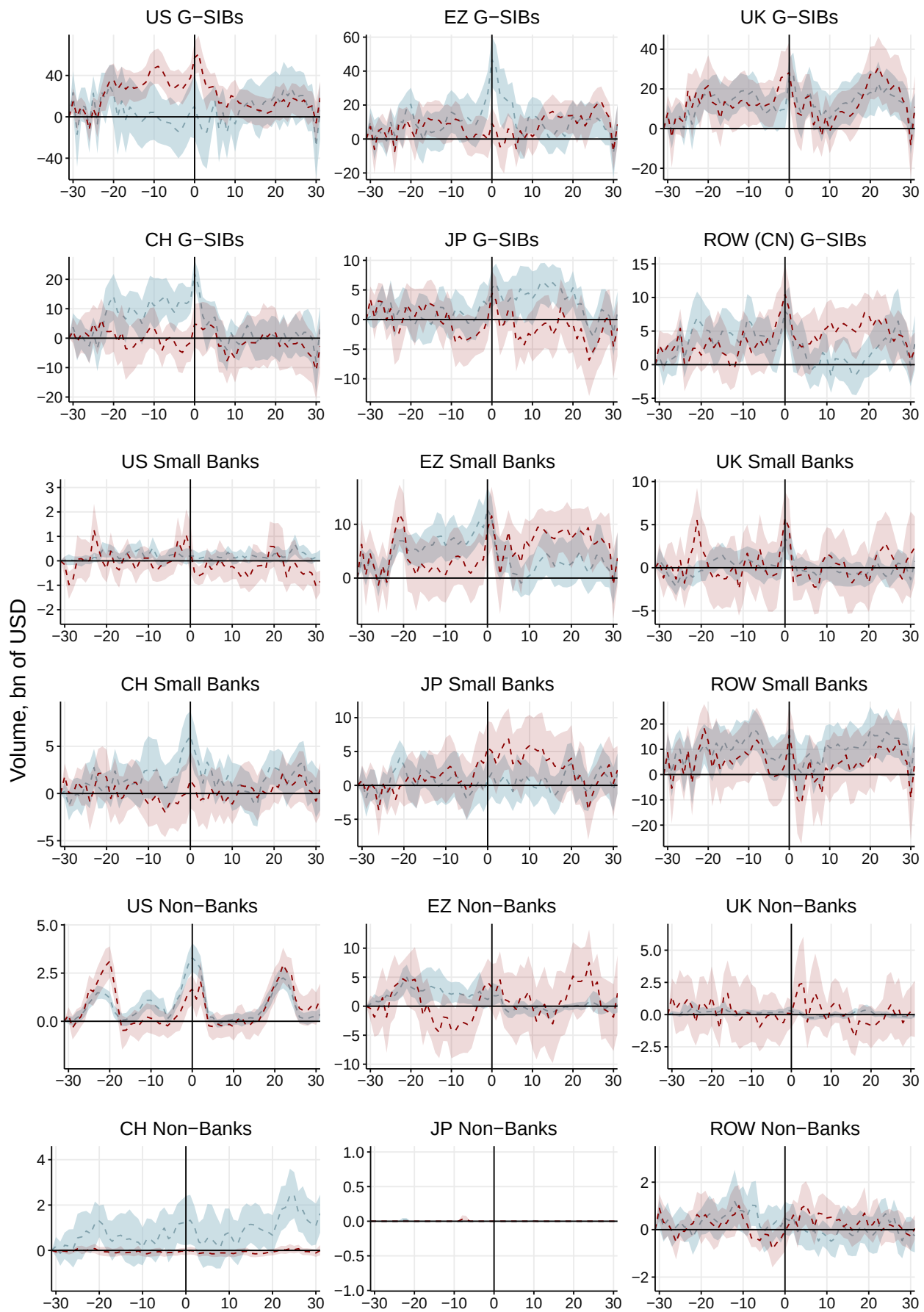


Fig. C1: Event studies around regulatory quarter-ends (year-ends not included) for all tenors combined. L.h.s. panel shows the influence of IMM dates (shaded blue) when many swaps expire. R.h.s. panel starts the event study after the IMM date and shows a \$500 billion increase. For both panels, the r.h.s. axis expresses values of the l.h.s. axis as a percentage of the sample's mean value.

Appendix D

The figure on the following page plots event studies for all 18 groups in our dataset. We center the event study 31 days before and after the quarter-end (as the quarter-end lasts 62 business days). We plot dollar sales and purchases separately and, for each of them, show the bootstrapped standard errors as a shaded area around the point estimates. The years under consideration are 2015-2021 as this was the period when repo-FX swap substitution was most in effect. All volumes are in USD. The shaded area represents the 90% confidence interval with bootstrapped standard errors.



-- USD purchases -- USD sales

Fig. D1

Appendix E

The below figure demonstrates that the same nationalities which drastically reduce their quarter-end repo dollar positions increase their synthetic dollar borrowing. Furthermore, while U.S. banks surge their net synthetic dollar lending, they do not do by increasing their repo borrowing from U.S. MMFs.

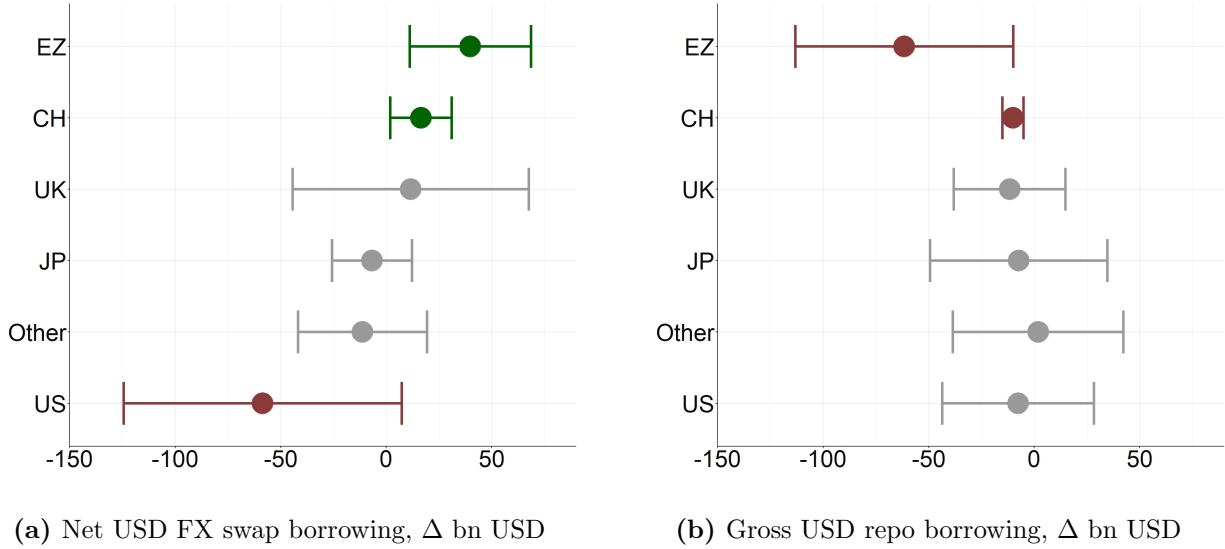


Fig. E1: The plot displays the coefficient β_1 from the following regression: $Y_t = \alpha + \beta_1 \cdot Q^{end} + \beta_2 \cdot Y^{end} + \epsilon_t$, where Q^{end} and Y^{end} are quarter- and year-end time dummies respectively. In the left-hand panel, Y_t is net borrowing of USD in FX swaps; in the right-hand panel, it is gross borrowing of USD from U.S. MMFs (as MMFs only lend cash, this is also a net position). We consider tenors up to one-week. The regression is run for banks of each nationality (including non-G-SIBs). Green (red) coloring indicates a statistically significant positive (negative) β_1 coefficient at the 1% level; gray indicates no significance. Dots show point estimates of β_1 ; line bars denote $\pm$ three standard deviations. Regulatory quarter-ends serve as the event-study basis, using data from December 2015 to September 2021.

Appendix F

FX swaps' full position counts towards the year-end calculation of G-SIB complexity score, meaning that they lose their relative attractiveness to repo instruments during these periods. The below regression results confirm that agents reverse their repo-FX swap substitution at year-end (relative to other quarter-ends).

	Swap Share (%)				
	EZ	CH	JP	U.K.	U.S.
Q^{end}	16.75*** (3.17)	47.93*** (8.08)	12.39 (15.79)	-23.86 (17.53)	-6.86*** (2.15)
$Q^{end} \times Y^{end}$	-13.22** (5.66)	-8.13 (11.64)	-6.27 (23.57)	-3.97 (43.34)	-11.60** (4.59)
Constant	Yes	Yes	Yes	Yes	Yes
Obs.	82	82	82	82	82
Adj. R ²	0.23	0.22	0.01	0.06	0.32

Table F1: All models are OLS with Newey-West standard errors. The dependent variable is the share of total USD borrowing through FX swaps by G-SIBs of various nationalities, as defined in eq. (8). Q_t^{end} (Y_t^{end}) is a dummy indicating a quarter-end (year-end). Frequency is monthly; the sample starts at the 2015 year-end and ends in September 2021. FX swaps volumes are amounts outstanding of USD borrowed in CLS and repo volumes are amounts outstanding of USD borrowed from U.S. MMFs. ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

Appendix G

We estimate a bank-level difference-in-differences model comparing the outstanding amount of secured vs. unsecured U.S. dollar borrowing by the various G-SIB banking groups at the quarter-end. $Funding_{i,t}^{\$}$ is the outstanding amount of U.S. dollars borrowed from U.S. MMFs. $Secured_{i,t}$ is a dummy variable with value 1 if the quantities borrowed were through repo instruments, and with value 0 if they were instead borrowed through unsecured means.

$$\begin{aligned} Funding_{i,t}^{\$} = & \beta_1 \cdot Q_t^{end} + \beta_2 \cdot Secured_{i,t} + \beta_3 \cdot Q_t^{end} \cdot Secured_{i,t} \\ & + \beta_4 \cdot Q_t^{end} \cdot Y_t^{end} + \beta_5 \cdot Q_t^{end} \cdot Y_t^{end} \cdot Secured_{i,t} + \alpha_i + u_{i,t} \end{aligned} \quad (15)$$

where α_i are G-SIB fixed effects. Table [G1](#) shows results. We estimate bank-level regressions on European, U.K., and U.S. banks separately.

For Eurozone and Swiss G-SIBs, secured funding (i.e. repo) significantly diminishes at the quarter-end by almost 9 billion USD per G-SIB, a 29% drop. No significant dynamics are observed for unsecured funding. Furthermore, unaffected U.K. and U.S. banks similarly window-dress neither their secured nor their unsecured funding, in line with our prior. This demonstrates that repo-FX swap substitution is a shift from regulatory-costly secured funding to synthetic dollar funding.

	Wholesale USD borrowing					
	EZ/CH G-SIBs		U.K. GS-SIBs		U.S. GS-SIBs	
	bn USD	log	bn USD	log	bn USD	log
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Secured</i>	16.18** (6.71)	0.72 (0.41)	8.42 (7.86)	−0.62 (1.32)	10.18* (4.33)	0.86 (0.88)
Q^{end}	−1.00 (0.71)	−0.04 (0.03)	−0.22 (0.48)	−0.14 (0.13)	−0.13 (0.32)	0.03 (0.10)
$Secured \times Q^{end}$	−8.68*** (2.08)	−0.34** (0.11)	−1.46 (1.62)	0.01 (0.09)	−0.28 (0.41)	0.01 (0.09)
<i>Controls</i>						
$Q^{end} \times Y^{end}$	−0.88 (0.64)	−0.08 (0.10)	0.25 (0.40)	0.08 (0.14)	0.85 (0.45)	0.13 (0.12)
$Secured \times Q^{end} \times Y^{end}$	−2.21 (2.80)	0.02 (0.08)	−5.21* (1.72)	−0.40** (0.06)	−1.11 (0.95)	−0.14 (0.15)
Fixed effects	G-SIB	G-SIB	G-SIB	G-SIB	G-SIB	G-SIB
Clustering	G-SIB	G-SIB	G-SIB	G-SIB	G-SIB	G-SIB
Observations	1,246	1,246	364	364	1,422	1,422
Adj. R ²	0.388	0.410	0.584	0.482	0.531	0.490

Table G1: Models are panel regressions with G-SIB-level fixed effects and clustering. The dependent variable is billions of wholesale USD funding, measured in absolute values and in logs. $Secured_{i,t}$ is a dummy variable denoting whether such funding was secured or unsecured, Q^{end} (Y^{end}) denotes whether the position was outstanding during a quarter-end (year-end). ***, **, and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

Appendix H

The below figure shows how the 2016 U.S. MMF reform caused a major rebalancing from unsecured to secured borrowing. Furthermore, one can observe how Eurozone banks strongly window-dress the latter relative to the former.

