Hunting for Dollars*

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Abstract

We study how financial intermediaries obtain US dollars from wholesale and synthetic funding markets, uncovering three key findings. First, non-US banks substitute funding from US repurchase agreements (repo) with FX swaps at quarter-ends. Second, this behavior arises from regulatory shadow costs which affect repos but not synthetic funding. Third, non-US institutions' inelastic demand for dollars drives up the cross-currency basis. Eurozone banks predominantly engage in this substitution, with US dealers benefiting while the costs are borne by end customers. Our study highlights how unintended regulatory effects impact interconnected money markets, driving quarter-end surges in synthetic dollar borrowing and no-arbitrage violations.

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

JEL classification: F31, G12, G15

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1. Introduction

As the world's reserve currency, the US dollar is essential to both the operations of global financial institutions and the broader real economy. Its steady availability and efficient distribution to non-US actors are vital for maintaining financial stability. Yet, in recent years, no-arbitrage principles have frequently broken down so as to imply a persistent scarcity premium for dollar funding. This phenomenon raises critical questions: what limits the seamless provision of dollar liquidity across money markets? Are the unintended consequences of banking regulation responsible, and if so, through which mechanisms do they affect these markets?

To address these questions, we examine how financial intermediaries obtain US dollars from two primary sources: US wholesale funding markets and FX swaps. Our analysis uncovers three key mechanisms. First, non-US banks systematically shift a substantial portion of dollar funding from repurchase agreements (repos) to synthetic funding via FX swaps at quarter-ends. Second, this substitution arises from regulatory shadow costs that burden wholesale borrowing while leaving synthetic funding largely unaffected. Third, we provide empirical evidence of an inelastic demand for FX swaps by non-US banks, which are willing to pay a higher cross-currency basis to avoid the shadow costs of repo borrowing. Eurozone banks, in particular, engage in repo-FX swap substitution, with the benefits accruing primarily to US dealers, while the costs are passed on to end customers. By uncovering these mechanisms, our paper highlights how frictions in wholesale funding markets spill over to currency markets, driving systematic surges in synthetic dollar borrowing and persistent deviations from the Covered Interest Parity (CIP) condition at quarter-ends.

We structure our analysis in three parts. First, we map global dollar funding by analyzing novel and granular data on institutions' activity across money markets. We access a bespoke dataset from Continuous Linked Settlement (CLS), classifying 4,169 banking entities and their customers by the *nationality* of their ultimate parent (following the 'home' rather than 'host'

principle).[1] This approach 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 often concentrated in major financial centers such as London.[2] We pair this new dataset with bank-level observations from US and European repo markets. Mapping the global FX swap market network reveals that both US and non-US G-SIBs provide dollar funding to their customers. Crucially, however, US G-SIBs act as the primary source of dollar liquidity, even for non-US G-SIBs, which reallocate these funds to other market participants.

Second, the Basel III regulatory framework imposes differing shadow costs depending on which of the two primary instruments is used to obtain dollar liquidity. Dollar funding via repos entails significantly higher regulatory costs compared to FX swaps, which can provide dollar funding without significantly expanding the balance sheet. While both instruments serve the same economic function of providing dollar liquidity, they have markedly different impacts on a bank's leverage ratio (LR). As a risk-unweighted capital adequacy measure, the LR imposes significant constraints and opportunity costs on banks. 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 dynamic particularly impacts non-US institutions which must access dollar funding through repo; US banks can instead rely on their domestic deposit base or drain their central bank reserves.

We identify this substitution effect by leveraging another key artifact of Basel III regulation. Most jurisdictions mandate that banks report their regulatory ratios as they stand at the end of the quarter, incentivizing certain banks—especially the Eurozone—to 'window-dress' their quarter-end financials and present a safer picture to regulators. As a result, on reporting dates, Eurozone banks dramatically reduce their USD repo borrowing and correspondingly increase syn-

[1] For example, an FX swap traded by J.P. Morgan in London identifies the party as a US Global Systemically Important Bank (G-SIB).

[2] We sort market participants into six regions: the US, the Eurozone, the UK, Switzerland, Japan, and a residual group combining all other nationalities (ROW). We further observe non-banks in CLS, allowing us to distinguish between G-SIBs, regular banks, and non-banks, resulting in 18 distinct agent types.

thetic funding, with the economic magnitude of this substitution reaching approximately $50 billion. By contrast, banks in the UK and US calculate their LRs using an average of daily values throughout the quarter and lack the incentive to engage in quarter-end repo-FX swap substitution. We therefore identify the motivation for substitution through a difference-in-differences analysis demonstrating that only banks with a regulatory incentive engage in this practice.

Finally, we address the question of whether the substitutability of wholesale and synthetic dollar funding uncovered in our study has pricing implications. To this end, we provide a simple analytical framework that connects the regulatory costs of US dollar funding to the CIP principle. This shows that for a bank to remain indifferent between funding sources, the price of synthetic dollar borrowing (via FX swaps) must equal the effective cost of its alternative: short-term funding in US wholesale money markets. In our setting, regulatory constraints act as shadow costs layered on top of interest rates. When a non-US bank pledges readily available domestic currency liquidity and swaps it for dollars, almost no additional regulatory costs are incurred since the balance sheet size remains unchanged. In contrast, borrowing USD via repos in US wholesale markets triggers the full Basel III LR penalty. Constrained banks are therefore willing to accept a higher cross-currency basis to mitigate the LR penalty, provided the cost remains lower than the additional shadow cost of borrowing in US money markets. As a result, the market-wide cross-currency basis will adjust to reflect the increased shadow costs of borrowing US dollars relative to domestic currency. These dynamics were likely exacerbated by the 2016 US Money Market Reform, which required US money market funds (MMFs) to shift from primarily unsecured lending to predominantly secured lending. For banks borrowing from money market funds, sourcing collateral and holding it on their balance sheets incurs additional shadow costs. We corroborate our hypothesis by showing a strong correlation between CIP deviations and two proxies for US wholesale shadow costs: Eurozone G-SIB withdrawals from repo markets, and the share of US MMF lending conducted through secured means. The cross-currency basis can be evaluated through the lens of the Funding Valuation Adjustments (FVA) associated with synthetic dollar funding, which impose smaller shadow costs than an equivalent position in US money markets

(Andersen, Duffie, and Song, 2019). The large shadow costs of wholesale dollar funding represent severe intermediation frictions, as described in Gabaix and Maggiori (2015). A key insight of our paper is that the LR, by penalizing the repo borrowing essential for *non-US* institutions to raise USD funding, imposes significant regulatory costs on their access to crucial dollar liquidity.

We empirically validate our framework's implication that non-US banks possess inelastic demand for the dollar. We use a granular instrumental variables (GIV) approach (Gabaix and Koijen, 2024) to confirm our hypothesis: a 1% increase in the basis results in only a 0.71% reduction in demand. Our results further suggest that demand shocks to non-US institutions impact the cross-currency basis. Furthermore, to shed light on the dollar's borrowing costs (and the profits earned from supplying it), we obtain data on settled FX swap trades, revealing the swap points paid by various institutions and nationalities. Non-bank customers emerge as the single largest payers of the cross-currency basis, while G-SIB banks profit by providing USD liquidity on the other side of these trades. Among globally active dealers, US G-SIBs generate the highest net income from cross-currency basis trading, consistent with their ease in supplying US dollar funding. At the quarter-end, the effective cost of obtaining the US dollar via FX swaps increases for all market participants. According to our estimates, non-US G-SIB banks incur large basis payments of up to $6.5 billion annually for short-term dollar funding at the quarter-end turn. However, most of these costs are ultimately passed on to end-customers, such as non-banks. For example, while dollar borrowing costs are to the order of $2.2 bn for Eurozone banks, this is offset by $2.5 bn in dollar lending. Thus, while gross basis payments for USD borrowing at quarter-end rise considerably, global banks minimize the total net losses, ensuring that their intermediation business across all G7 currencies and tenors remains profitable. These dynamics are even larger in long-term swaps, which are all intrinsically impacted by regulation: non-US G-SIBs pay $43 bn annually in long-term dollar borrowing costs. Non-bank customers are left paying costs of $6.6 bn annually. Overall, these findings support our hypothesis that the basis reflects (regulatory) shadow costs, which intensify at quarter-ends. Furthermore, they demonstrate that FX swap intermediation costs driven by banking regulations are largely passed on to end-customers.

While the extant literature has conclusively linked Basel III banking regulation with the breakdown of CIP (Du, Tepper, and Verdelhan (2018); Cenedese, Della Corte, and Wang (2021)), several important questions remain unresolved: if regulation penalizes balance sheet space, why is it that global FX swap positions *surge* to the tune of $200 bn at the quarter-end, as demonstrated in Kloks, Mattille, and Ranaldo (2023) and further substantiated in our analysis? Why is FX swap pricing consistently distorted during such periods, even though these instruments are largely exempt from the crucial LR regulation? And why does the cost of *US dollar* funding, rather than euro funding, spike during such episodes, when it is *European* banks that are constrained by quarter-end regulation?

Our work cohesively resolves these questions and makes significant contributions to two main strands of the literature. First, it adds to the large literature that studies how financial frictions impact market functionality, and in particular how intermediaries' constraints impact various OTC markets (Duffie (2017), Fleckenstein and Longstaff (2020), Du, Hébert, and Huber (2023)). We focus on regulatory frictions and how non-US institutions' holding of USD assets and hedging demand causes global imbalances (Liao and Zhang (2022), Bräuer and Hau (2022), Du, Hébert, and Li (2023), Du and Huber (2024)). We also add to the discussion of how economic outcomes such as cross-currency lending and international capital flows are linked to the basis (Becker, Schmeling, and Schrimpf (2023), Kubitza, Sigaux, and Vandeweyer (2024), Ben Zeev and Nathan (2024)).

We further contribute to the literature on CIP deviations, which, prior to the financial crisis, were attributed to frictions such as counterparty risk and funding shortages (Baba, Packer, and Nagano (2008), Mancini-Griffoli and Ranaldo (2013)). Post-crisis deviations have primarily been explained by intermediary constraints stemming from tighter bank balance sheet requirements (Ivashina, Scharfstein, and Stein (2015), Abbassi and Bräuning (2020), Krohn and Sushko (2022)). Rime, Schrimpf, and Syrstad (2022) show that low-credit quality banks, struggling to obtain USD funding, shift from wholesale to synthetic borrowing, where the dollar is supplied by high-credit quality banks. 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, Du, and Liao (2022) use data on US banks to study how their supply responds to potential arbitrage opportunities over balance sheet reporting periods; by contrast, we use our globally representative data to study the behavior of non-US banks. Our paper is also related to Wallen (2022), who documents evi dence of US banks' market power in the pricing of the synthetic dollar rate when European banks reduce their supply, lowering competition. Finally, Khetan (2024) studies how concentration limits cap Euro-area banks' access to American money markets, driving them toward synthetic funding. In contrast, the dynamics we study occur as Eurozone banks dramatically *reduce* their USD money market borrowing, driving the sizable quarter-end dislocations that are the salient feature of post-crisis CIP deviations.

Our paper offers several key innovations: first, it explains how LR regulation affects the cross-currency basis when FX swaps are ostensibly largely exempt from it (Borio, Iqbal, McCauley, McGuire, and Sushko (2018), BCBS (2014)). Second, it demonstrates that non-US institutions accessing USD through secured means in wholesale markets face penalties under the regulatory framework. Third, it identifies substitution between repo and FX swap markets and provides a framework explaining how frictions in wholesale funding spill over into FX markets. Fourth, it offers evidence of inelastic demand for FX swaps among non-US financial institutions, and shows why such demand surges at quarter-ends. Finally, it quantifies realized CIP net revenues resulting from FX swap portfolio positions across banks by the nationality of their ultimate parent.

2. Wholesale and Synthetic Funding: Conceptual Framework

This section outlines the regulatory landscape and pricing implications of US dollar funding, laying the groundwork for the hypotheses tested in the subsequent sections.

2.1. Regulatory landscape

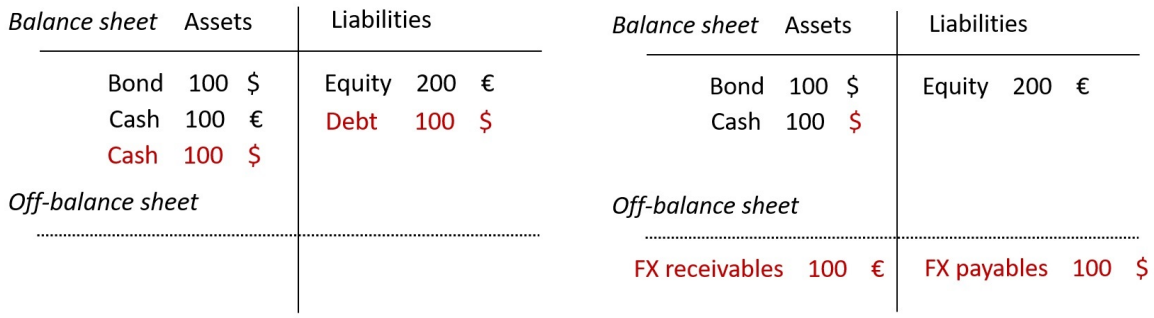
The first hypothesis we develop is that financial regulation incentivizes some non-US financial institutions to substitute US dollar funding sourced from repos with synthetic dollar funding through FX swaps. Two mechanisms are at play. First, following the implementation of Basel III, banks must report their LR, which is a risk-*unweighted* capital adequacy measure that particularly penalizes activities which expand the balance sheet - such as repo borrowing - with the result that balance sheet space incurs a higher opportunity cost. 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 other banks, such as UK and US banks, calculate it using the average of the quarter's daily values. These different regulatory treatments have significant unintended effects for the regulation of financial institutions. For one, they encourage Eurozone banks to consistently 'window dress' their quarterly reports, presenting a more favorable financial position to regulators than is accurate.[3]

A second artifact of banking regulation is its heterogeneous treatment *across financial instruments* which may ostensibly serve the same function. Consider the two primary methods for sourcing US dollar funding. The first is to directly borrow liquidity in US money markets via repo, while the second is to borrow US dollar synthetically via the FX swap market by converting foreign currency liquidity, such as the euro, into USD. While economically similar, these two transactions have very different outcomes for a bank's Basel III LR if non-USD cash is readily available. Regulation mandates that banks shall maintain a ratio of Tier 1 Capital to the Exposure Measure at a minimum threshold θ, with $\theta = 3\%$ for Eurozone banks at the group level:

$$\text{LR} = \frac{\text{Tier 1 Capital}}{\text{Total Exposure}} \geqslant \theta \tag{1}$$

[3] In response to the window-dressing issues discussed in this paper, the Basel Committee on Banking Supervision has issued new guidance requesting that, as of January 2022 and for the purposes of Pillar 3 disclosure requirements, internationally active banks active 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 is Common Equity Tier 1 (CET1) plus Additional Tier 1 (AT1) instruments, and Total Exposure means on-balance sheet exposures, derivative and SFT exposures, and, crucially, certain off-balance sheet items. Consider the simplified T-accounts in Figure (1) which depict the evolution of a bank's stylized balance sheet and its LR. A bank may raise short-term USD funding either with a repo as in panel (a), or through an FX swap in panel (b). The bank, say a globally active Eurozone bank, holds local currency worth 100 euro and a US Treasury bond worth 100 USD.[4] It holds no debt such that its assets equal its net equity (200 USD, assuming a 1:1 exchange rate). With Tier 1 Capital of 200 and Total Exposure of 200, the LR is 1.0. Suppose that this bank wishes to source USD by conducting a repo in US money markets. This expands the balance sheet, as a new position is created for the repo cash it has borrowed, matched by a liability denoting the future repayment obligation. Upon receiving the cash, the bank simultaneously lends out the collateral (e.g., a US Treasury), which remains on its balance sheet despite the exchange.[5] While Tier 1 Capital remains unchanged, the Total Exposure measure increases to 300, resulting in a decrease of the LR from 1 to 0.67.



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

(b) After FX swap: LR = 200/(200 + 0.01·100) = 0.995.

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

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

[5] See e.g. Ranaldo, Schaffner, and Vasios (2021) for the balance sheet implications of repo contracts.

Consider now the alternative of sourcing US dollar synthetically through an FX swap. Unlike a repo, FX swaps are an off-balance sheet instrument, and as such contribute to the LR through the "add-on factor" for potential future exposure; this means that 1% of FX swap positions counts towards the exposure calculation (Borio et al. (2018), BCBS (2014)).[6] Panel (b) of Figure (1) demonstrates how this impacts the balance sheet. The near leg of the FX swap simply converts the currency composition of the euro liquidity to USD. The far leg of the FX swap increases both assets and liabilities,[7] 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 at 0.995.[8]

Note that it is the secured nature of repo contracts which creates additional costs relative to unsecured borrowing; repo is balance-sheet intensive, and as such is disproportionately penalized by the LR. Unless collateral is readily available, borrowing 100 USD through repo requires an additional 200 USD of balance sheet space, versus 100 USD through unsecured means, as both collateral and cash remain on the balance sheet. With this in mind, the 2016 US MMF reform takes on added importance. The reform led to a significant reallocation of assets under management in US money markets, shifting them from prime funds to government funds.[9] This fundamentally

[6] Instead, FX swaps merely change the composition of banks' on-balance sheet assets. Borio, McCauley, and McGuire (2020) write that when an "agent enters into an FX swap, using another currency as collateral, the new currency simply replaces the old one on the asset side of the balance sheet: the size of the balance sheet does not change… the debt remains 'hidden.'"

[7] We focus solely on the impact of FX swaps' and repos' *notional* amounts on the balance sheet. FX swaps' marked-to-market value will be included in the P&L and thus impact the balance sheet through retained earnings. Borio, McCauley, and McGuire (2017) estimate that the marked-to-market value of FX forwards averages about 3% of the notional amount. These start at zero at contract initiation and vary afterwards relative to the current spot rate.

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

[9] Prime funds invest in public-sector securities, commercial paper, and certificates of deposit issued particularly by the private sector and non-US issuers. Government funds on the other hand invest in debt, including repo. Before the reform, both operated on a constant net asset value (CNAV) model, which caused adverse selection issues during crises. Instigated by the SEC, the reform entered into force on October 10, 2016 and obliged private funds to instead adopt a floating net asset value (VNAV) model, leading to a large reallocation from private to government funds.

changed USD borrowing, transitioning it from a primarily unsecured to a predominantly secured basis, significantly impacting non-US banks (see Choulet (2018), Anderson, Du, and Schlusche (2021), Aldasoro, Ehlers, and Eren (2022)). The reform thus effectively requires banks to keep sufficient appropriate collateral (e.g. US Treasuries) on their balance sheets if they wish to fund themselves through US MMFs. This is constraining, given a regulatory framework that imposes costs on balance sheet space (Duffie, 2022). Indeed, Munyan (2017) presents evidence that banks reduce their Treasury holdings at quarter-ends as they scale down their balance sheets.

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 US and domestic wholesale markets. At the quarter-end, a widespread rise in the effective US repo borrowing cost transmits to a higher basis, consistent with the additional demand for FX swaps being inelastic.