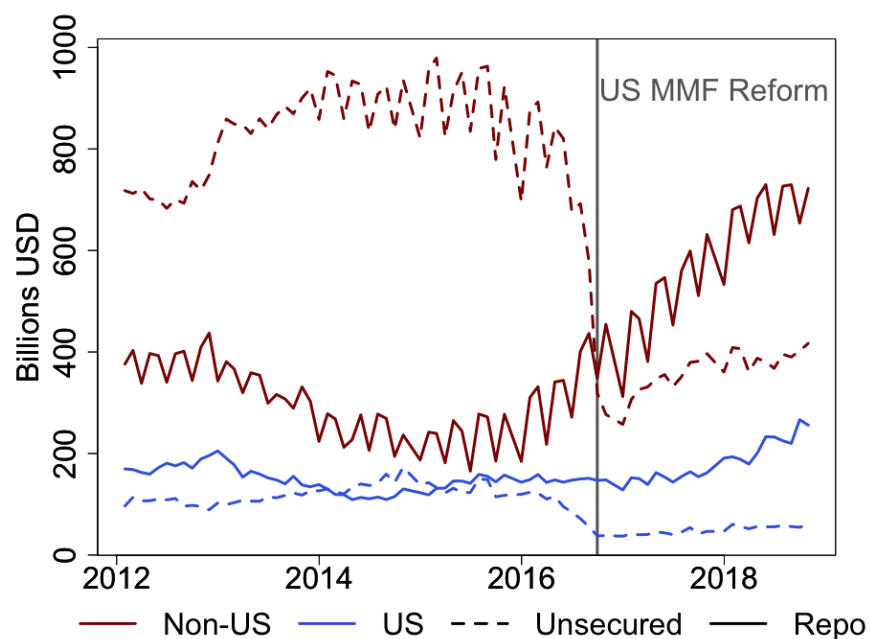


Fig. H1: Plot of U.S. and non-U.S. secured (repo) and unsecured funding volumes around the 2016 U.S. MMF reform.

Appendix I

Dealer:	Dependent variable: Dealers' net positions with U.S. dealers					
	EZ	U.K.	CH	JP	ROW	U.S.
Customers' net positions with...						
EZ dealers	0.44*** (0.11)	0.07 (0.04)	0.08 (0.05)	-0.08 (0.05)	-0.01 (0.07)	-0.19 (0.12)
U.K. dealers	-0.06 (0.05)	0.26*** (0.09)	0.01 (0.02)	-0.03 (0.02)	-0.01 (0.01)	-0.05 (0.04)
CH dealers	-0.06 (0.08)	0.16 (0.10)	0.18*** (0.04)	-0.04** (0.02)	-0.04** (0.01)	0.01 (0.05)
JP dealers	-1.92*** (0.11)	-1.31*** (0.06)	0.79*** (0.05)	1.56*** (0.04)	-0.16*** (0.04)	1.88*** (0.09)
ROW dealers	-0.12 (0.11)	0.001 (0.04)	0.02 (0.05)	0.01 (0.05)	0.28*** (0.04)	0.04 (0.07)
U.S. dealers	-0.22*** (0.03)	-0.10*** (0.02)	-0.04** (0.02)	-0.02** (0.01)	-0.08*** (0.01)	0.20*** (0.04)
Currency FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,823	8,823	8,823	8,823	8,823	8,823
Adj. R ²	0.11	0.07	0.04	0.06	0.08	0.49

Table I1: The table displays results of a regression of dealers' net dollar position with U.S. dealers on their customers' net position. For example, column (1) regresses EZ dealers' net position with U.S. dealers on customers' net position with EZ dealers, and with other dealers (which act as controls for a broad-based dollar movement). For U.S. dealers in column (6), the dependent variable is their net position with non-U.S. dealers. Dealer here is synonymous with G-SIB. Net dollar position is the absolute difference between dollars purchased and sold. Regression is performed in weekly differences. Clustering is performed at currency-level. ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

Appendix J

Supply determinant (SD):	Dependent variable: cross-currency basis							
	HKM_1	HKM_2	HKM_3	$CDS_{U.S.}$	CDS_{EZ}	$GCF-IOER$	S	H
SD	−4.61 (2.67)	0.57 (0.44)	0.0001 (0.0002)	0.002** (0.001)	0.002* (0.001)	0.01*** (0.001)	0.98*** (0.32)	1.18** (0.42)
Q^{end}	0.74* (0.37)	0.65*** (0.10)	0.56*** (0.16)	0.51** (0.17)	0.51*** (0.17)	0.62*** (0.11)	−0.43 (0.25)	−0.93* (0.51)
$SD \times Q^{end}$	1.49 (5.51)	0.60 (0.67)	0.0003 (0.0005)	0.001 (0.002)	0.002 (0.002)	−0.002 (0.002)	3.84*** (0.71)	5.16*** (1.68)
<i>Controls</i>								
$Q^{end} \times Y^{end}$	−0.03 (0.23)	0.71*** (0.06)	0.92*** (0.16)	0.97*** (0.17)	0.96*** (0.16)	0.67*** (0.06)	0.71** (0.24)	1.10 (0.64)
$SD \times Q^{end} \times Y^{end}$	−12.35*** (3.89)	−0.80 (0.98)	−0.001 (0.0004)	−0.003* (0.002)	−0.003* (0.002)	−0.003* (0.001)	0.01 (0.85)	−1.23 (2.00)
Currency-Tenor FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Curr.-Tenor Clusters	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	39,985	39,985	39,985	41,047	41,047	37,433	37,591	37,591
Adj. R^2	0.17	0.17	0.17	0.18	0.18	0.21	0.20	0.19

Table J1: Regression of the daily cross-currency basis for the short-term tenors of EURUSD, USDJPY, GBPUSD, and USDCHF on various determinants of supply SD . We estimate:

$$\chi_{t,x,m} = SD_{t,x,m} + Q_{t,x,m}^{end} + SD_{t,x,m} : Q_t^{end} + Q_t^{end} : Y_t^{end} + SD_{t,x,m} : Q_t^{end} : Y_t^{end} + \alpha_{x,m} + u_t$$

The specific SD is denoted in the header column. HKM_1 to HKM_3 are the intermediary (inverse) capital ratio, (inverse) value-weighted investment return, and leverage ratio (assets over equity) of [He et al. \(2017\)](#), respectively. $CDS_{U.S.}$ (CDS_{EZ}) denotes the mean credit default swap spread of U.S. (Eurozone) G-SIBs. $GCF-IOER$ is spread between GCF repo rates and the interest paid on excess reserves. S denotes market share of U.S. G-SIBs for that currency pair-tenor. H is the currency pair-tenor specific excess Herfindahl index $\sqrt{-\frac{1}{N} + \sum_{i=1}^N S_i^2}$ where S_i is agent i 's share of the market. Q^{end} (Y^{end}) denotes whether the cross-currency basis of that tenor crossed the quarter-end (year-end) for that date. ***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Appendix K

To form our GIV, we consider the flows of all nationality-institution types other than U.S. G-SIBs (i.e., 17 parties, $i = 1, \dots, N$; $i \neq g$, referred to as non-U.S.-G-SIBs) in the four main currencies (EURUSD, USDJPY, GBPUSD, and USDCHF) and in five different tenors (TN, 1W, 1M, 3M, 1Y). For every currency x and tenor m , we have $\mathcal{O}_{i,t}^{Net} = \mathcal{O}_{i,t}^{\$} - \mathcal{O}_{i,t}^x$ where $\mathcal{O}_{i,t}^{\$}$ and $\mathcal{O}_{i,t}^x$ are outstanding positions whereby party i is borrowing USD and foreign currency, respectively. We derive the building block of the GIV as: $Y_{i,t} := \frac{\mathcal{O}_{i,t}^{Net} - \mathcal{O}_{i,t-1}^{Net}}{|\mathcal{O}_{i,t-1}^{Net}|} \cdot 100$ and weights $S_{i,t-1} = \frac{\mathcal{O}_{i,t-1}^{\$}}{\sum_{i=1}^N \mathcal{O}_{i,t-1}^{\$}}$.⁵⁸ In sum, we create a GIV for each of the 20 currency pair-tenor combinations in our sample, and then require the economic relationships we test to hold over the entire panel.

The main threat to identification is failing to fully isolate idiosyncratic shocks, and instead letting aggregate ones impact our estimate.⁵⁹ For example, a potential concern is that the large agents in our setting are G-SIBs, and may thus be impacted by systemic effects specific to that fact; for instance they are specifically affected by year-end G-SIB capital surcharges (see sec. 4.3.3); we thus control for quarter-ends and year-ends in our estimations. To further mitigate such concerns, we residualize $Y_{i,t,x,m}$ by controlling for several agent-specific characteristics, as well as a battery of fixed effects to absorb group-specific influences:

$$Y_{i,t} = \beta_1 \cdot \log(\mathbf{mat})_{i,t,x} + \beta_2 \cdot \mathbf{h_index}_{i,t,x} + \beta_3 \cdot \mathbf{tradesize}_{i,t,x,m} + x_i + \iota_i + \eta_i + \tau_t + \check{Y}_{i,t}, \quad \forall x, m \quad (16)$$

where, for each agent type i , $\mathbf{mat}_{i,t,x}$ is the average initial maturity of their outstanding positions, $\mathbf{h_index}$ is the currency-specific Herfindahl index of short-term synthetic activity with their counterparties (i.e. measuring agents' degree of connectivity), and $\mathbf{tradesize}_{i,t,x,m}$ is agents' currency-tenor-specific average trade size. We also include fixed effects at the

⁵⁸ Basing size weights on gross dollar amounts (as opposed to net) results in a more stable variable, which we then use to instrument for agents' overall net flow.

⁵⁹ The main assumptions of the GIV approach are (1) granularity (with heterogeneous agent dimensions), (2) shock independence, (3) instrument validity, and (4) a lack of immediate feedback effects. A further critical requirement of the GIV is a high industry concentration, such that there are major idiosyncratic shocks to exploit. We check this by considering the excess Herfindahl index of each currency pair-tenor, i.e. $h := \sqrt{-\frac{1}{N} + \frac{1}{T} \sum_{i=1}^N \sum_{t=1}^T S_{i,t}^2}$. An excess Herfindahl index in the range of [0.2,0.7] is considered desirable; we obtain values within the range of [0.23,0.37], fulfilling this requirement.

agent, nationality, and institution type level as well as trade date fixed effects. We further consider the possibility that the shocks may have a richer factor structure, with r factors such that $\check{Y}_{i,t} = \sum_{f=1}^r \lambda_i^f \eta_t^f + u_{i,t}$. We therefore run a principal component analysis (PCA); while only the first component explains meaningful variance for some currency pair-tenor series, we nevertheless control for the first three principal components as aggregate factors in our IV estimation.

The GIV crucially depends on extracting idiosyncratic shocks by forming differences between size-weighted and equal-weighted shocks to agents' $\check{Y}$ (which we winsorize at the 1% level):

$$\check{Y}_S = \sum_{\substack{i=1 \\ i \neq g}}^N S_i \check{Y}_i, \quad \check{Y}_E^{equi} = \frac{1}{N} \sum_{\substack{i=1 \\ i \neq g}}^N \check{Y}_i, \quad Z^{equi} = \check{Y}_S - \check{Y}_E^{equi}. \quad (17)$$

The above GIV Z^{equi} depends on weights $\Gamma = S - E$; however a more optimal version controls for correlation between shocks by using inverse-variance weights $\tilde{E}_i$ such that:

$$\tilde{E}_i := \frac{1/\sigma_{u_i}^2}{\sum_j 1/\sigma_{u_j}^2}, \quad \tilde{\Gamma}_i = S_i - \tilde{E}_i, \quad Z^{preci} = \sum_i \tilde{\Gamma}_i \check{Y}_i, \quad (18)$$

where Z^{preci} refers to the fact that this GIV uses precision-weighted quasi-equal weights.

We now estimate eq. (11) through two-stage IV, instrumenting $\mathcal{O}_{t,x,m}^{Net}$ with our GIV. We include a vector of controls $\mathbf{X} = \{\mathcal{A}_{t,x,m}, s_{t,x}, Q_{t,m}^{end}, Y_{t,m}^{end}, PCA_{t,x,m}^1, PCA_{t,x,m}^2, PCA_{t,x,m}^3\}$ where $\mathcal{A}_{t,x,m}$ is the currency-tenor specific realized illiquidity measure of [Kloks et al. \(2023a\)](#), $s_{t,x}$ are log spot returns, $Q_{t,m}^{end}$ ($Y_{t,m}^{end}$) refers to whether the underlying swap contract of that maturity crossed a quarter-end (year-end), and PCA are the aforementioned principal components. Panel A of Table 2 reports the first stage results with [Montiel Olea and Pflueger \(2013\)](#) (MOP) effective F-statistics; we find a strong relationship between overall net dollar flows and our GIV, and thus reject the null hypothesis of weak instruments.

We regress the cross-currency basis on agents' positions in Panel B of Table 2.⁶⁰ Columns (1) and (4) perform a direct OLS regression over the whole sample and for the post-2015

⁶⁰ Note that we calculate the cross-currency basis as follows:

sample respectively; no significant relationship is found. Columns (2)-(3) and (5)-(6) perform IV estimation; the exclusion restriction $E[Z_{t,x,m}^{GIV}\epsilon_{t,x,m}] = 0$ is given to us from the theory underlying GIVs: idiosyncratic shocks, cleansed of common shocks, can only impact the price through their direct transmission. The results uncover a significantly positive link: across our specifications, a 1% increase in non-U.S.-G-SIB agents' flow results in a 0.52% to 1.1% increase in the basis. We are thus able support the notion that non-U.S.-G-SIB agents act as the demand side w.r.t. to synthetic U.S. dollar funding, as their flows have a significant price impact. This relationship grew stronger during the post-2015 period, when the basis more easily fluctuated.⁶¹

We now turn our attention to supply and demand elasticities. Here, a stronger relevance condition is required, chiefly that $E[\Delta\chi_{t,x,m}Z_{t,x,m}^{GIV}] \neq 0$, i.e. demand shocks can impact the price. We run regressions of the form:

$$\Delta\chi_{t,x,m} = \beta \cdot Z_{t,x,m}^{GIV} + \gamma^X \cdot \mathbf{X}_{t,x,m} + \alpha_{x,m} + \tau_t + \epsilon_{t,x,m}^X \quad (19)$$

Panel (a) of Table K1 presents results. Significance is achieved on all versions of our GIV. We then extract the supply and demand elasticities, ψ and ϕ respectively, as follows:

$$\check{Y}_{t,x,m}^S = \psi \cdot \widehat{\Delta\chi}_{t,x,m} + \gamma^S \cdot \mathbf{X}_{t,x,m} + \alpha_{x,m} + \tau_t + \epsilon_{t,x,m}^S \quad (20)$$

$$\check{Y}_{t,x,m}^E = \phi \cdot \widehat{\Delta\chi}_{t,x,m} + \gamma^E \cdot \mathbf{X}_{t,x,m} + \alpha_{x,m} + \tau_t + \epsilon_{t,x,m}^E \quad (21)$$

$$\chi_t^{x|y,m} = 100 \cdot \left(i_t^{y,m} - \left(i_t^{x,m} - 100 \cdot \left(\frac{360}{m} \right) \cdot \left(-\log \left(F_t^{x|y,m} \right) + \log \left(S_t^{x|y} \right) \right) \right) \right),$$

$$\Delta\chi_t^{x|y,m}, \% = \frac{\chi_t^{x|y,m} - \chi_{t-1}^{x|y,m}}{\widehat{\chi}^{x|y,m}},$$

where $i_t^{y,m}$ and $i_t^{x,m}$ are the compounded interest rates of the quote and base currencies, respectively. We take the cross-currency basis in differences as a percentage of the median value over the sample (i.e. as a percentage of $\widehat{\chi}^{x|y,m}$). The basis is often at zero; taking it as a share of its average over time avoids this issue. Our results are robust to using a rolling-average specification as well. We further winsorize the basis as well as $\Delta\mathcal{O}_{t,x,m}^{Net}$ at the 2.5% level.

⁶¹ Note that the derived price impact estimates cannot on their own explain the quarter-end surge in deviations from CIP. This is to be expected, as first, our estimates are generated over the entire sample, and second, quarter-end values price in the shadow cost differential independent of order flow.

Panels (b) and (c) in Table [K1](#) display results for the supply and demand elasticities, respectively. Note that they comply with the theory underlying GIVs in that the price sensitivity estimated in the first stage can be retrieved from the estimated supply/demand elasticities in the second stage; i.e. we observe that $\beta = \frac{1}{\psi - \phi}$. In response to a 1% increase in the basis, U.S. G-SIB dealers increase their provision of synthetic dollar funding by approximately 3-4% while non-U.S.-G-SIB institutions decrease their dollar demand by 0.15% to 0.95%, validating our hypothesis of inelastic dollar demand. Furthermore, we observe that both supply and demand became more inelastic in the post-2015 period.

Panel A: First Stage				
	Full sample		Post-2015 period	
Dep. variable:	$\Delta\chi^{t,m,x}, \%$			
	Z^{preci}	Z^{equi}	Z^{preci}	Z^{equi}
	(1)	(2)	(3)	(4)
Z^{GIV}	0.20*** (0.07)	0.24*** (0.08)	0.27*** (0.08)	0.31*** (0.10)
Panel B: Second Stage - Supply				
Dep. variable:	$\check{Y}_S$			
	Z^{preci}	Z^{equi}	Z^{preci}	Z^{equi}
	(1)	(2)	(3)	(4)
$\Delta\chi_t^{x y,m}, \%$	4.01*** (1.28)	4.18*** (1.44)	2.99*** (0.91)	3.18*** (1.02)
Panel C: Second Stage - Demand				
Dep. variable:	$\check{Y}_E$			
	Z^{preci}	Z^{equi}	Z^{preci}	Z^{equi}
	(1)	(2)	(3)	(4)
$\Delta\chi_t^{x y,m}, \%$	-0.95** (0.36)	-0.20** (0.10)	-0.69** (0.25)	-0.15** (0.07)
Controls	Yes	Yes	Yes	Yes
Fixed effects	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$
Clustering	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$
Obs.	48,740	48,740	36,900	36,900
MOP effective F-statistic	12	10	13	11

Table K1: The table shows GIV estimation of eq. (19)-(21). The specifications are panel regressions over 4 currency pairs and 5 tenors, with currency pair-tenor (α) and date (τ) fixed effects and clustering. $\mathbf{X} = \{\mathcal{A}_{t,x,m}, s_{t,x}, Q_{t,m}^{end}, Y_{t,m}^{end}, PCA_1, PCA_2, PCA_3\}$ where $\mathcal{A}_{t,x,m}$ is the currency-tenor specific realized illiquidity measure of Klok et al. (2023a), $s_{t,x}$ are log spot returns, $Q_{t,m}^{end}$ ($Y_{t,m}^{end}$) refers to whether the underlying swap contract of that maturity crossed a quarter-end (year-end), and PCA are the aforementioned principal components. MOP denotes the Montiel Olea-Pflueger effective F-statistic. Columns (1)–(3) use the full sample (Sept. 2012 – Mar. 2022); columns (4)–(6) use the subsample from Jan. 1, 2015 onwards. ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

Appendix L

We seek to analyze the distribution of gains and losses among market participants arising from regulatory shadow cost dynamics. Table L1 calculates the profit and losses associated with (i) repo-FX swap substitution and (ii) long-term FX swap trading. We compute the *realized* CIP income earned or lost (in mn of USD) as a result of market participants' FX swap trading with each other. We first calculate agents' effective cost of borrowing/lending as follows:

$$\gamma_{t,i}^{(d)} = \frac{\sum_{x=1}^X \sum_{m=1}^M Q_{i,t,x,m}^{(d)} \cdot \chi_{i,t,x,m}^{g,(d)}}{\sum_{x=1}^X \sum_{m=1}^M Q_{i,t,x,m}^{(d)}}, \quad d \in \{b, \ell\} \quad (22)$$

where Q is agent i 's quantity of FX swaps outstanding, χ^g is the cross-currency basis paid/earned to U.S. G-SIBs during time interval t , x, m refer to currency pair and tenor respectively, and (d) indicates whether we are considering borrowing or lending. We then calculate profits and losses as:

$$P/L_i = \frac{1}{T} \sum_x \sum_m \left(\sum_{t=1}^T Q_{i,k,t,x,m}^b - Q_{i,k,t,x,m}^l \right) \cdot \left(\gamma_i^{r,(d)} - \gamma_i^{n,(d)} \right) \quad (23)$$

where k denotes the specific counterparty to agent i . $\gamma_i^{r,(d)}$ and $\gamma_i^{n,(d)}$ represent the effective basis during regulatory and normal periods respectively. When considering repo-FX swap substitution costs, we consider quarter-ends as the regulatory period and the normal period as within-quarter values. For long-term swaps, we similarly consider the spread between post-2015 and pre-2015 average values.

To calculate substitution costs, we multiply the unannualized regulatory spread by agents' surge in quarter-end borrowing, times the number of yearly quarter-ends. To compute the gains/losses stemming from long-term swaps, we multiply the annualized pre/post 2015 spread by agents' average *daily* post-2015 outstanding position, as in eq. (23). We then scale our results based on CLS data by the actual size of the FX market according to the BIS Triennial Survey. In short, our method approximates the share of the cross-currency basis which is due to shadow costs and multiplies this by agents' trading flows to obtain an estimate of their yearly profits/losses due to regulatory dynamics.

	Substitution	Long-term swaps						
		U.S. G-SIBs	Non-U.S. G-SIBs	Non-U.S. reg. banks	U.S. reg. banks	Non-U.S. non-banks	U.S. non- banks	Total
Non-U.S. G-SIBs	(-81)	(-1,765)	–	(-764)	4,132	26	(-348)	1,200
Eurozone	(-63)	(-589)	474	(-96)	1,501	7	(-192)	1,042
Swiss	(-23)	(-202)	(-196)	(-197)	641	0	20	43
Japan	1	(-641)	(-591)	(-21)	17	0	0	(-1,235)
U.K.	(-1)	(-112)	(-46)	(-281)	1,491	15	(-109)	957
China	5	(-221)	288	(-169)	482	4	(-67)	322
Regular banks	(-19)	262	738	(-13)	2,318	13	90	3,389
Non-U.S. reg. banks	(-20)	306	764	–	2,317	13	92	3,472
U.S. reg. banks	1	(-44)	(-26)	(-13)	1	–	(-2)	(-83)
Non-banks (customers)	(-10)	(-3,697)	(-3,784)	(-2,409)	0	1	0	(-9,899)
Non-U.S. non-banks	(-6)	(-3,945)	(-4,132)	(-2,317)	–	(-1)	0	(-10,401)
U.S. non-banks	(-4)	248	348	(-92)	0	2	–	502
U.S. G-SIBs	68	–	1,766	(-306)	3,945	44	(-248)	5,269

Table L1: The table shows the gains and losses stemming from regulatory shadow costs for various agents, in mn of USD. Column ‘Substitution’ considers the costs resulting from the net change in short-term FX swap positions at quarter-end by multiplying the quarter-end delta in position times the quarter-end surge in basis costs; we further multiply by the number of yearly quarter-ends. The same exercise is repeated for long-term swaps by multiplying agents’ average post-2015 daily position by the spread between annualized pre- and post-2015 bases, giving an annual figure. Values are scaled to the actual size of the FX market according to BIS estimates.

Appendix M

The figure below demonstrates how the implementation of the Basel III regulatory framework coincided with a considerable loss of market share for Eurozone and U.K. dealer-banks w.r.t. their U.S. counterparts in long-term synthetic funding segments. U.S. G-SIBs' market share surged from around 30% to 50% at the expense of their European counterparts precisely at the time of the reform. As these are outstanding positions in long-term swaps, a pre-trend is to be expected during the time period highlighted in grey; some swaps initiated during this period would already require securing dollar funding under the new regime.