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:

$$(1 + i^{y}_{t,t+n}) = (1 + i^{x}_{t,t+n}) \cdot \left(\frac{F^{x|y}_{t,t+n}}{S^{x|y}_{t}} \right) \tag{2}$$

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 $i^{x}_{t,t+n}$ and $i^{y}_{t,t+n}$ represent the interest earned in the base and quote currencies respectively.[10] We refer to deviations from CIP as the

[10] 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.

cross-currency basis;[11] if substantial enough, such deviations represent an arbitrage opportunity. We thus have:

$$\chi^{x|y}_{t,t+n} = \left(\frac{F^{x|y}_{t,t+n}}{S^{x|y}_{t}} \right) \cdot (1 + i^{x}_{t,t+n}) - (1 + i^{y}_{t,t+n}) \tag{3}$$

The CIP condition held well empirically before the 2008 financial crisis (Akram, Rime, and Sarno, 2008), but it broke down during the recession, with deviations persisting ever since. This fundamental change has been largely 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). In the remainder of this section, we argue that the observed rise in the basis is in fact consistent with no-arbitrage if one takes into account the increase in shadow cost of US repo borrowing. Thus, intermediary constraints emerge in wholesale funding markets, but spill over to synthetic dollar funding markets.

We illustrate such an effect by augmenting the CIP no-arbitrage principle with shadow costs. Setting $y = \$$ in eq. (2) states that the cost of borrowing in US money markets (l.h.s.) must equal the cost of raising domestic currency and swapping it into USD (r.h.s.). Expressed as such, the CIP principle is an expression of the law of one price (Rime et al., 2022). We then incorporate various shadow costs C associated with wholesale funding.[12] We thus obtain:

$$\underbrace{(1 + i^{\$}_{t,t+n} + C^{\$}_{t,t+n})}_{\text{Cost of USD funding}} = \underbrace{(1 + i^{x}_{t,t+n} + C^{x}_{t,t+n})}_{\text{Cost of domestic funding}} \cdot \underbrace{\left(\frac{F^{x|\$}_{t,t+n}}{S^{x|\$}_{t}} \right)}_{\text{Cost of FX swap}} \tag{4}$$

Re-arranging the above in log-terms yields:

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

[12] There may also be a shadow cost to using an FX swap instrument; however, given that only 1% of these instruments enter the LR calculation, we simplify this cost to zero.

$$\underbrace{\left(i^{*,\$}_{t,t+n} - i^{*,x}_{t,t+n}\right)}_{\text{i-rate differential}} + \underbrace{\left(c^{\$}_{t,t+n} - c^{x}_{t,t+n}\right)}_{\text{shadow cost differential}} = \underbrace{\left(f^{x|\$}_{t,t+n} - s^{x|\$}_{t}\right)}_{\text{forward premium}} \tag{5}$$

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 US money markets and that of raising domestic funding:

$$\chi^{*,x|\$}_{t,t+n} = c^{\$}_{t,t+n} - c^{x}_{t,t+n} \tag{6}$$

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 dynamics we observe at the quarter-end. On the one hand, the shadow cost of US MMF borrowing $c^{\$}_{t,t+n}$ rises for those non-US banks reporting a snapshot of their supervisory ratios due to the mechanism described in section 2.1. Moreover, borrowing in the US repo market requires eligible collateral, which may further add to shadow costs;[13] these costs likely increased post-2016 as the US MMF reform of that year converted wholesale funding to a collateralized standard.[14] On the other hand, non-USD borrowing can be readily conducted in non-US agents' domestic currency. For example, raising e.g. euro liquidity has been particularly easy during our sample period due to the ECB's unconventional monetary policy, which has resulted in high levels of central bank reserves, excess liquidity, and an enlarged domestic deposit base (Rime et al. (2022)). Moreover, even if Eurozone banks turn to the European repo market to raise funding, they benefit from more favorable netting opportunities as well as the ECB's accommodating collateral policy (Corradin,

[13] Repo borrowing requires maintaining an inventory of eligible collateral, which may be difficult to source during times of Treasury scarcity. Data from the European Banking Authority's biannual Transparency Exercise reveals that Eurozone banks hold, on average, 161 bn USD of US Treasuries while at the same time borrowed 96 bn USD worth of Treasury-backed repo. Thus, banks do not necessarily hold more Treasuries than what is required to pledge in repo. See also Georgievska (2022) on how costly collateralization contributes to CIP violations.

[14] The 2016 US MMF reform furthermore reduced the scope of non-US banks to obtain unsecured dollar funding. The resulting shift to secured borrowing means that non-US institutions must perform repo borrowing to obtain USD funding, which is both balance sheet-intensive and requires prior ownership of collateral securities.

Heider, and Hoerova, 2017).[15]

While this is naturally a simplified framework that abstracts from other factors which can explain variation in the basis, the mechanism described above provides intuitive insights. First, it highlights that the rise in the price of synthetic dollar funding, namely the cross-currency basis, reflects the increased regulatory cost of borrowing its substitute, wholesale funding. The intuition is that the law of one price implies that synthetic and wholesale dollar funding, being economically identical, must have the same effective price. When the average implicit cost of wholesale funding rises, the price of synthetic dollar funding adjusts to reflect this shift. Second, our framework suggests that it is the *differential* between the shadow costs of sourcing USD relative to domestic currency which impacts the basis. Third, when choosing their source of dollar funding, each individual agent in the market efficiently compares its own individual shadow costs relative to the market price for synthetic funding. The differential in shadow costs between direct and synthetic funding sources creates an upper bound on the market-wide cross-currency basis ($\bar{\chi}$) that each agent j is willing to pay to borrow in the FX swap market. The decision rule governing whether to substitute can be described as:

$$\text{Bank } j\text{'s funding choice} = \begin{cases} \text{Wholesale}, & \text{if } \bar{\chi}^{*,x|\$}_{t,t+n} \geqslant c^{j,\$}_{t,t+n} - c^{j,x}_{t,t+n}, \\ \text{Synthetic}, & \text{otherwise.} \end{cases} \tag{7}$$

In conclusion, we propose a framework linking the cross-currency basis to the shadow cost differential between USD and domestic wholesale funding sources. Understanding the post-2015 landscape requires taking agents' funding shadow costs into account when considering this relationship. Quarter-end spikes in the cross-currency basis reflect that regulation disproportionately penalizes secured USD borrowing in US money markets (relative to domestic currency) for some of the largest market participants such as Eurozone banks. Those banks which find the cost of synthetic funding cheaper than the penalty from wholesale shadow costs accordingly substitute

[15] The quality of the euro repo market is discussed in Mancini, Ranaldo, and Wrampelmeyer (2016).

to FX markets. In a broader sense, the larger shadow costs of wholesale relative to synthetic dollar borrowing are severe frictions which are priced into equilibrium by intermediaries (Gabaix and Maggiori, 2015). Eurozone banks opting for synthetic dollar funding can also be interpreted as an attempt to minimize FVA, ensuring dollar funding at quarter-ends (Andersen et al., 2019).

3. Mapping the Market for USD Funding

This paper sheds light on the global US dollar funding chain through the lens of its two crucial segments: FX swap and repo markets. For FX swaps, we source novel settlement data to map banks' synthetic funding positions globally, comprising volumes and prices. We then compare and contrast this data with banks' positioning in repo money markets.

3.1. Data on the global FX swap market

With their sheer size of around US$ 3.8 trillion of global daily turnover (BIS, 2022), FX swaps represent the largest market in the world. However, obtaining representative 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 where or on what platform (if any) they were executed.[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 global systemically

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

[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.

important banks (G-SIBs), regular banks, or non-banks. This allows us in particular to study the role of the large dealers which dominate the FX market; Appendix IA.A lists the G-SIB banks in our data.[18] Second, we manually classify 4,169 banking entities in our data set based on the *nationality* of participants' ultimate parent (i.e. the 'home' as opposed to the 'host' principle), divided into six regions: the US, the Eurozone, the UK, Switzerland, Japan, and the rest of the world (ROW).[19] To give an example, J.P. Morgan's London branch is classified as a US firm rather than as a UK firm (and is further denoted as a G-SIB). Additionally, we classify non-bank customers per geography.[20] 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 banking nationality shares classified by location 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 US banks, which account for 47% of the market, whereas only 19% of their trading occurs within the US itself. Eurozone and UK G-SIBs are the other major banking sectors, with 23% and 16% market share, respectively. To the best of our knowledge, 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 from

[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 (G-SIBs) published annually by the Financial Stability Board (FSB) in consultation with the Basel Committee on Banking Supervision (BCBS) and national authorities.

[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 intra-sectoral flows cannot have a direction by definition).

[21] Kloks, McGuire, Ranaldo, and Sushko (2023) use this data to analyze how banks' FX swap positions compare with their balance sheet currency mismatches.

September 3rd, 2012 to June 30th, 2022 and is available at daily frequency. It covers 40 currency pairs (including 17 USD pairs) and 8 tenors[22] and captures at least 30% of the FX market according to BIS estimates.[23] Table (IA.B1) provides further summary statistics.

Fig. (2) visualizes the global market for US 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-SIB banks and customers, with the latter group including both regular banks and non-banks. We consider the net US dollar position between agents in *domestic* currency pairs.[25] Several key insights emerge. First, the market is dominated by G-SIB banks, with US 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, US 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. (2) as a share of the underlying volume.

Fig. (3) supports our narrative and provides initial evidence of regulatory-driven demand effects. It is 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 $<= t$ and its far-leg settlement date is $> t$.[26] Thus, the swap volumes appearing on date t are those volumes which would be shown on a bank's balance

[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 (2023).

[24] The arrows represent the direction of the US 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 UK 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.

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

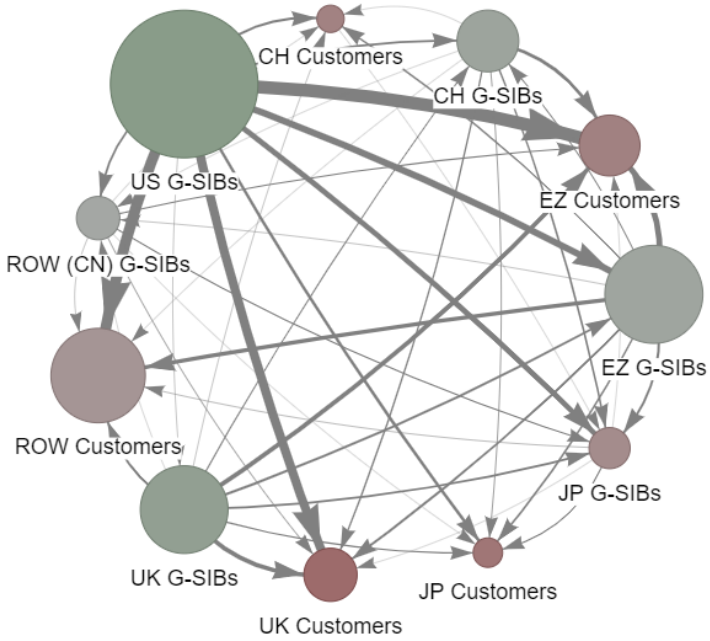


Fig. 2: The edges of the network show absolute net US dollar positions in participants' domestic currency pairs. The nodes' colors represent the extent to which they are an overall dollar lender (green) or borrower (red) in their domestic currency pairs. Size of the nodes is determined by participants' trading volume in all dollar pairs. Data is daily average positions and volumes for the 2012-2022 period.

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 US$ 200 billion worth of FX swap trades is conducted on average. 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.[28] Appendix IA.D formalizes our findings in a regression setting.

Finally, we complement our data on synthetic funding volumes with observations of FX swap

[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.

[28] When considering all tenors, we observe a remarkable drop in volume several days before the quarter-end; this occurs during the IMM dates when many swaps expire; see Appendix C for details.

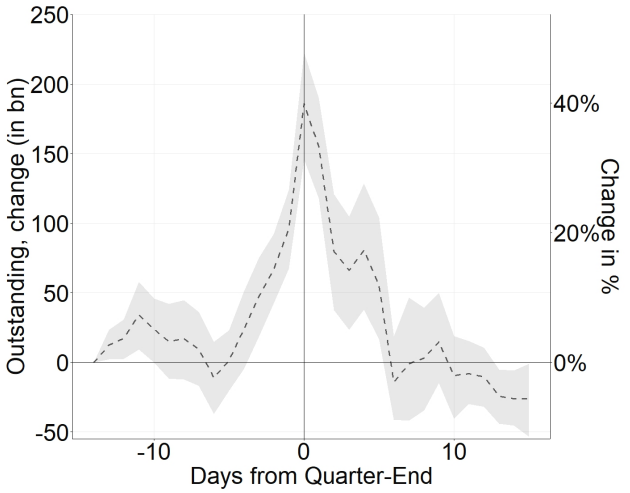


Fig. 3: Regulatory quarter-ends serve as the basis of the event study. Year-ends are not included. Short-term maturities means tenors between spot-next to 1W. All volumes are in USD. Dotted lines represent the 95% confidence interval with bootstrapped standard errors. The r.h.s. axis expresses values of the l.h.s. axis as a percentage of the sample's mean value.

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 FX swap prices are quoted and exchanged. The implied rates of the near (S) and far (F) legs of each FX swap contract were manually and carefully matched. Then, daily volume-weighted average prices were calculated for each currency pair, tenor, party and counterparty. Appendix D shows the actual prices charged by US banks based on 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 the traded CLS rates with daily overnight interest rate swap (OIS) and LIBOR interest rates from Bloomberg. Due to data limitations, interest rate data is often only available for the G7 currency pairs in a historically reliable time series. Where needed, currency conversions to the US dollar are performed using Olsen spot exchange rates. Finally, for a comparison to CLS rates, we obtain Bloomberg data on swap points.

3.2. Data on US and European repo markets

We source data on US wholesale funding from reports on MMF portfolio holdings, i.e. US 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-US banks, obtain US dollars from MMFs, who are the largest primary cash lenders in this market. The data set includes outstanding repo volumes for US and non-US banks at an individual entity level and is available as a snapshot at each month-end from 2012 onwards.[29] We further obtain data on Eurozone banks' activity in euro markets from BrokerTec, the largest repo electronic exchange in Europe.[30] Our data allows us to obtain a representative, even if imperfect, picture of Eurozone banks' trading activity in their home repo markets.[31]

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 FX swaps avoid hindering banks' regulatory ratios. Here, we empirically demonstrate how and why constrained banks substitute away from repo instruments to FX swaps when sourcing US dollar funding.

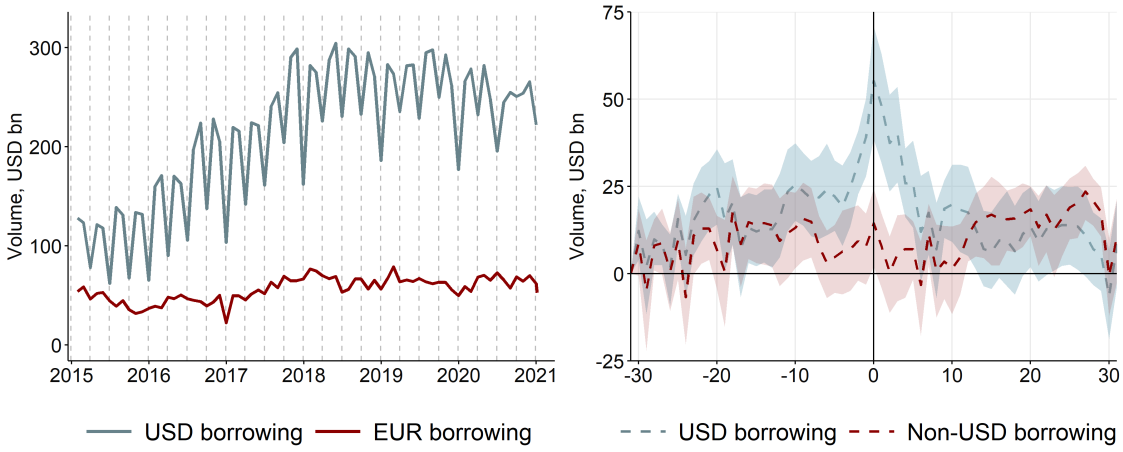
[29] US MMF borrowing is a sub-segment of the GCF repo market studied in Egelholf, Martin, and Zinsmeister (2017), who observe similar window-dressing dynamics as we do.

[30] Note that the European market structure is different relative to the tri-party US repo market. Our European repo data come from the central (clearing) counterparty (CCP) based interbank market, which is the dominant segment in Europe.

[31] Two other electronic trading platforms are prominent in Europe, namely Eurex Repo and MTS. Only MTS, which is primarily the market for Italian repos, is comparable in size to BrokerTec, but market participant identifiers are not available in MTS. Regardless, Italian banks do not play a large role in the global US dollar funding markets in comparison to either Eurozone or UK banks.

4.1. Empirical evidence of substitution

We begin by presenting visual evidence supporting the substitution hypothesis. Panel (a) of Figure (4) shows Eurozone G-SIBs' gross repo borrowing of USD (in blue) from US MMFs and euro borrowing (in red) in domestic money markets. It is clearly discernible that Eurozone banks systematically reduce their dollar borrowing in the US repo market by an order of magnitude of 50 billion USD during quarter-ends (denoted by dotted vertical lines). Euro repo borrowing remains relatively constant in comparison.[32]



(a) Repo (b) FX swaps

Fig. 4: This figure shows the behavior of Eurozone G-SIBs in repo (l.h.s.) and FX swap (r.h.s.) markets. In panel (a), we see that Eurozone G-SIBs dramatically window-dress their US dollar borrowing, while non-USD borrowing remains relatively unchanged. In panel (b), we conduct an event study around quarter-ends (excluding year-ends) and see that USD swap borrowing surges, while euro borrowing remains unchanged. The time period runs from January 2015 to December 2020.

Panel (b) of Figure (4) essentially presents the mirror image of Panel (a). Specifically, it shows the FX swap patterns from an event study spanning 31 days before and after the quarter-end for Eurozone banks (as a quarter spans 62 business days). We analyze the purchases of USD and euro

[32] CCP-based Euro repo can be window-dressed through netting, or through the fact that reverse repo is exempt.

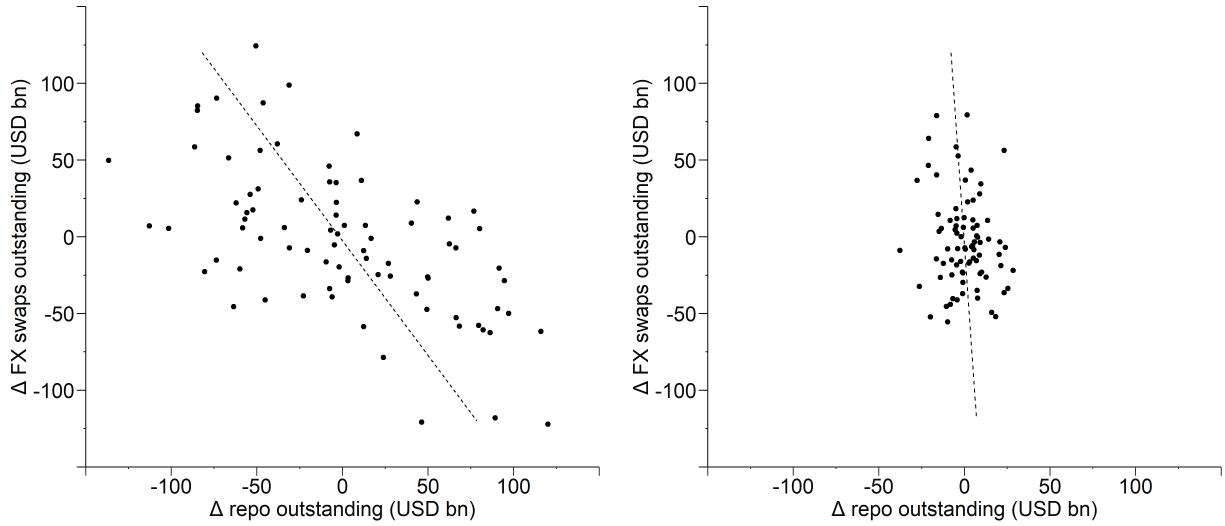
separately across all currency pairs. Bootstrapped standard errors are depicted as a shaded area around the point estimates. The figure clearly shows that Eurozone G-SIBs' dollar borrowing through FX swaps significantly increases by a magnitude similar to the drop observed in the US repo market, whereas their euro borrowing (via FX swaps) remains constant.