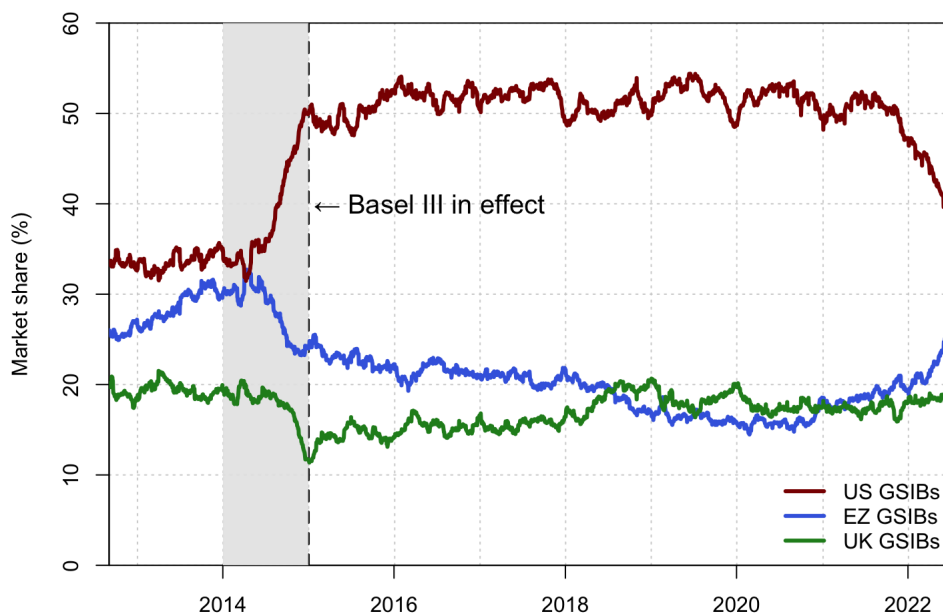


Fig. M1: Market share of U.S., EZ, and U.K. G-SIBs in long-term (>1M) FX swap trading. Market share is defined as the percentage share of customers with each group (where customers are all non-G-SIB entities). Values are *outstanding* FX swap positions as a share of the total market (Japanese, Swiss, and Chinese G-SIB market shares are omitted for visualization purposes). The year before the Basel III implementation is highlighted in grey.

INTERNET APPENDIX

“Hunting for Dollars”

Appendix IA.A

Region	G-SIB
United States	Bank of America Bank of New York Mellon Citigroup Goldman Sachs JP Morgan Chase Morgan Stanley State Street Wells Fargo
Eurozone	BNP Paribas BPCE Groupe Crédit Agricole Deutsche Bank ING Bank Santander Société Générale UniCredit
United Kingdom	Barclays HSBC Standard Chartered
Japan	Mitsubishi UFJ FG Mizuho FG Sumitomo Mitsui FG
Switzerland	Credit Suisse Groupe UBS
ROW (China)	Agricultural Bank of China Bank of China China Construction Bank Industrial and Commercial Bank of China

Table IA.A1: List of G-SIBs in our dataset, by region. Banks were classified as G-SIBs if they were designated as such at least 7 times during the years 2012-2021 according to the List of Global Systemically Important Banks published annually by the Financial Stability Board.

Appendix IA.B

The table below presents the descriptive statistics of the bespoke FX swap volume data from CLS used for this paper.

	Volume (in tn \$)	Trades (‘000)	Volume (%)	Trades (%)
EURUSD	4.75	77,940	37.4	30.9
USDJPY	2.54	31,963	20.0	12.7
GBPUSD	1.66	30,401	13.1	12.0
USDCHF	0.54	10,346	4.2	4.1
Other dollar	3.20	101,893	25.2	40.3
Maturity ≤ 7 days	0.87	7,413	6.9	2.9
Maturity > 7 days	11.82	245,129	93.1	97.1
Bank to Bank	10.15	155,951	80.0	61.8
Bank to Non-Bank	2.54	96,591	20.0	38.2
Involves a G-SIB Bank	11.83	230,444	93.2	91.2
w/o a G-SIB Bank	0.86	22,098	6.8	8.8
Total	12.69	252,543	100	100

Table IA.B1: FX swap outstanding open positions of dollar pairs: 2012-2022 daily averages.

Appendix IA.C

		TN	SN	1W	2W–1M	1M	1M–3M	3M	3M+	Σ
G-SIBs	U.S.	519	120	195	328	1435	1,233	1,883	3,567	9,280
	EZ	246	54	97	163	619	487	794	1,827	4,287
	U.K.	217	41	73	132	580	469	742	1,376	3,630
	CH	120	23	42	83	348	309	448	685	2,058
	JP	52	8	14	28	110	91	179	423	905
	Other	47	11	16	40	209	147	244	439	1,151
	Σ	1,200	256	437	774	3,301	2,736	4,289	8,317	21,310
Small banks	U.S.	4	1	1	6	55	17	23	47	154
	EZ	90	16	33	46	127	130	268	506	1,217
	U.K.	41	8	21	51	127	145	205	456	1,053
	CH	30	4	10	17	47	40	57	104	308
	JP	47	8	10	21	75	59	109	253	583
	Other	248	39	77	119	455	450	827	1,418	3,632
	Σ	461	76	152	259	885	841	1,489	2,785	6,947
Non-Banks	U.S.	3	1	6	27	410	241	195	385	1,268
	EZ	11	3	6	10	149	63	216	87	546
	U.K.	5	2	4	11	179	135	179	182	698
	CH	0	1	7	6	28	14	15	50	120
	JP	0	0	0	0	3	1	1	6	11
	Other	4	2	5	10	61	74	123	218	498
	Σ	24	9	28	64	829	529	730	929	3,141

Table IA.C1: FX swap open (outstanding) **total** volumes (dollar purchases **plus** sales), 2012-22 daily averages, in bn of USD.

		EUR	JPY	GBP	CHF	AUD/NZD/CAD	SEK/NOK/DKK	Other dollar	Σ
G-SIBs	U.S.	3,039	2,056	1,316	434	741	396	1,296	9,280
	EZ	1,782	817	485	193	265	136	609	4,287
	U.K.	1,158	701	606	174	241	119	631	3,630
	CH	639	356	239	315	177	91	240	2,058
	JP	172	533	44	9	31	5	111	905
	Other	258	221	244	48	84	27	269	1,151
	Σ	7,048	4,685	2,935	1,173	1,539	775	3,155	21,310
Small banks	U.S.	36	24	40	5	30	4	14	154
	EZ	773	90	82	82	28	20	141	1,217
	U.K.	380	147	257	58	74	40	98	1,053
	CH	79	18	18	171	6	4	12	308
	JP	125	285	42	12	29	4	85	583
	Other	872	410	318	72	542	557	861	3,632
	Σ	2,265	974	758	400	710	629	1,210	6,947
Non-Banks	U.S.	433	319	192	30	101	29	164	1,268
	EZ	448	18	41	10	10	4	15	546
	U.K.	251	56	275	35	36	9	36	698
	CH	38	3	2	72	2	0	4	120
	JP	0	11	0	0	0	0	0	11
	Other	98	33	21	7	99	132	108	498
	Σ	1,267	440	532	153	248	175	326	3,141

Table IA.C2: FX swap open (outstanding) **total** volume (dollar purchases **plus** sales), 2012-22 daily averages, in bn of USD.

		G-SIBs						Banks						Non-Banks					
		U.S.	EZ	U.K.	JP	CH	CN	U.S.	EZ	U.K.	JP	CH	ROW	U.S.	EZ	U.K.	JP	CH	ROW
G-SIBs	U.S.	–	13.7	2.6	24.2	24.3	20.1	24.2	2.6	-5.4	24.6	0.9	10.0	-4.8	68.5	78.2	97.7	86.5	70.3
	EZ	-13.7	–	-9.1	18.0	9.1	9.2	-88.7	-2.4	-19.7	42.8	18.9	13.6	-37.2	66.1	75.8	100.0	96.6	83.1
	U.K.	-2.6	9.1	–	31.9	24.0	6.3	89.9	-1.7	3.0	43.3	2.7	3.3	-5.5	66.1	70.0	86.3	96.5	82.5
	JP	-24.2	-18.0	-31.9	–	-71.1	-86.6	n.a.	71.6	86.5	38.0	-100.0	26.8	n.a.	n.a.	n.a.	93.8	n.a.	n.a.
	CH	-24.3	-9.1	-24.0	71.1	–	51.3	96.7	1.8	-40.5	73.3	-9.0	-4.2	11.9	83.3	76.9	n.a.	92.6	82.7
	CN	-20.1	-9.2	-6.3	86.6	-51.3	–	-89.4	4.8	-26.2	96.9	77.6	-13.8	12.1	74.6	80.9	n.a.	100.0	92.5
Banks	U.S.	-24.2	88.7	-89.9	n.a.	-96.7	89.4	–	n.a.	-100.0	n.a.	-100.0	-71.4	-58.8	95.2	100.0	n.a.	n.a.	n.a.
	EZ	-2.6	2.4	1.7	-71.6	-1.8	-4.8	n.a.	–	8.2	49.0	29.9	-5.7	n.a.	99.6	n.a.	n.a.	n.a.	n.a.
	U.K.	5.4	19.7	-3.0	-86.5	40.5	26.2	100.0	-8.2	–	75.3	38.2	-15.9	-11.0	95.3	93.1	n.a.	n.a.	91.0
	JP	-24.6	-42.8	-43.3	-38.0	-73.3	-96.9	n.a.	-49.0	-75.3	–	98.5	-52.2	100.0	n.a.	n.a.	n.a.	n.a.	n.a.
	CH	-0.9	-18.9	-2.7	100.0	9.0	-77.6	100.0	-29.9	-38.2	-98.5	–	-10.7	n.a.	n.a.	n.a.	n.a.	100.0	n.a.
	ROW	-10.0	-13.6	-3.3	-26.8	4.2	13.8	71.4	5.7	15.9	52.2	10.7	–	25.5	87.0	80.2	100.0	76.8	84.5
Non-Banks	U.S.	4.8	37.2	5.5	n.a.	-11.9	-12.1	58.8	n.a.	11.0	-100.0	n.a.	-25.5	–	n.a.	n.a.	n.a.	n.a.	n.a.
	EZ	-68.5	-66.1	-66.1	n.a.	-83.3	-74.6	-95.2	-99.6	-95.3	n.a.	n.a.	-87.0	n.a.	–	n.a.	n.a.	n.a.	n.a.
	U.K.	-78.2	-75.8	-70.0	n.a.	-76.9	-80.9	-100.0	n.a.	-93.1	n.a.	n.a.	-80.2	n.a.	n.a.	–	n.a.	n.a.	n.a.
	JP	-97.7	-100.0	-86.3	-93.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-100.0	n.a.	n.a.	n.a.	—	n.a.	n.a.
	CH	-86.5	-96.6	-96.5	n.a.	-92.6	-100.0	n.a.	n.a.	n.a.	n.a.	-100.0	-76.8	n.a.	n.a.	n.a.	n.a.	–	n.a.
	ROW	-70.3	-83.1	-82.5	n.a.	-82.7	-92.5	n.a.	n.a.	-91.0	n.a.	n.a.	-84.5	n.a.	n.a.	n.a.	n.a.	n.a.	–

Table IA.C3: The table shows the net dollar position of participants with each other, considering domestic currency pairs. Figures are daily average net outstanding positions (dollar purchases minus sales) as a percentage of underlying volume. A positive number represents dollar lending from the row party to the column party.