Overall, Figure (4) shows that Eurozone banks significantly withdraw from the US repo market at quarter-ends, while simultaneously increasing their FX borrowing of US dollars through FX swaps by approximately the same amount. Our findings shed new light on global dollar funding in two key respects. First, our data enable us to analyze both borrowing and lending volumes via FX swaps, whereas other work such as Wallen (2022) could observe only the total net positions. Our findings clearly show that Eurozone banks increase their borrowing of USD at quarter-ends while maintaining their dollar lending largely constant, challenging the notion that Eurozone banks withdraw from the FX swap market at quarter-ends. Second, our findings provide a deeper understanding of the mechanisms which characterize the US repo market at quarter-ends. While it has been widely documented that non-US banks substantially decrease their dollar funding in the US repo market (Munyan, 2017), our joint analysis of repo and FX swaps suggest that non-US banks *substitute* the lost dollar funding from the US repo market with FX swaps, which represent an attractive alternative for regulatory reasons.

4.2. Identification: heterogeneous regulatory reporting

To rule out the possibility that the repo-FX swap substitution described above is coincidental rather than regulatory-driven, we refine our identification strategy by comparing those G-SIB banking groups 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 UK and the US, are an exception. In the UK, 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 US has been based on daily averages since its inception. Figure (5) shows prima facie evidence that repo-FX swap substitution is an activity pursued by Eurozone G-SIBs (l.h.s.) but not their UK counterparts (r.h.s.). While a clear negative association is visible between (changes in) net USD FX swap positions and borrowing from US MMFs in US dollars for Eurozone banks (l.h.s.), this relationship applies less, if at all, to UK banks (r.h.s.).



(a) Eurozone G-SIB banks (b) UK G-SIB banks

Fig. 5: Repo-FX swap substitution. The figure displays monthly *changes* in Eurozone (l.h.s.) and UK (r.h.s.) net USD FX swap positions in all US dollar currency pairs vis-à-vis the monthly *change* in their borrowing from US MMFs. For both FX swaps and repos, values combine all maturities and are measured in bn of USD. The sample runs from January 2015 to September 2021.

We therefore 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.[33] Note that this approach is likely to lead to an under-

[33] Note that UK G-SIBs are classified as snapshot reporters for the duration of 2015, and thereafter are labelled as "averagers."

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. Further note that whether averaging was taken using daily values or monthly figures (as in the UK transition period) does not matter for our identification given our regression model, which is as follows:

$$\begin{aligned} Y_{i,t} = \beta_1 \cdot Q_t^{end} \; + \; \beta_2 \cdot Snapshot_i \; + \; \beta_3 \cdot Q_t^{end} \cdot Snapshot_i \; + \; \beta_4 \cdot Y_t^{end} \\ + \; \beta_5 \cdot Q_t^{end} \cdot Y_t^{end} \cdot Snapshot_i + \alpha_i + u_{i,t} \end{aligned} \tag{8}$$

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 the volume of US dollars borrowed in FX swap and repo markets (in logs). We further calculate the share of USD borrowing which occurs through FX swaps as opposed to repo as follows:

$$SwapShare_{i,t}^{\$} \coloneqq 100 \cdot \left(\frac{SwapBorrowing_{i,t}^{\$}}{SwapBorrowing_{i,t}^{\$} + RepoBorrowing_{i,t}^{\$}} \right) \tag{9}$$

Note that we are only considering the borrowing of US dollars in the dependent variable, be it in repo, FX swaps, or as a share.

The results in Table (1) provide support for our first hypothesis. When crossing the quarter-end, snapshot-reporting G-SIBs show a 14%[34] higher outstanding position in FX swap dollar borrowing than G-SIBs on an averaging scheme. In the US repo market, constrained bank volumes drop by 30% when crossing the regulatory period, as opposed to the control group. When considering FX swaps as a share of money market borrowing (i.e. swaps and repos combined), we see a statistically and economically significant surge of 7.3% relative to G-SIBs on an averaging scheme. Our results support the notion that the opposite dynamics observed in repo and FX swap markets

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

are driven by a common factor, namely, regulatory reporting. Note that this analysis, pooled over all G-SIB banking groups in our sample, hides a considerable amount of heterogeneity across jurisdictions, which we will clarify in the next section. The general picture that emerges, however, is that repo-FX swap substitution is driven by balance-sheet reporting concerns.

	Snapshot vs. daily average reporters		
	FX swap (logs)	Repo (logs)	Swap Share (%)
	(1)	(2)	(3)
Q^{end}	−0.014	−0.093	1.644
	(0.055)	(0.096)	(1.731)
Snapshot	−0.266***	−0.786***	9.864***
	(0.091)	(0.159)	(2.862)
Q^{end} : *Snapshot*	0.133**	−0.355***	7.310***
	(0.066)	(0.121)	(2.183)
Controls			
Q^{end} : Y^{end}	−0.515***	−0.025	−10.954***
	(0.096)	(0.168)	(3.028)
Q^{end} : Y^{end} : *Snapshot*	0.153	0.008	5.867
	(0.114)	(0.209)	(3.756)
Observations	492	411	411
Adj. R^2	0.910	0.834	0.813

Table 1: All models are panel regressions with banking nationality fixed effects. The dependent variable is the amount of US dollars borrowed by G-SIBs in FX swaps, in repo, and as a share as defined in eq. (9). "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 UK and the US). 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 dollars borrowed in CLS and repo volumes are amounts outstanding of USD borrowing from US MMFs (results are in logs). $***$, $**$ and $*$ indicate significance at the 1%, 5%, and 10% significance levels respectively.

4.3. Robustness analyses

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, such as the liquidity coverage ratio, the impact of netting in repo markets, and the role of clients in FX swap markets.

4.3.1. Breakdown by jurisdiction

We examine heterogeneity across banking jurisdictions by replicating the difference-in-differences analysis in equation (8) for each of the three major nationalities (the Eurozone, Switzerland, and Japan) reporting on a quarter-end snapshot basis separately.[35] Furthermore, we alternate between the UK and the US as the control group. Results are shown in Appendix IA.E. Repo-FX swap substitution is most pronounced for Eurozone and Swiss G-SIBs, while it is less evident for Japanese G-SIBs. Compared to UK banks, Eurozone banks accumulate a 17% larger position in FX swaps and a 12% lower position in US repo at the quarter-end in terms of USD borrowing on an outstanding basis. Moreover, they also increase the share of FX swap borrowing by 7.4% more relative to UK counterparts. In addition, further evidence for the substitution effect is evinced by the fact that those *same* nationalities which decrease their wholesale funding also increase their synthetic borrowing, as shown in Appendix E. That is, Eurozone and Swiss banks significantly decrease their repo borrowing and increase their FX swap borrowing, while other banks do neither (or relatively far less). Aldasoro et al. (2022) suggest that repo window-dressing is prevalent amongst European banks specifically because French banks in particular are large repo intermediaries. US banks supply that synthetic dollar funding, but interestingly do not do so through increased US MMF borrowing, which fits well with the findings of Correa et al. (2022), who show that these banks rely on excess reserves instead. In Appendix IA.F, we more formally test FX swap borrowing dynamics through a difference-in-differences regression for the three

[35] We exclude Chinese (ROW) G-SIBs from the analysis, as they do not borrow repos from US MMF.

major G-SIB nationalities.

4.3.2. Uniqueness of the dollar

A second piece of evidence that the FX swap and repo movements we observe are not coincidental stems from the fact that they are particular to the US dollar. On the FX swap side, Appendix F shows that USD purchases dominate quarter-end activity. In the case of Eurozone banks' repo positions, we observe that the dramatic withdrawals are similarly specific to USD repo. Panel (a) of Figure (4) shows the time series of European banks' borrowing in domestic European repo markets as well as from US MMFs. These Eurozone banks clearly decrease their US dollar repo borrowing at quarter-ends, but do not do so nearly as much in European repo (we formalize this finding in Appendix IA.G through a difference-in-differences analysis). While European repo transactions conducted with central counterparty clearing houses can be netted out, borrowing from US MMFs cannot be netted as it is one-directional. Thus, there is a strong incentive to simply exit these positions and replace them with off-balance sheet funding.

4.3.3. Year-ends

At year-end, FX swaps become less attractive than repos (see Krohn and Sushko (2022)) due to G-SIB capital surcharges (BCBS, 2013), as their positions are fully impacted, unlike the typical 1% regime during regular quarter-ends. We should thus expect a reversion of repo-FX swap substitution at year-end relative to non-year-end quarter-ends. For each G-SIB group, we run a regression of the share of synthetic to total USD funding (as in eq. (9)) on quarter-end and year-end dummies (i.e. $SwapShare_{i,t} = \beta_0 + \beta_1 \cdot Q_t^{end} + \beta_2 \cdot Q_t^{end} \cdot Y_t^{end} + u_{i,t}$). Results are shown in Table (G1). While the composition of dollar funding shifts from wholesale to synthetic at non-year-end quarter-ends, it reverts for all participants at the year-end. For instance, Eurozone G-SIBs increase their share of synthetic borrowing by 12% at the quarter-end, but scale it back by almost 6% at the year-end. Our results support the notion that the regulatory cost differential

between wholesale and synthetic dollar funding determines agent's funding choice: when the differential is reduced or even reversed, banks tend to rely less on the latter source.

4.3.4. Secured vs. unsecured funding

Finally, we investigate whether the window-dressing patterns in US money markets differ between secured and unsecured borrowing. Our prior belief is that secured funding is constrained due to its requiring collateral, which negatively impacts the LR and requires agents to own or source the appropriate security. While unsecured funding has its own disincentives stemming from the regulatory framework (such as the liquidity coverage ratio) and XVA costs, it does not require collateral. We estimate a bank-level difference-in-differences model comparing the outstanding amount of secured vs. unsecured US dollar borrowing by G-SIB banks at the quarter-end. As shown in Appendix H, no significant dynamics are observed for unsecured funding; secured borrowing is the focus of window-dressing efforts.[36]

4.3.5. Role of liquidity coverage ratio and HQLA requirements

Could other regulatory measures beyond the LR drive the substitution effect? In particular, the liquidity coverage ratio (LCR) mandates that banks hold a sufficient stock of high-quality liquid assets (HQLA) on their balance sheets which could be quickly liquidated during a period of stress (see e.g. European Central Bank (2023)). However, while the LCR may be a contributing factor, the patterns we document here point to the LR as the principal determinant because LCRs are reported on a *monthly* basis in Europe,[37] whereas the LR is reported quarterly; the substitution effects we observe are likewise a distinctly quarter-end phenomenon. This is in line with the findings of Cenedese et al. (2021), who find no results when considering the LCR introduction date in the UK.

[36] Note that the 2016 US money market reform greatly reduced the supply of unsecured lending, and therefore USD borrowing became far more repo-driven. Appendix I shows that non-US unsecured borrowing suffered a precipitous drop of 600 B USD at the time of the reform, and was replaced by a surge in secured borrowing.

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

4.3.6. Netting in repo markets

Because repo positions may be netted,[38] agents should in principle only care about their net repo positions when window-dressing regulatory ratios such as the LR's exposure measure. However, the repo segment we study - US MMF borrowing - is inherently one-sided, as US MMFs only perform reverse repo (i.e. lend cash) and do not incur repo liabilities (Baklanova, Kuznits, and Tatum (2021)). Furthermore, the structure of the market does not allow netting with any other repo segment. This is in contrast with the US interbank repo market, which is conducted through a central counterparty, thereby permitting netting. Indeed, Egelholf et al. (2017) find that banks attempt to balance their net positions in the interdealer segment; however, they confirm that, in total, Eurozone banks reduce their overall repo dollar borrowing at quarter-end. This is consistent with our mechanism whereby the shortfall is made up through synthetic funding.

4.3.7. Role of end-customers

Do banks engage in FX swap transactions for their own purposes, or do they trade on behalf of their customers? Note that the main mechanism of this paper does not depend on the ultimate destination of the USD funding, as this does not impact the regulatory considerations we describe. Nevertheless, we conduct two additional analyses to paint a more complete picture of the role of customers in the trading behavior of non-US banks. First, we find no evidence that non-bank USD borrowing increases at quarter-end in the same way as non-US bank borrowing. Second, we do find evidence that dealers are responsive to their customers' flows and replenish their dollar inventory by purchasing synthetic dollars from US G-SIBs. Thus, there is a positive correlation between customers' positions with non-US dealers and those dealers' positions with US G-SIBs. We perform tests to this effect in Appendix J by regressing non-US G-SIBs' dollar positions w.r.t. US G-SIBs on their own customers' positions with themselves. Both pieces of evidence suggest

[38] Repo/reverse repo positions may be netted, provided the positions match in counterparty, payment dates, settlement mechanism, and other technical considerations (BCBS (2014), CGFS (2017)).

that the additional USD funding sought by non-US banks through FX swaps at quarter-end may ultimately go to non-bank customers, but this does not necessarily imply higher overall customer demand; instead, banks seek to minimize the regulatory costs of USD funding regardless of its end destination.

5. Pricing Analysis

In the previous section, we established empirical support for the volume dynamics underpinning our demand hypothesis. Here, we test whether shadow costs and non-US agents' demand for FX swaps have price effects which manifest through the cross-currency basis. We proceed in three steps: we (i) show that CIP deviations coincide with greater shadow costs in US money markets, (ii) study the inelasticity of demand for synthetic dollar funding, and (iii) quantify the economic impact of regulatory shadow costs across different market participants.

5.1. Shadow costs and the basis

According to the conceptual framework in section 2.2, the cross-currency basis should increase as the cost of sourcing dollars from US MMFs rises. We consider two proxies for shadow costs in US repo markets: (i) Eurozone G-SIB repo withdrawals, and (ii) the share of US MMF borrowing which is performed on a secured relative to an unsecured basis. Proxy (i) indicates the severity with which Eurozone G-SIBs need to window-dress their LRs. Panel (a) of Figure (6) plots changes in the cross-currency basis versus changes of outstanding Eurozone G-SIB repo positions with US 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.[39] With regard to (ii), one of the factors making US wholesale funding *relatively*

[39] A similar correlation has been documented in Aldasoro et al. (2022).

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 $\Delta_t^{Secured} := \frac{\sum_{j=1}^{J}\left(\mathcal{O}_{j,t}^{Secured}\right)}{\sum_{j=1}^{J}\left(\mathcal{O}_{j,t}^{Secured}+\mathcal{O}_{j,t}^{Unsecured}\right)}$, where $\mathcal{O}$ denotes an outstanding quantity of US dollar borrowing from US MMFs. Secured borrowing is proxied by repo while unsecured borrowing is proxied by commercial paper (CP) and certificates of deposit (CD).[40] Panel (b) of Figure (6) shows that both during and outside the quarter-end reporting period the share of secured borrowing heavily coincides with spikes in the cross-currency basis.[41]

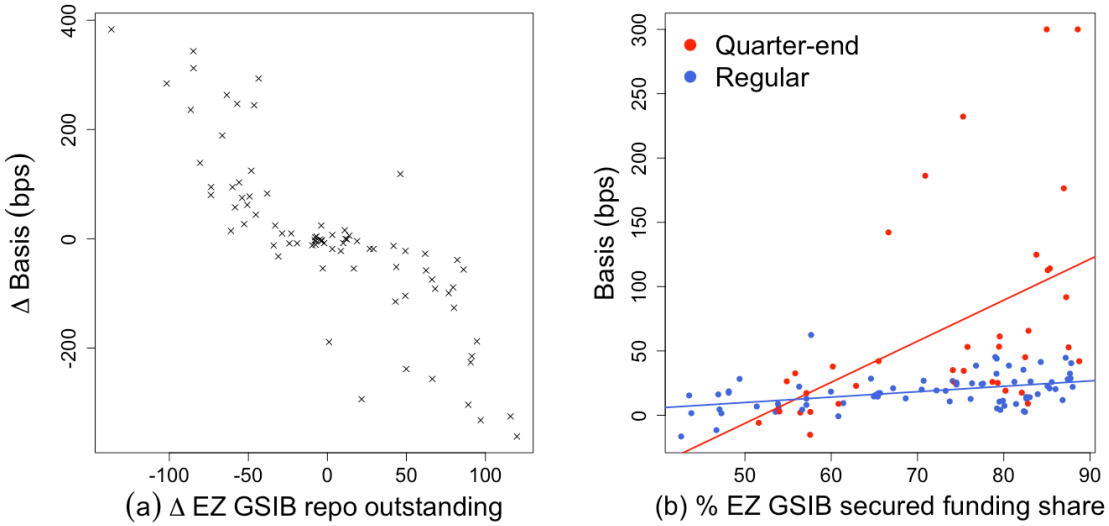


Fig. 6: Panel (a) depicts a scatterplot of changes in the cross-currency basis (USDJPY 1W) versus changes of outstanding Eurozone G-SIB repo positions with US MMFs. Observations are month-end. Panel (b) depicts a scatterplot of the share of secured borrowing by European G-SIBs versus the level of the 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.

[40] 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).

[41] We consider lagged values of the secured funding share. 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.

5.2. Non-US bank demand and basis effects

The mapping of global dollar funding markets in section 3.1 suggests that US G-SIB banks are the primary suppliers of synthetic US dollar funding, while non-US agents constitute the primary drivers of demand. Here, we investigate whether such demand shocks impact the cross-currency basis, indicating a downward-sloping demand curve. We proceed by calculating for each non-US G-SIB group i, currency x w.r.t. the dollar, maturity m, and trade date t, the daily *net* open position across all settled outstanding FX swap contracts l as follows:

$$\mathcal{O}^{Net}_{i,t,x,m} = \sum_{l=1}^{L} \mathbb{1}[\mathrm{T}_{i,t,x,m} = \mathrm{B}] \; - \; \mathbb{1}[\mathrm{T}_{i,t,x,m} = \mathrm{S}], \tag{10}$$

where B and S refer to trade direction and indicate whether a given traded volume T resulted in a dollar cash inflow or outflow at the near leg of the contract. The sum of net positions across all US dollar currency pairs and tenors yields for each non-US G-SIB group:

$$\mathcal{O}^{Net}_{t,x,m} = \sum_{i=1}^{I} \mathcal{O}^{Net}_{i,t,x,m}. \tag{11}$$

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

$$\Delta\chi_{t,x,m} = \beta \cdot \Delta\mathcal{O}^{Net}_{t,x,m} + \gamma \cdot \mathbf{X}_{t,x,m} + \alpha_{x,m} + \tau_t + \epsilon_{t,x,m} \tag{12}$$

where $\mathcal{O}^{Net}_t$ is the net outstanding dollar borrowing of all institutions in our sample other than US G-SIBs, $\mathbf{X}$ is a vector of controls, and $\alpha_{x,m}$, τ_t are currency-tenor and trade date fixed effects. However, endogeneity and reverse causality issues plague the estimation of eq. (12). We thus use the granular instrumental variables (GIV) approach of Gabaix and Koijen (2024) which extracts idiosyncratic shocks from flow data; the underlying intuition is that those idiosyncratic shocks which occur to large agents in a market are severe enough to affect its price (relevance condition). By virtue of their being idiosyncratic, however, these shocks are not otherwise linked to price or e.g. macroeconomic variables (exclusion restriction). These shocks can be obtained by subtracting

equal-weighted from size-weighted characteristics of agents within the market.