Appendix IA.D

We now formally test whether banks purposefully trade swaps to have them appear on balance sheet reporting dates. An alternative explanation could be that quarter-ends are an important period for many actors and it should perhaps be no surprise that we see a general increase in market activity, which may be linked to volatility or other conditions. To test this, we run a difference-in-differences analysis leveraging our *flow* data as well as variation in an FX swap’s maturity. For example, a 1-week FX swap traded one week before the quarter-end will appear on the balance sheet, but a tomorrow-next swap traded on that same day will not. Thus, if banks are interested in using FX swaps at the quarter-end specifically, we would expect the 1-week swap trading to increase relative to tomorrow-next swaps on that day. We thus estimate difference-in-differences models for the spot-next (SN) and 1-week (1W) tenors as the treated group with tomorrow-next (TN) swaps as our control group. That is,

$$TradedVol_{i,t} = \beta_1 \cdot Tenor_i + \beta_2 \cdot PreQ_t^{end} + \beta_3 \cdot Tenor_i \cdot PreQ_t^{end} + \beta \cdot \mathbf{X}_{i,t} + \alpha_i + u_{i,t}, \quad (24)$$

where $TradedVol_{i,t}$ is the amount of FX swaps of currency pair i traded on date t in logarithms, $Tenor_i$ is a dummy variable which is 1 if a swap contract has a spot-next (1-week) maturity and 0 if it has a tomorrow-next tenor, $PreQ_t^{end}$ is a dummy indicating whether SN (1W) swaps traded on that day crossed the quarter-end, α_i are currency pair fixed effects, $\mathbf{X}_{i,t}$ are controls, and $Tenor_i \cdot PreQ_t^{end}$ is the difference-in-differences estimator and the coefficient of interest.

Table [IA.D1](#) shows our results. Our results are economically and statistically significant for banks’ trading, signifying that banks’ increase 1-week swap trades one week before the quarter-end relative to tomorrow-next swaps (which would not appear on the balance sheet). That this mechanism also applies to spot-next swaps vs. tom-next swaps further emphasizes that these trades are driven by balance-sheet purposes only, and are not the result of general volatility.

	Banking volume (logs)					
	Spot-next			1-week		
	EURUSD	USDJPY	All	EURUSD	USDJPY	All
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Tenor</i>	−1.92*** (0.06)	−1.85*** (0.05)	−2.45*** (0.12)	−2.13*** (0.04)	−2.42*** (0.05)	−2.81*** (0.13)
<i>PreQ^{end}</i>	−0.05 (0.06)	−0.06 (0.05)	0.05 (0.04)	−0.05 (0.05)	−0.12** (0.05)	−0.01 (0.02)
<i>Tenor</i> × <i>PreQ^{end}</i>	0.39*** (0.12)	0.34*** (0.12)	0.38** (0.15)	0.47*** (0.10)	0.68*** (0.10)	0.33*** (0.07)
Constant	Yes	Yes	No	Yes	Yes	No
Currency FE	No	No	Yes	No	No	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,918	2,764	40,556	3,203	3,076	34,187
Adj. R ²	0.74	0.73	0.84	0.80	0.79	0.71

Table IA.D1: Regressions (1) - (3) perform difference-in-differences estimation by comparing the spot-next and tomorrow-next tenors; (4) - (6) do the same with the 1-week and tomorrow-next tenors. Regressions for EURUSD and USDJPY are OLS models with Newey-West standard errors. (3) and (6) are panel regressions on all available currency pairs, for which fixed effects and clustered standard errors are applied. Banking volume is the amount of FX swaps of currency pair i traded by banks on date t in logarithms, $Tenor_i$ is a dummy variable which is 1 if a swap contract has a spot-next (1-week) maturity and 0 if it has a tomorrow-next tenor, $PreQ_t^{end}$ is a dummy indicating whether SN (1W) swaps traded on that day crossed the quarter-end, α_i are currency pair fixed effects, and the coefficient of $Tenor_i \times PreQ_t^{end}$ is the difference-in-differences estimator. Controls are for month-ends and year-ends ($\beta \cdot \mathbf{X}_{i,t} = \beta_4 \cdot PreM_t^{end} + \beta_5 \cdot PreQ_t^{end} \cdot PreY_t^{end} + \beta_6 \cdot PreM_t^{end} \cdot Tenor + \beta_7 \cdot PreQ_t^{end} \cdot PreY_t^{end} \cdot Tenor$, where $PreM_t^{end}$ ($PreY_t^{end}$) is a dummy indicating whether swaps traded on that day crossed the month-end (year-end)). ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

Appendix IA.E

Figure IA.E1 shows the settled prices charged by U.S. banks based on CLS data, compared to indicative quotes from Bloomberg. It displays the volume-weighted average swap points $F - S$ for EURUSD 1W FX swaps traded on a given day by U.S. banks across all counterparties, in comparison to the mid-quotes available on Bloomberg. The figure confirms that CLS rates, while naturally slightly noisier, are well-behaved and highly correlated with Bloomberg prices.

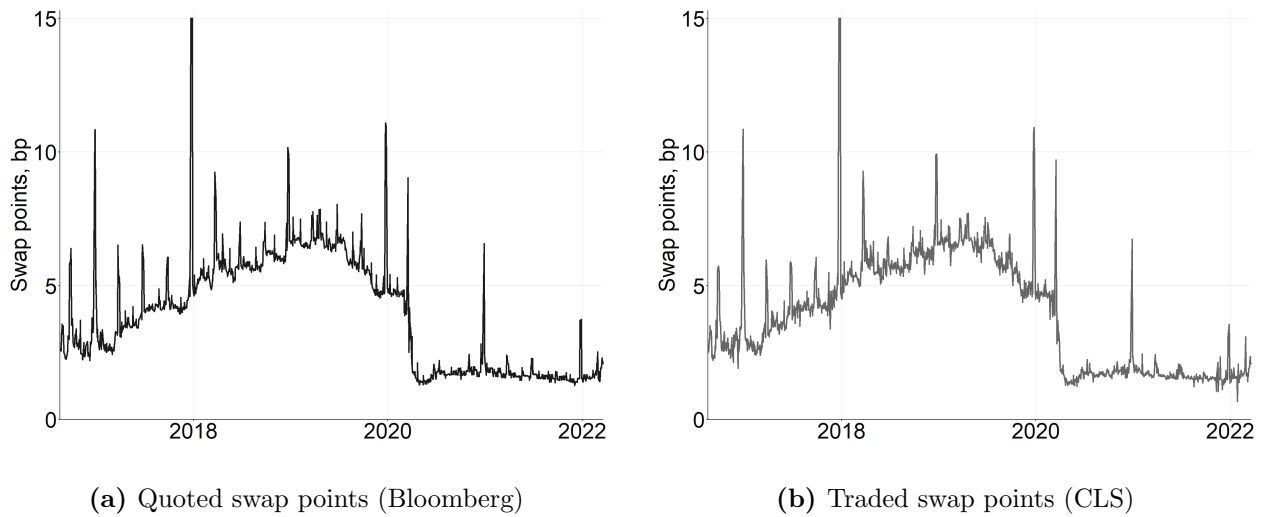


Fig. IA.E1: EURUSD 1W swap points based on *quoted* swap points (Bloomberg, left) vs. volume-weighted daily average *traded* swap points charged by U.S. banks (CLS, right). Both series are capped at 15 basis points for better visualization. Data is daily from January 2017 until March 2022.

Appendix IA.F

Correa et al. (2020) develop a proxy for U.S. G-SIBs' net synthetic dollar positions by using balance sheet data to sum up their non-U.S. excess currency reserves and net reverse repo positions. Using this methodology, they perform an event study around the quarter-end and identify a \$20 bn surge in synthetic dollar lending, as opposed to the \$50 bn we estimate in panel (b) of Fig. 6. Here, we replicate their estimation by running an event study with the same parameters; that is, we consider short-term FX swaps (one month and under) for the currency pairs EURUSD, USDJPY, GBPUSD, and AUDUSD from December 2015 to May 2020, including year-ends.⁶²

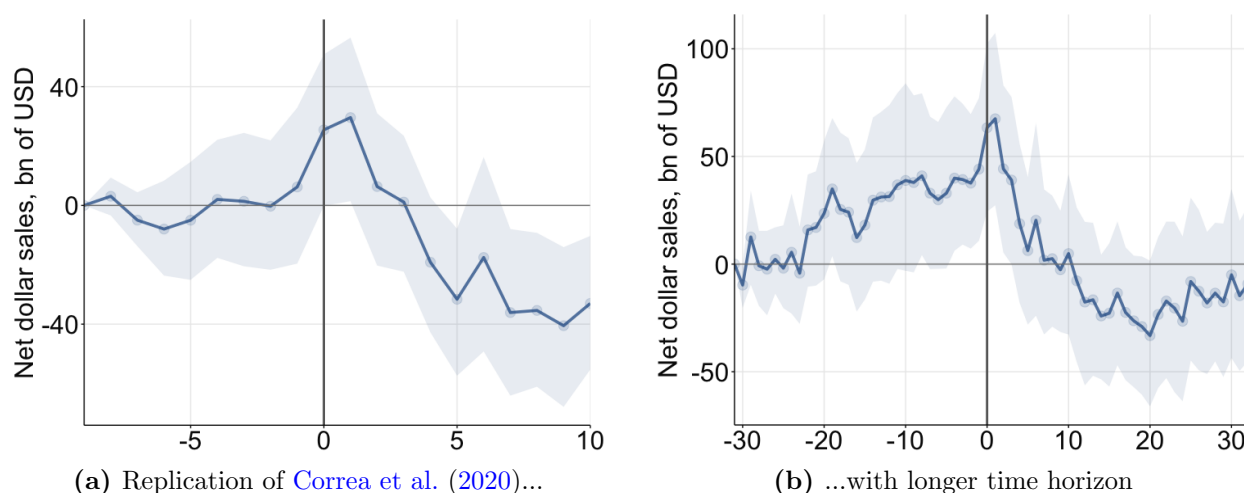


Fig. IA.F1: Panel (a) is an event study around the quarter-end considering U.S. G-SIBs' net synthetic dollar lending in the currency pairs EURUSD, USDJPY, GBPUSD, and AUDUSD for short-term tenors (one month and under), including year-ends. Panel (b) does the same, but expands the time horizon of the event study from 10 days to 32 days.

Panel (a) shows that when using the parameters of Correa et al. (2020), we obtain a much more similar result of approximately 25B USD. The distinction between our result and theirs, however, lies in the time horizon. When considering a broader time span of 32 days (as a quarter-end consists of 63 business days), as in panel (b), one observes that the surge in dollar lending commences much earlier in the quarter-end, and one instead obtains

⁶² In Fig. 6, we consider tenors of one week and under in all dollar currency pairs for the time period January 2015 to December 2020, excluding year-ends. A discrepancy between our exercises is that our data includes two additional U.S. G-SIBs (State Street and the Bank of New York Mellon).

an estimate of 63B. This is in large part due to the confounding effect of the IMM dates, which is more clearly seen in panel (b) of Fig. 6.

Appendix IA.G

Tables [IA.G1](#) and [IA.G2](#) quantify agents' quarter-end change in gross and net positions, respectively. Table [IA.G3](#) presents Eurozone G-SIBs' quarter-end borrowing per currency pair. Tables [IA.G4](#) and [IA.G5](#) breaks down the respective groups' quarter-end borrowing per counterparty. U.K. G-SIBs and regular ROW banks provide Eurozone G-SIBs a substantial amount of quarter-end dollar funding; they themselves source this funding from U.S. G-SIBs. Note that these figures may differ somewhat from the values provided by event studies elsewhere in this paper; these are summary statistics, whereas event studies provide estimates which are affected by the degree of confidence in the statistical inference.

Party	Q ^{end} surge (bn)	Party	Q ^{end} surge (bn)
U.S. G-SIBs	52.9	JP G-SIBs	5.7
EZ G-SIBs	43.2	JP reg. banks	4.0
EZ reg. banks	15.6	U.S. non-banks	0.9
U.K. G-SIBs	15.5	CH non-banks	0.7
CH G-SIBs	9.5	U.K. non-banks	0.4
ROW (CN) G-SIBs	6.8	U.S. reg. banks	0.3
CH reg. banks	6.7	JP non-banks	0.0
ROW reg. banks	6.7	ROW non-banks	-0.1
U.K. reg. banks	6.1	EZ non-banks	-2.4

Table IA.G1: Quarter-end surge in gross positions

Party	Q ^{end} surge (bn)	Q ^{end} surge (%)	Party	Q ^{end} surge (bn)	Q ^{end} surge (%)
EZ G-SIBs	54.4	19.9	U.S. reg. banks	0.2	7.6
EZ reg. banks	8.7	9.1	ROW non-banks	0.1	3.1
CH G-SIBs	6.6	5.6	JP non-banks	0.0	0.0
EZ non-banks	6.5	30.0	U.K. reg. banks	0.0	-0.1
ROW reg. banks	5.1	1.8	JP G-SIBs	-1.5	-3.2
CH reg. banks	3.9	13.5	ROW (CN) G-SIBs	-3.3	-8.4
U.S. non-banks	3.5	33.5	JP reg. banks	-4.7	-11.6
U.K. non-banks	0.6	13.0	U.K. G-SIBs	-6.8	-2.6
CH non-banks	0.5	23.1	U.S. G-SIBs	-73.6	-12.7

Table IA.G2: Quarter-end surge in net dollar positions, both in billions and as a percentage of the non-Q^{end} gross position. Positive values signify dollar borrowing.