To form our GIV, we consider the flows of all nationality-institution types which are not US G-SIBs (i.e., 17 parties, $i = 1, ..., N$) in the four main currencies (EURUSD, USDJPY, GBPUSD, and USDCHF) and in five different tenors m (TN, 1W, 1M, 3M, 1Y). For every currency x and tenor m, we have $\mathcal{O}^{Net}_{i,t} = \mathcal{O}^{\$}_{i,t} - \mathcal{O}^{x}_{i,t}$ where $O^{\$}_{i,t}$ and $O^{x}_{i,t}$ are outstanding positions whereby party i is borrowing USD and foreign currency, respectively. We derive the building block of the GIV as: $Y_{i,t} := \frac{\mathcal{O}^{Net}_{i,t} - \mathcal{O}^{Net}_{i,t-1}}{|\mathcal{O}^{Net}_{i,t-1}|} \cdot 100$ and weights $S_{i,t-1} = \frac{\mathcal{O}^{\$}_{i,t-1}}{\sum_{i=1}^{N} \mathcal{O}^{\$}_{i,t-1}}$. 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.[42] 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 G-SIBs 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:

$$Y_{i,t} = \beta_1 \cdot \log\left(\mathsf{mat}\right)_{i,t,x} + \beta_2 \cdot \mathsf{h_index}_{i,t,x} + \beta_3 \cdot \mathsf{tradesize}_{i,t,x,m} + x_i + \iota_i + \eta_i + \tau_t + \check{Y}_{i,t}, \qquad \forall\, x, m \quad (13)$$

where, for each agent type i, $\mathsf{mat}_{i,t,x}$ is the average initial maturity of their outstanding positions, h_index is the Herfindahl index of short-term synthetic activity with counterparties per currency (i.e. measuring agents' degree of connectivity), and $\mathsf{tradesize}_{i,t,x,m}$ is agents' currency-tenor specific average trade size. We also include fixed effects at the agent, nationality, and institution type level as well as trade date fixed effects. We further consider the possibility that the shocks may

[42] 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 that the industry is highly concentrated, 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. $h := \sqrt{-\frac{1}{N} + \frac{1}{T}\sum_{i=1}^{N}\sum_{t=1}^{T} S^2_{i,t}}$. An excess Herfindal 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.

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' Y:

$$\check{Y}_S = \sum_{i=1}^{N} S_i \check{Y}_i, \qquad \check{Y}_E^{equi} = \frac{1}{N} \sum_{i=1}^{N} \check{Y}_i, \qquad Z^{equi} = \check{Y}_S - \check{Y}_E^{equi}. \tag{14}$$

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 $\widetilde{E}_i$ such that:

$$\widetilde{E}_i := \frac{1/\sigma_{u_i}^2}{\sum_j 1/\sigma_{u_j}^2}, \qquad \widetilde{\Gamma}_i = S_i - \widetilde{E}_i, \qquad Z^{preci} = \sum_i \widetilde{\Gamma}_i \check{Y}_i, \tag{15}$$

where Z^{preci} refers to the fact that this GIV uses precision-weighted quasi-equal weights. We winsorize $\check{Y}_{i,t,x,m}$ at the 1% level and bound our GIV terms to be within (-100,100).

We now estimate eq. (12) 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. (2023), $s_{t,x}$ 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).[43] Columns (1) and (4) perform a direct OLS regression over the whole sample and for the post-2015 sample respectively; no significant relationship is found. Columns (2)-(3) and (5)-(6) perform IV estimation; the exclusion restriction $\mathrm{E}[Z_{t,x,m}^{GIV} \epsilon_{t,x,m}] = 0$ is given to us from the theory underlying GIVs:

[43] Note that we calculate the cross-currency basis as follows:

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}		0.33***	0.27***		0.30***	0.25***
		(0.02)	(0.02)		(0.03)	(0.02)
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}
$\Delta\mathcal{O}_{t,x,m}$	−0.12			−0.15		
	(0.08)			(0.15)		
$\widehat{\Delta\mathcal{O}_{t,x,m}}$		0.68**	0.91**		1.02***	1.33**
		(0.24)	(0.37)		(0.34)	(0.51)
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	0.13	0.17	0.13	0.16	0.17	0.16
MOP effective F-statistic	-	184	156	-	148	125

Table 2: Columns (1) and (4) estimate a direct regression of the cross-currency basis on non-US agents' outstanding synthetic positions. The other columns perform GIV estimation of eq. (12). 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 $\mathbf{X} = \{\mathcal{A}_{t,x,m}, s_{t,x}, Q^{end}_{t,m}, Y^{end}_{t,m}, PCA_1, PCA_2, PCA_3\}$ where $\mathcal{A}_{t,x,m}$ is the currency-tenor specific realized illiquidity measure of Kloks et al. (2023), $s_{t,x}$ are log spot returns, $Q^{end}_{t,m}$ ($Y^{end}_{t,m}$) 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) are performed over the whole sample (Sept. 2012 to March 2022), (4)-(6) repeat the exercise for the subsample starting Jan. 1st, 2015. $***$, $**$ and $*$ indicate significance at the 1%, 5%, and 10% significance levels respectively.

$$\chi_t^{x|y,m} = 100 \cdot \left(i_t^{y,m} - \left(i_t^{x,m} - 100 \cdot \left(\frac{360}{m} \right) \cdot \left(-\log\left(F_t^{x|y,m} \right) + \log\left(S_t^{x|y} \right) \right) \right) \right), \tag{16}$$

$$\Delta\chi_t^{x|y,m}, \% = \frac{\chi_t^{x|y,m} - \chi_{t-1}^{x|y,m}}{\widehat{\chi}^{\,x|y,m}}, \tag{17}$$

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-US G-SIB agents' flow results in a 0.68% to 1.33% increase in the basis. We are thus able support the notion that non-US G-SIB agents act as the demand side w.r.t. to synthetic US dollar funding, as their flows have a significant price impact.[44] This relationship grew stronger during the post-2015 period, when the basis more easily fluctuated.[45]

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

$$\Delta\chi_{t,x,m} = \beta \cdot Z^{GIV}_{t,x,m} + \gamma^{\chi} \cdot \mathbf{X}_{t,x,m} + \alpha_{x,m} + \tau_t + \epsilon^{\chi}_{t,x,m} \tag{18}$$

Panel (a) of Table (K1) in Appendix K 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:

$$\check{Y}^{S}_{t,x,m} = \psi \cdot \widehat{\Delta\chi}_{t,x,m} + \gamma^{S} \cdot \mathbf{X}_{t,x,m} + \alpha_{x,m} + \tau_t + \epsilon^{S}_{t,x,m} \tag{19}$$

$$\check{Y}^{E}_{t,x,m} = \phi \cdot \widehat{\Delta\chi}_{t,x,m} + \gamma^{E} \cdot \mathbf{X}_{t,x,m} + \alpha_{x,m} + \tau_t + \epsilon^{E}_{t,x,m} \tag{20}$$

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, US G-SIB dealers increase their provision of synthetic dollar funding by approximately 3-4% while non-US G-SIB institutions decrease their dollar demand by 0.14% to 1.01%, validating our hypothesis of inelastic dollar demand. Furthermore, we observe that both supply and demand became more inelastic in the post-2015 period.

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where $i^{y,m}_t$ and $i^{x,m}_t$ 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.

[44] We also perform a sub-sampling exercise where we estimate the GIV based on non-G-SIBs' flows (as opposed to non-US G-SIBs); our results remain.

[45] 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.

5.3. Quantifying regulatory shadow costs

The econometric analysis conducted above is best suited to provide parametric estimates of the systematic relationship between the cross-currency basis and transaction flows. In the final part of our analysis, we calculate two non-parametric statistics to estimate the cost of regulatory pressure on wholesale dollar borrowing. For each market participant, we combine data on their traded volumes with the actual FX swap points paid to execute those trades and compute (a) their CIP net income earned or lost and (b) their per-dollar effective USD borrowing cost to gauge the magnitude of price discrimination, if any, against constrained agents.

5.3.1. CIP revenue

We compute the *realized* CIP income earned or lost (in millions of USD) as a result of each market participant's FX swap business. For agent i, the realized net income on a trading day t is the sum of revenues across all FX swap contracts of currency x and tenor m: $\pi_{i,t} = \sum_{x=1}^{X} \sum_{m=1}^{M} (Net_{i,t,x,m} \cdot \chi_{i,t,x,m}) \cdot \frac{n}{N}$.[46] Columns (3) and (6) of Table (3) depict the *net* income for short-term and long-term contracts separately, with values aggregated at the yearly level.[47] Recall that regulatory shadow costs affect not only short-term (e.g. 1-week) FX swaps that cross the quarter-end, but also long-term (e.g. 1-year) contracts, which intrinsically encompass at least one reporting period. Additionally, we decompose net revenue into the basis cost of USD purchases (columns (1) and (4)) and the basis income from USD sales (columns (2) and (5)). Quarter-ends significantly increase funding costs at the short end of the term structure, with non-US G-SIBs collectively incurring up to $6.5 bn annually in basis payments for USD borrowing. The basis costs are even heavier in long-term tenors at $43.2 bn per annum. These values reflect the shadow costs associated

[46] Note that the annualized expected cash flow is translated into a realized cash flow by applying a fraction of $\frac{n}{N}$, where n is the maturity of the FX swap, and $N = 365$ ($N = 360$) for GBPUSD (all other currencies), in line with accounting convention. The number is further adjusted to reflect global market size by dividing it by the market share of CLS-settled FX swaps according to a comparison with BIS data.

[47] For any given year, the total additional CIP earned or lost due to the quarter-end turn is the sum of the respective daily values across all G7 USD currency pairs $\pi_i = \sum_{t=1}^{T} \pi_{i,t}$, which is then averaged over all our sample to obtain a yearly additional CIP income loss or gain in absolute US dollar terms.

with USD borrowing. They are, however, ultimately passed on to end-customers, as our data reveal. While most G-SIB groups have an overall relatively flat position, non-bank customers incur losses in synthetic funding markets of $6.6 bn during an average year. Thus, our results suggest that the shadow costs associated with Basel III are ultimately borne by end-customers, primarily non-banks.[48] Among non-US G-SIBs, Japanese banks emerge as having the least balanced book, accumulating losses due to CIP basis payments up to $3.1 bn USD per year on average.