Currency pair	Q ^{end} increase (bn)	... as a pct.
EURUSD	34.4	63.2%
GBPUSD	9.0	16.5%
USDJPY	8.4	15.4%
USDCHF	1.7	3.0%
USDHKD	1.3	2.3%
Other	-0.2	-0.4%
Total	54.4	100.0%

Table IA.G3: Eurozone G-SIB Q^{end} surge per currency pair.

Counterparty	Q ^{end} increase (bn)	... as a pct.
U.S. G-SIBs	21.4	39.4
U.K. G-SIBs	12.2	22.5
ROW reg. banks	7.1	13.1
JP G-SIBs	3.6	6.7
Swiss G-SIBs	2.7	4.9
Other	7.3	13.4
Total	54.4	100.0%

Table IA.G4: Eurozone G-SIB Q^{end} surge in dollar borrowing per counterparty.

Counterparty	Q ^{end} increase (bn)	... as a pct.
Eurozone G-SIBs	-21.4	29.1%
U.K. G-SIBs	-15.0	20.3%
ROW regular banks	-10.6	14.4%
Swiss G-SIBs	-9.3	12.6%
Eurozone regular banks	-5.1	6.9%
Other	-12.2	16.6%
Total	-73.6	100.0%

Table IA.G5: U.S. G-SIB Q^{end} surge in dollar borrowing per counterparty.

Eurozone G-SIB USD borrowing										
	vs. U.K. banks					vs. U.S. banks				
	FX swap (logs)		Repo (logs)		FX swap	FX swap (logs)		Repo (logs)		FX swap
	Borrowing	Lending	Net	Net	Share (%)	Borrowing	Lending	Net	Net	Share (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
β_0	4.98*** (0.04)	5.32*** (0.05)	-3.47*** (0.34)	4.25*** (0.10)	-14.06 (14.26)	6.12*** (0.03)	5.44*** (0.03)	5.36*** (0.07)	5.21*** (0.04)	53.69*** (1.76)
Q^{end}	0.04 (0.06)	0.003 (0.07)	-0.09 (0.41)	-0.16*** (0.05)	-27.16 (20.99)	-0.06 (0.05)	0.14*** (0.05)	-0.32*** (0.10)	-0.03 (0.05)	-7.04*** (2.40)
EZ	0.09** (0.04)	-0.12*** (0.04)	1.94*** (0.53)	1.26*** (0.06)	3.79 (12.78)	-1.05*** (0.04)	-0.24*** (0.03)	-6.90*** (0.49)	0.30*** (0.03)	-63.96*** (3.74)
$Q^{end} \times EZ$	0.16*** (0.06)	-0.02 (0.06)	3.49*** (0.79)	-0.12** (0.05)	44.89** (21.07)	0.26*** (0.05)	-0.16*** ⁶³ (0.04)	3.72*** (0.73)	-0.25*** (0.06)	24.76*** (4.82)
<i>Controls</i>										
$Q^{end} \times Y^{end}$	-0.54*** (0.10)	-0.40*** (0.10)	-0.30 (0.38)	-0.17 (0.20)	7.89 (42.72)	-0.57*** (0.05)	-0.48*** (0.07)	-0.69*** (0.12)	-0.04 (0.11)	-14.94*** (3.82)
$Q^{end} \times Y^{end} \times EZ$	0.04 (0.11)	0.06 (0.08)	-2.34* (1.32)	-0.11 (0.11)	-20.19 (40.07)	0.07 (0.07)	0.14** (0.07)	-1.96 (1.23)	-0.25*** (0.09)	2.64 (7.10)
Obs.	140	140	140	140	140	140	140	140	140	140
Adj. R ²	0.33	0.20	0.34	0.76	0.01	0.87	0.51	0.70	0.30	0.82

Table IA.H1: All models are OLS with Newey-West standard errors. Dependent variables are (1) gross U.S. dollar FX swap borrowing, (2) gross U.S. dollar FX swap lending, (3) net U.S. dollar FX swap borrowing, (4) net U.S. dollar repo borrowing (which is also a gross position, given borrowing from U.S. MMFs is one-directional), and (5) the share of dollars sourced through net synthetic funding as defined in eq. (8). All positions are outstanding. Models (1)-(5) use U.K. G-SIBs as a control, (6)-(10) use U.S. G-SIBs. Q_t^{end} (Y_t^{end}) is a dummy indicating a quarter-end (year-end) and EZ_i is unity for Eurozone banks and 0 for U.K. (U.S.) banks. Frequency is monthly; the sample starts at the 2015 year-end when considering U.K. banks and September 2012 when considering U.S. banks, and ends in September 2021. ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

⁶³ Note that this coefficient reflects U.S. G-SIBs' increased lending to Eurozone G-SIBs, rather than a decrease in Eurozone lending. As discussed in sec. 4, Eurozone dealer-banks' lending stays constant through the quarter-end.

Swiss G-SIB USD borrowing										
	vs. U.K. banks					vs. U.S. banks				
	FX swap (logs)		Repo (logs)		FX swap Share (%)	FX swap (logs)		Repo (logs)		FX swap Share (%)
	Borrowing	Lending	Net	Net		Borrowing	Lending	Net	Net	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
β_0	4.98*** (0.04)	5.32*** (0.05)	-3.47*** (0.39)	4.25*** (0.08)	-14.06 (13.75)	6.12*** (0.03)	5.44*** (0.03)	5.36*** (0.08)	5.21*** (0.04)	53.69*** (1.77)
Q_t^{end}	0.04 (0.04)	0.003 (0.07)	-0.09 (0.30)	-0.16** (0.07)	-27.16 (21.67)	-0.06 (0.04)	0.14*** (0.05)	-0.32*** (0.10)	-0.03 (0.05)	-7.04*** (2.45)
CH	-0.44*** (0.04)	-0.90*** (0.04)	4.42*** (0.58)	-1.65*** (0.17)	39.56** (16.61)	-1.58*** (0.03)	-1.02*** (0.04)	-4.42*** (0.41)	-2.61*** (0.14)	-28.19*** (9.26)
$Q_t^{end} \times CH$	0.08* (0.04)	0.03 (0.07)	1.20** (0.56)	-0.79*** (0.15)	73.37*** (24.64)	0.18*** (0.05)	-0.10 (0.07)	1.43*** (0.47)	-0.92*** (0.14)	53.24*** (10.93)
<i>Controls</i>										
$Q_t^{end} \times Y_t^{end}$	-0.54*** (0.09)	-0.40*** (0.11)	-0.30 (0.38)	-0.17 (0.25)	7.89 (43.01)	-0.57*** (0.05)	-0.48*** (0.07)	-0.69*** (0.12)	-0.04 (0.12)	-14.94*** (3.95)
$Q_t^{end} \times Y_t^{end} \times CH$	0.20* (0.11)	-0.002 (0.10)	0.82 (0.75)	0.45 (0.28)	-18.08 (44.26)	0.23*** (0.07)	0.08 (0.08)	1.21* (0.62)	0.31* (0.18)	4.75 (10.77)
Obs.	140	140	140	140	140	140	140	140	140	140
Adj. R ²	0.53	0.72	0.56	0.80	0.17	0.94	0.83	0.57	0.92	0.12

Table IA.H2: All models are OLS with Newey-West standard errors. Dependent variables are (1) gross U.S. dollar FX swap borrowing, (2) gross U.S. dollar FX swap lending, (3) net U.S. dollar FX swap borrowing, (4) net U.S. dollar repo borrowing (which is also a gross position, given borrowing from U.S. MMFs is one-directional), and (5) the share of dollars sourced through net synthetic funding as defined in eq. (8). All positions are outstanding. Models (1)-(5) use U.K. G-SIBs as a control, (6)-(10) use U.S. G-SIBs. Q_t^{end} (Y_t^{end}) is a dummy indicating a quarter-end (year-end) and CH_i is unity for Swiss banks and 0 for U.K. (U.S.) banks. Frequency is monthly; the sample starts at the 2015 year-end when considering U.K. banks and September 2012 when considering U.S. banks, and ends in September 2021. ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

	Japanese G-SIB USD borrowing									
	vs. U.K. banks					vs. U.S. banks				
	FX swap (logs)		Repo (logs)		FX swap	FX swap (logs)		Repo (logs)		FX swap
	Borrowing	Lending	Net	Net	Share (%)	Borrowing	Lending	Net	Net	Share (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
β_0	4.98*** (0.04)	5.32*** (0.05)	-3.47*** (0.35)	4.25*** (0.09)	-14.06 (13.34)	6.12*** (0.04)	5.44*** (0.03)	5.36*** (0.07)	5.21*** (0.06)	53.69*** (1.76)
Q_t^{end}	0.04 (0.05)	0.003 (0.06)	-0.09 (0.42)	-0.16** (0.06)	-27.16 (23.74)	-0.06 (0.04)	0.14** (0.06)	-0.32*** (0.11)	-0.03 (0.05)	-7.04*** (2.65)
JP	-1.71*** (0.05)	-1.60*** (0.06)	1.39*** (0.49)	-0.04 (0.04)	-12.12 (13.85)	-2.85*** (0.06)	-1.72*** (0.04)	-7.44*** (0.25)	-1.00*** (0.07)	-79.87*** (9.43)
$Q_t^{end} \times JP$	0.12 (0.08)	0.10 (0.08)	0.43 (0.74)	0.05 (0.06)	35.37 (28.61)	0.22*** (0.07)	-0.04 (0.09)	0.67 (0.60)	-0.08 (0.09)	15.24 (15.32)
<i>Controls</i>										
$Q_t^{end} \times Y_t^{end}$	-0.54*** (0.08)	-0.40*** (0.10)	-0.30 (0.38)	-0.17 (0.22)	7.89 (36.10)	-0.57*** (0.05)	-0.48*** (0.07)	-0.69*** (0.12)	-0.04 (0.10)	-14.94*** (3.45)
$Q_t^{end} \times Y_t^{end} \times JP$	0.33*** (0.09)	-0.24* (0.13)	2.43*** (0.91)	0.04 (0.10)	-2.92 (42.38)	0.36*** (0.11)	-0.16 (0.11)	2.82*** (0.78)	-0.09 (0.16)	19.92 (16.05)
Obs.	140	140	140	140	140	140	140	140	140	140
Adj. R ²	0.88	0.91	0.20	0.002	-0.02	0.96	0.95	0.87	0.61	0.49

Table IA.H3: All models are OLS with Newey-West standard errors. Dependent variables are (1) gross U.S. dollar FX swap borrowing, (2) gross U.S. dollar FX swap lending, (3) net U.S. dollar FX swap borrowing, (4) net U.S. dollar repo borrowing (which is also a gross position, given borrowing from U.S. MMFs is one-directional), and (5) the share of dollars sourced through net synthetic funding as defined in eq. (8). All positions are outstanding. Models (1)-(5) use U.K. G-SIBs as a control, (6)-(10) use U.S. G-SIBs. Q_t^{end} (Y_t^{end}) is a dummy indicating a quarter-end (year-end) and JP_i is unity for Japanese banks and 0 for U.K. (U.S.) banks. Frequency is monthly; the sample starts at the 2015 year-end when considering U.K. banks and September 2012 when considering U.S. banks, and ends in September 2021. ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

Appendix IA.I

We test our evidence through a difference-in-differences regression whereby we check whether Eurozone bank borrowing increases for those currencies that involve the U.S. dollar, and compare our results to U.S. and U.K. G-SIBs. We thus run the following model:

$$SwapBorrowing_t = \delta_0 + \delta_1 \cdot USD_t + \delta_2 \cdot Q_t^{end} + \delta_3 \cdot Q_t^{end} \cdot USD_t + \delta \cdot \mathbf{X} + u_t \quad (25)$$

where $SwapBorrowing_t$ is the outstanding amount of FX swap borrowing undertaken on day t , Q_t^{end} (Y_t^{end}) is the day of the quarter-end, USD is a dummy variable indicating whether that FX swap borrowing was for U.S. dollars or for foreign currency, and $\delta \cdot \mathbf{X} = \delta_4 \cdot Q_t^{end} \cdot Y_t^{end} + \delta_5 \cdot Q_t^{end} \cdot Y_t^{end} \cdot USD_t$ is a set of control variables. Results are displayed in Table IA.I1.

	Volume					
	Eurozone G-SIBs		US G-SIBs		U.K. G-SIBs	
	bn	Log	bn	Log	bn	Log
USD	−20.72** (8.88)	−0.12** (0.05)	206.50*** (32.08)	0.63*** (0.09)	−45.88** (22.40)	−0.24* (0.14)
Q_t^{end}	−0.06 (4.86)	0.005 (0.03)	29.07*** (9.80)	0.12*** (0.04)	2.82 (6.64)	0.02 (0.04)
$USD : Q_t^{end}$	33.83*** (8.04)	0.19*** (0.05)	−50.02*** (18.35)	−0.17*** (0.05)	3.28 (8.68)	0.02 (0.06)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	144	144	144	144	144	144
Adj. R^2	0.330	0.353	0.646	0.687	0.230	0.228

Table IA.I1: Volumes are summed across all currency pairs and are USD-denominated. $SwapBorrowing_t$ is the log outstanding amount of FX swap borrowing undertaken by G-SIBs on day t , Q_t^{end} is the day of the quarter-end, USD is a dummy variable indicating whether that FX swap borrowing was for U.S. dollars or for foreign currency. Controls are for the year-end, i.e. $\mathbf{X} = \delta_4 \cdot Q_t^{end} \cdot Y_t^{end} + \delta_5 \cdot Q_t^{end} \cdot Y_t^{end} \cdot USD_t$. ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

Across all currency pairs, Eurozone G-SIB dollar borrowing increases by 17%, whereas non-dollar borrowing at the quarter-end increases by an insignificant 0.5%. U.S. G-SIBs increase their dollar lending to accommodate this demand. Crucially, however, these dynamics

are not visible for U.K. G-SIBs, which do not report their balance sheets as a quarter-end snapshot; the coefficient is economically and statistically insignificant. Dollar (non-dollar) volumes increase by 3.8% (2.1%).

Appendix IA.J

We aim to show that European banks active in both Euro and U.S. dollar repo markets scale back their activity in the latter, but not the former. In order to do so, we calculate the outstanding amount of repo borrowing for each bank in the Eurozone and abroad in the U.S. (i.e. for EUR and USD respectively). Given the reporting frequency of U.S. MMF data, we are limited to monthly observations. We run a difference-in-differences model as follows:

$$\begin{aligned} EZRepoBorrowing_{i,t} = & \beta_1 \cdot USD_{i,t} + \beta_2 \cdot Q_t^{end} + \beta_3 \cdot USD_{i,t} \cdot Q_t^{end} + \beta_4 \cdot Q_t^{end} \cdot Y_t^{end} \\ & + \beta_5 \cdot Q_t^{end} \cdot Y_t^{end} \cdot USD_{i,t} + \alpha_i + u_{i,t} \end{aligned} \quad (26)$$

where $EZRepoBorrowing_{i,t}$ is the outstanding amount of repo borrowing⁶⁴ of Eurozone bank i at time t , $USD_{i,t}$ is a dummy variable indicating whether that volume borrowed U.S. dollars (euros), Q_t^{end} (Y_t^{end}) is a dummy variable denoting whether time t represents a quarter-end (year-end), and α_i are bank-specific fixed effects. β_3 is thus the difference-in-differences estimator. We run the regression model on both absolute and logarithmic volumes (the latter giving us a percentage reaction). The first two specifications of Table [IA.J1](#) consider all banks in our sample; as a further robustness check, the second two specifications solely consider those banks for which we have data in both U.S. and European markets. Finally, to give us a total magnitude, specifications (5) and (6) run OLS regressions on all volumes combined.

All specifications show strong statistical and economical significance for the difference-in-differences estimator. Column (2) tells us that the average treatment effect per bank is 41%. Column (5) shows that the quarter-end results in a \$61 bn drop for all banks combined in our sample; this corresponds well with the visualization in Figure [5](#). Thus, our bank-specific data tells us that those European banks which are window-dressing in U.S. MMFs do so less, if at all, in Europe, where they instead window-dress through netting with CCPs.

⁶⁴ We exclude reverse repos (which do not have a regulatory cost); thus we are only considering cash borrowing in money markets.

	Eurozone G-SIB repo borrowing					
	bn USD	log	bn USD	log	bn USD	log
<i>USD</i>	13.941* (7.037)	0.552* (0.312)	14.897* (7.035)	0.587* (0.291)	−62.978*** (9.907)	−0.285*** (0.048)
<i>Q^{end}</i>	0.213 (0.158)	0.064 (0.040)	−0.078 (0.296)	−0.020 (0.046)	6.082 (13.414)	0.022 (0.065)
<i>Q^{end} × USD</i>	−7.066*** (2.460)	−0.346*** (0.106)	−6.874** (2.524)	−0.259** (0.092)	−61.151*** (18.971)	−0.353*** (0.092)
<i>Controls</i>						
<i>Q^{end} × Y^{end}</i>	−1.829*** (0.493)	−0.274*** (0.075)	−2.504** (0.859)	−0.311* (0.158)	−64.020*** (22.880)	−0.257*** (0.111)
<i>Q^{end} × Y^{end} × USD</i>	−0.594 (1.942)	0.130 (0.095)	0.060 (1.829)	0.176 (0.169)	44.337 (32.357)	0.142 (0.156)
Constant	No	No	No	No	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	No	No
Frequency	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly
Standard errors	Clustered	Clustered	Clustered	Clustered	Newey-West	Newey-West
Obs.	4,486	4,486	1,654	1,654	216	216
Adjusted R ²	0.609	0.667	0.448	0.509	0.369	0.393

Table IA.J1: Specifications (1)-(2) are panel regressions with bank fixed effects, considering all banks in the sample; (3)-(4) only consider those banks which appear in both BrokerTec and U.S. MMF data. (5)-(6) are ordinary least squares (OLS) regressions summing up all banks' volume. $EZRepoBorrowing_{i,t}$ is the outstanding amount of repo borrowing of Eurozone bank i at time t , $USD_{i,t}$ is a dummy variable indicating whether that volume borrowed U.S. dollars (euros), Q^{end} (Y^{end}) is a dummy variable denoting whether time t represents a quarter-end (year-end). ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

Appendix IA.K

Fig. IA.K1 shows that U.S. MMFs park their funding at the Fed's ON RRP facility when facing a loss in demand from Eurozone banks. Fig. IA.K2 demonstrates that the fact we do not observe a significant drop in the repo rate indicates that the supply of U.S. MMF repo is elastic relative to its demand. Finally, Fig. IA.K3 plots the repo rate in the GCF segment, which spikes at quarter-end due to agents netting their positions for regulatory purposes.

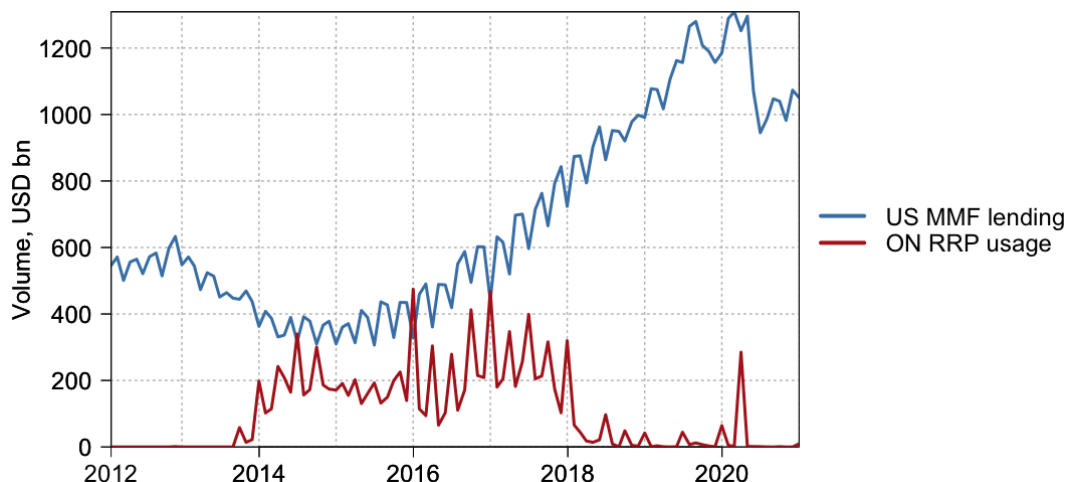


Fig. IA.K1: U.S. MMF lending and total usage of the ON RRP facility.

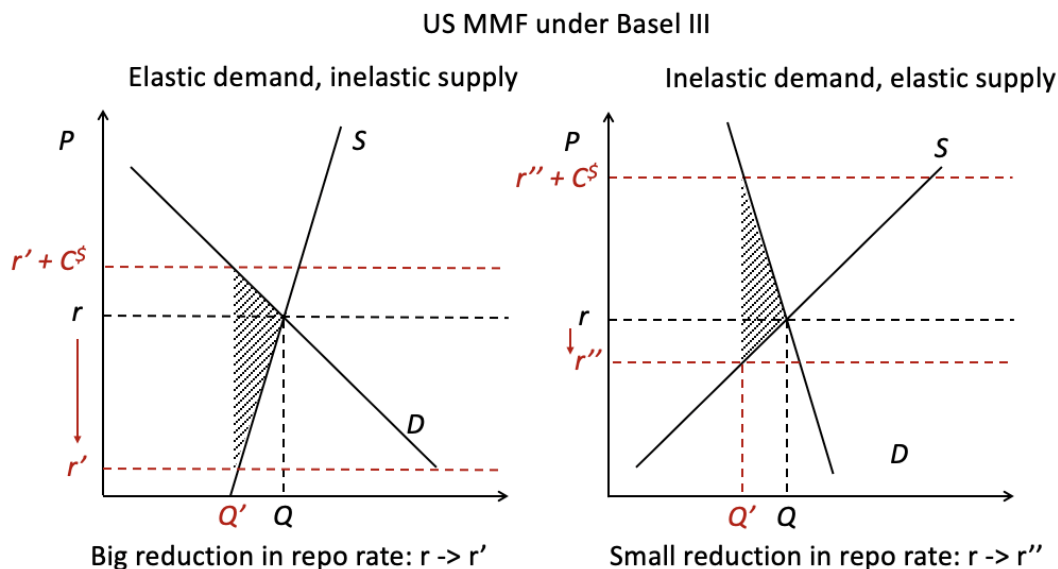


Fig. IA.K2: Were demand (supply) in U.S. MMF repo to be elastic (inelastic), one would observe a significant drop in the repo rate. Instead, demand (supply) is inelastic (elastic), the repo rate remains relatively unchanged, and regulatory shadow costs are passed on the repo borrower, not the lender.

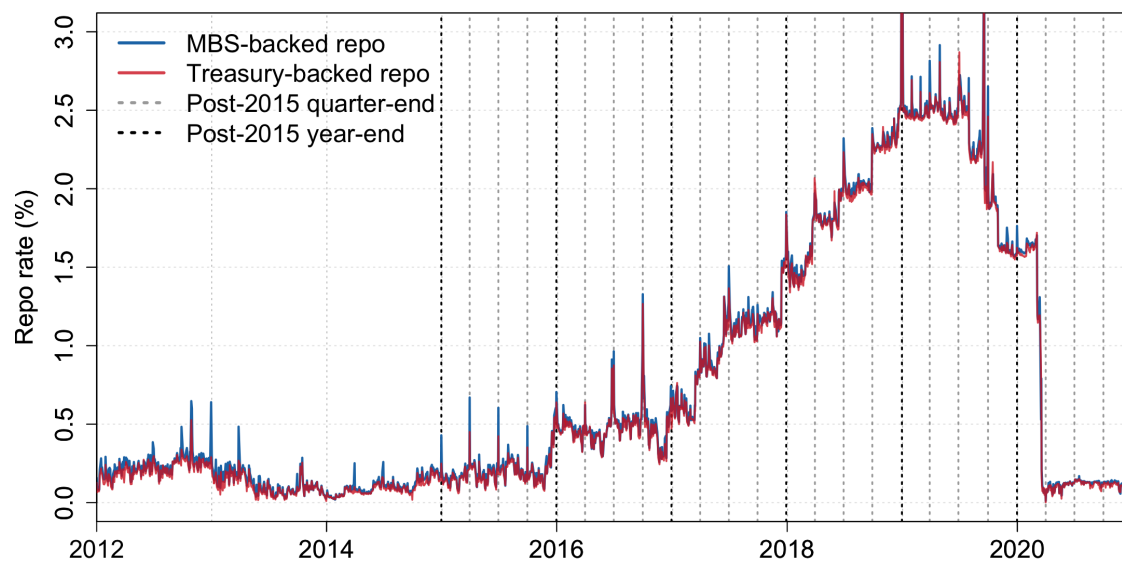


Fig. IA.K3: The DTCC GCF Repo Index tracks the average daily interest rate paid for the most-traded GCF repo contracts for U.S. Treasury and mortgage-backed securities issued by Fannie Mae and Freddie Mac.

Appendix IA.L

The below figures depict correlations of the cross-currency basis with measures of U.S. G-SIBs' dominance in FX swap markets, as measured by (i) their market share and (ii) the excess Herfindahl index, thereby demonstrating that the cross-currency basis increases the more synthetic markets are concentrated around U.S. dealers.

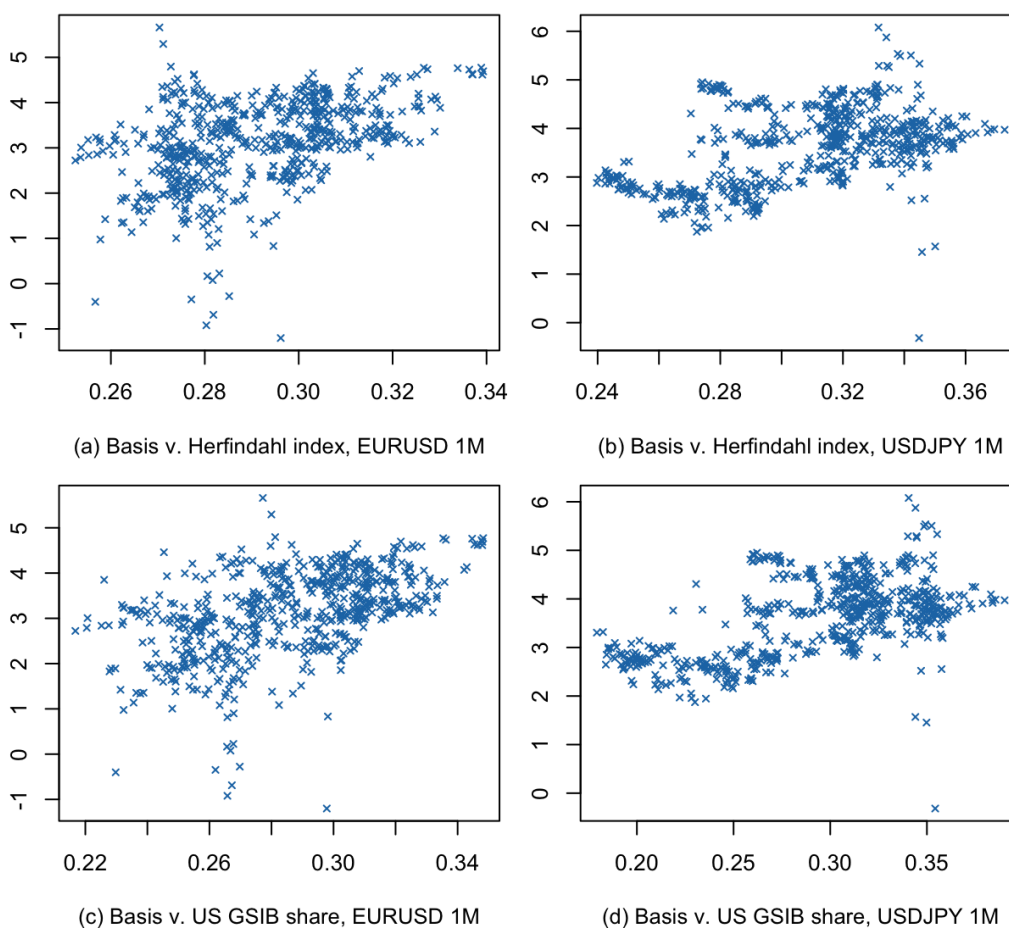


Fig. IA.L1: This figure depicts the correlation of the cross-currency basis (EURUSD and USDJPY, 1M) vs. (i) U.S. G-SIBs' share of FX swap trading and (ii) the excess Herfindahl index (both at the currency pair-tenor level). Values are plotted only for FX swaps crossing quarter-end reporting periods.

Appendix IA.M

The purpose of a thresholded or narrative GIV is to isolate the top shocks driving the GIV, and to check that they are indeed idiosyncratic. Note that this is very likely the case in our setting: whereas other studies operate with lower frequencies (i.e. monthly or quarterly), and are thus exposed to potential latent macro confounders, our data consists of daily synthetic funding trading flows, whose movements are more likely to reflect institution-specific liquidity needs or trading imbalances rather than broad macroeconomic trends.

We first construct our thresholded GIV by re-constructing the variables in eq. (17) and (18) using the top and bottom quartiles of shocks $\check{Y}$. We then remove dates which are likely to be influenced by latent factors. Fig. IA.M1 for example plots $\Delta\mathcal{O}_t^{Net}$ for the EURUSD 1W segment in 2018; many major shocks coincided with monetary policy announcement dates. We therefore drop (i) monetary policy announcement dates for the relevant currencies,⁶⁵ (ii) dates when swaps cross the quarter-end, (iii) the last week of the year, (iv) IMM dates, and (v) March 2020, which was disproportionately influenced by Covid-19. We then list the median value of Z^{preci} for each day across all currency pair-tenor combinations and consider the largest 50 shocks in absolute value. Narrative checks were then conducted to confirm that these were idiosyncratic in nature by considering news articles from Bloomberg Terminal and Factiva for the relevant days; those shocks determined as macro-related were dropped from the sample. 10 values were dropped due to probable macroeconomic factors; these occurred largely on dates following major (unconventional) monetary policy announcements. Idiosyncratic shocks were usually associated with specific banks making major bond purchases or settling regulatory fines. We then re-ran the regression models in eq. (11), (20), and (21), this time considering our narrative GIV on the truncated data sample. Table IA.M1 provides results and compares them to the original specifications; they remain largely unaffected, confirming the robustness of our instrument.

⁶⁵ That is, we remove dates when there were announcements from the Fed, the ECB, the Bank of England, the Swiss National Bank, and the Bank of Japan, for those currency pairs which include the respective domestic currency.

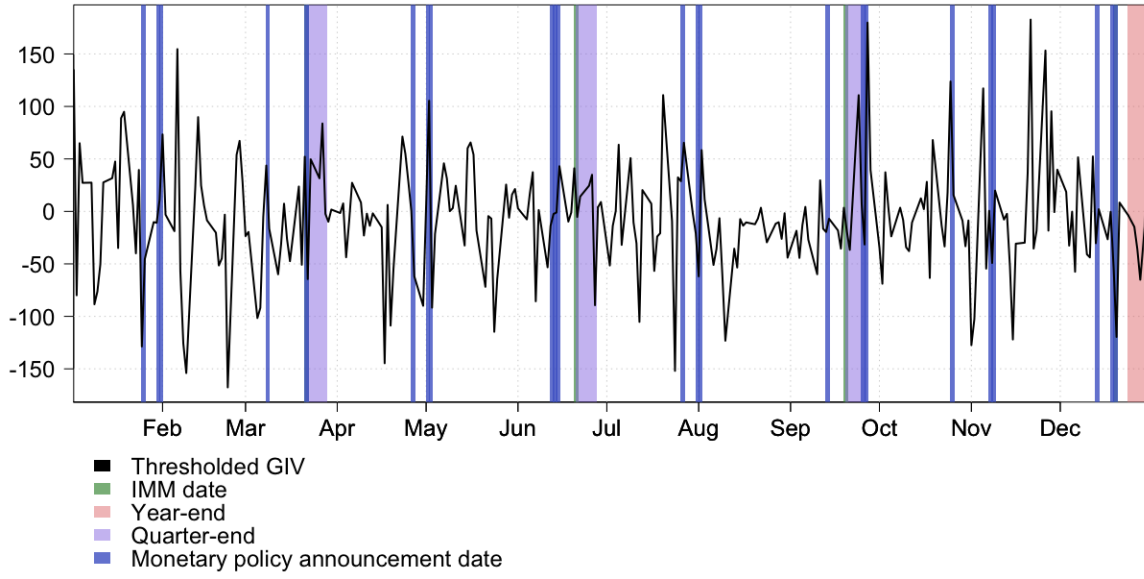


Fig. IA.M1: The figure plots non-U.S. agents' flow in EURUSD 1W, showing the influence of various significant dates for the 2018 calendar year.

	Full sample		Post-2015 period	
	Z^{preci}	Z^{equi}	Z^{preci}	Z^{equi}
Price sensitivity, original	0.52***	0.72**	0.78***	1.10**
Price sensitivity, threshold	0.82**	0.84*	1.10**	1.00*
Supply elasticity, original	4.01***	4.18***	2.99***	3.18***
Supply elasticity, threshold	3.96**	7.00*	3.39**	6.33*
Demand elasticity, original	-0.95**	-0.20**	-0.69**	-0.15**
Demand elasticity, threshold	-0.07	-0.16	-0.05	-0.13

Table IA.M1: Narrative GIV results compared to baseline.

Appendix IA.N

	Covered interest rate parity deviations (annualized bps)						
	G-SIBs					Non-G-SIBs	Non-banks
	EZ	CH	JP	U.K.	CN	Non-U.S.	Non-U.S.
<i>Baseline</i>	27.1 (-)	25.9 (-)	48.7 (-)	26.6 (-)	27.3 (-)	27.7 (-)	26.4 (-)
<i>NonUS</i>	3.1 (5.3)	3.6 (7.2)	4.0 (4.5)	6.7 (3.1)	5.2 (3.8)	5.3 (4.9)	-4.0 (4.7)
Q^{end}	53.1*** (13.1)	51.0*** (13.4)	48.7*** (13.0)	51.9*** (15.5)	53.3*** (13.3)	53.6*** (13.8)	52.8*** (13.1)
$Q^{end} \times NonUS$	4.3 (8.8)	17.5 (11.0)	35.9 (12.0)	4.4* (17.7)	44.2* (24.7)	8.6 (9.6)	-15.2 (9.8)
<i>Controls</i>							
$Q^{end} \times Y^{end}$	65.1** (12.6)	65.6** (12.6)	-44.2** (12.6)	65.1 (21.1)	65.3** (12.6)	65.2** (12.5)	65.2** (12.5)
$Q^{end} \times Y^{end} \times NonUS$	18.4 (17.0)	61.1 (22.5)	48.6** (28.0)	38.7 (53.2)	44.1 (53.8)	-25.2* (14.0)	-35.1 (21.0)
CurrPair-Tenor FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	43,257	38,378	32,175	40,692	32,175	85,517	37,767
Adj. R ²	0.10	0.10	0.20	0.10	0.10	0.05	0.10

Table IA.N1: The specifications are panel regressions over the G7 currency pairs and short-term tenors (i.e. TN to 1M), with currency pair-tenor fixed effects. Standard errors are also clustered by currency pair-tenor and day. The baseline is the average fixed effect retrieved from the panel regression. *NonUS* is a dummy variable equal to unity if the transaction price occurred between a U.S. G-SIB and a non-U.S. party (specified in the column name) and equal to 0 if the two parties were both American G-SIBs. Q_t^{end} (Y_t^{end}) is a dummy indicating a quarter-end (year-end). The sample is 2011 to 2021. ***, ** and * indicate significance at the 1%, 5%, and 10% significance levels respectively.

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