	CIP revenue gained or lost per year (in mn of USD)							
	Short-term tenors			Long-term tenors			Total gain/loss	
	$ Borrow	$ Lend	Gain/loss	$ Borrow	$ Lend	Gain/loss	In mn	In %
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Non-US G-SIB banks	(6,536)	6,359	(175)	(43,188)	44,888	1,700	1,878	1.6%
Eurozone	(2,244)	2,526	283	(16,838)	18,603	1,765	2,557	5.7%
Swiss	(1,176)	1,005	(171)	(5,406)	5,567	161	(92)	(0.6)%
Japan	(539)	350	(189)	(5,533)	2,765	(2,767)	(3,076)	(30.8)%
UK	(2,163)	1,965	(197)	(13,536)	15,341	1,805	1,589	4.2%
China	(414)	513	99	(1,875)	2,612	736	900	14.2%
Other non-US banks	(2,266)	2,956	690	(17,158)	20,030	2,872	4,442	9.3%
Non-Banks	(2,062)	1,510	(552)	(8,205)	2,847	(5,357)	(6,610)	(34.7)%
US G-SIB banks	(5,782)	5,851	69	(47,479)	51,611	4,132	3,543	2.9%

Table 3: Realized CIP basis gross and net revenue in G7 currencies based on settlement data. Columns (1) - (3) consider short-term (one-day to one-month) contracts that have crossed a quarter-end while columns (4) - (6) refer to long-term contracts which intrinsically cross a reporting date. Columns (1) and (4) compute the basis paid to borrow USD while columns (2) and (5) compute the basis earned from lending USD. The basis paid is a cost item and thus shown as a negative number in parentheses; the basis earned is an income item. The net revenue is displayed in columns (3) and (6). Finally, columns (7) and (8) compute the total CIP net revenue in millions of USD and in relative terms (relative to gross CIP payments). Values refer to revenues per year, on average. Data is 2015 to 2022.

5.3.2. Effective borrowing costs and price discrimination

Do we observe any evidence for price discrimination w.r.t. those agents which are constrained in FX swap markets? We proceed by calculating market participant i's effective USD borrowing

[48] Similar mechanisms can be found in Ivashina et al. (2015), Eguren-Martin, Ossandon Busch, and Reinhardt (2023), and Kubitza et al. (2024).

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 (4) compare the effective borrowing cost outside and inside 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. Evidently, outside the quarter-end, effective borrowing costs are largely similar across agents; in comparison, market participants incur a steep increase in realized borrowing costs at the quarter-end, with a much higher dispersion than during regular days. Japanese banks tend to borrow at the highest effective per-dollar cost, which is expected due to their portfolios being heavily concentrated in the yen-dollar pair (a basis-expensive currency pair).

	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)
Non-US G-SIB banks	41	79	38	7.6
Eurozone	45	78	33	1.4
Swiss	35	87	52	7.2*
Japan	29	110	81	5.5
UK	45	77	32	3.0
China	23	79	56	2.0
Other non-US banks	28	68	40	0.7
Non-Banks	33	65	32	-2.2
US G-SIB banks	35	74	39	-

Table 4: Effective CIP cost for one-day to one-month 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: $\chi_{i,t,x,m} = \beta \cdot isNonUS + \alpha_{x,m} + \tau_t + u_{t,i,x,m}$. Data spans 2015 to 2022. $***$, $**$, and $*$ in column (4) indicate significance at the 1%, 5%, and 10% significance levels, respectively.

[49] $\mathbb{1}[\mathrm{T}_{i,t,x,m} = \mathrm{B}] = 1$ for contracts that result in a USD inflow at the near leg of the swap. The effective USD borrowing cost is then expressed as: $\gamma_{t,i} = \frac{\sum_{x=1}^{X}\sum_{m=1}^{M}\mathbb{1}[\mathrm{T}_{i,t,x,m}=\mathrm{B}]\cdot\chi_{\mathrm{i,t,x,m}}}{\sum_{x=1}^{X}\sum_{m=1}^{M}\mathbb{1}[\mathrm{T}_{i,t,x,m}=\mathrm{B}]}$. The basis χ is calculated using actual traded swap points obtained from settlement data on the FX side and market-wide OIS interest rates obtained from Bloomberg on the interest rate side.

Next, we seek to determine what share of the quarter-end surge in effective borrowing cost reported in column (3) can be attributed to US dealer banks charging different FX swap prices to different market participants. Systematic differences in average borrowing costs can indicate the magnitude of price discrimination in the FX market.[50] To do so, we compare the cross-currency basis that US G-SIBs set when trading with other US G-SIBs vs. the basis charged to others. We aim to capture the coefficient β_i in the following panel regression:

$$\chi_{i,t,x,m} = \beta_i \cdot isNonUS + \alpha_{x,m} + \tau_t + u_{t,i,x,m} \tag{21}$$

where $\chi_{t,i,x,m}$ is the daily volume-weighted average cross-currency basis charged by US banks to counterparty i for USD purchases, $isNonUS$ equals 1 for trades between a US G-SIB and counterparty i and 0 for trades between US G-SIBs, and $\alpha_{x,m}$ and τ_t are currency-tenor and date fixed effects respectively. Column (4) of Table (4) reports the β_i coefficient estimate along with the significance level. Our results indicate that heterogeneity in FX swap pricing is, by and large, economically small (<5bps per annum) relative to the steep increase in effective borrowing cost (around 40bps). Although price discrimination in the FX swap market cannot be ruled out entirely, our results suggest that pricing differences across counterparties have a limited economic impact at the quarter-end. Further, there is no evidence that Eurozone banks suffer worse prices than UK banks. Appendix IA.H formalizes these results in a difference-in-differences setting; we fail to reject the null hypothesis of no price discrimination both inside and outside the quarter-end. Our results are in line with Rime et al. (2022), who argue that FX swap prices are largely homogeneous in the inter-dealer market.

6. Policy Implications

This paper highlights key insights for policymakers concerning the unintended consequences of banking regulation on USD funding markets. The primary friction underlying the observed dynamics stems not from the structure of US money markets, which are deep, liquid, and secure,

[50] For example, Hau, Hoffmann, Langfield, and Timmer (2021) find price discrimination against unsophisticated customers in FX derivative markets.

but rather from their treatment under the Basel III regulatory framework. The LR disproportionately penalizes the repo borrowing effectively required for non-US institutions to source US dollar funding. We identify this constraint by observing how these banks substitute their US MMF positions at quarter-ends. While non-US institutions benefit from the relative ease of exiting and re-entering US money markets, these agents are nevertheless penalized by the fact that US dollar funding must be obtained through balance-sheet intensive secured means.

The findings underscore the spillover effects of the LR's design on interconnected financial markets, highlighting that the regulatory framework's impact on money markets extends into currency markets, where it distorts pricing. The LR's catch-all nature heterogeneously impacts agents by penalizing the repo borrowing required for non-US banks to source the reserve currency. US institutions, on the other hand, can leverage their deposit base or central bank reserves to obtain USD. Thus, the introduction of Basel III in 2015 has worsened the competitive position of Eurozone banks in USD funding markets. Eurozone banks incur higher borrowing costs, much of which is passed on to their customers. As illustrated in Figure (L1), the LR implementation coincided with a significant decline in Eurozone G-SIBs' FX swap market share, while US G-SIBs' share correspondingly increased from 30% to 50%.

Harmonizing Basel III reporting standards across jurisdictions represents a further step to addressing these issues. The shift to daily-averaging schemes for the LR, while likely to reduce window-dressing practices, may transform quarter-end frictions into a persistent but less severe year-round phenomenon. Coordinated policy tools, such as central bank swap lines, will remain essential in alleviating systemic pressures during periods of market stress. Another takeaway is the need for enhanced data collection and sharing among international regulators, particularly concerning off-balance-sheet OTC instruments such as FX derivatives and total return swaps. Such data would enable more effective monitoring of market practices and help standardize liquidity stress-testing frameworks globally. Improved data availability could also assist in identifying destabilizing behaviors which result from regulatory misalignments.

Structural reforms could further enhance the resilience of short-term USD funding markets.

Expanding central clearing in repo markets and improving netting efficiencies would reduce the incentive for regulatory arbitrage. In FX derivatives markets, increasing the adoption of electronic and automated trading— currently far less developed compared to FX spot markets— would boost liquidity, enhance price discovery, and facilitate arbitrage. Furthermore, a practical impediment to fully arbitraging the cross-currency basis is the restriction on globally active non-banks from directly borrowing from US MMFs, requiring them to rely on intermediary dealer banks.

7. Conclusion

Our research sheds new light on the channels of global dollar funding and the interplay between wholesale and synthetic markets. We analyzed how financial intermediaries obtain dollars from two major sources: US money markets and FX swaps. First, we mapped global dollar funding activity using novel and granular data on institutions' operations across these markets. Second, we demonstrated that financial regulation incentivizes non-US banks, particularly Eurozone banks, to substitute dollar funding through US repos with FX swaps at quarter-ends. Third, we examined the price effects of repo-FX swap substitutability, providing evidence that demand for swaps is inelastic and that regulatory shadow costs significantly impact the CIP basis. As a result, non-US institutions are disadvantaged by the fact that regulation penalizes the repo borrowing required for them to source US dollar funding. The findings of our study have important implications for both academics and policymakers. For academics, our research provides deeper insights into the mechanics of global dollar funding, particularly the previously unexplored link between wholesale and synthetic dollar markets, and demonstrates how frictions in the former spill over to the latter. For policymakers, our results underscore the importance of understanding the linkages between interconnected financial markets and the unintended consequences of current regulatory frameworks, suggesting that adjustments—especially to the LR's catch-all nature—could help reduce distortions in global funding markets.

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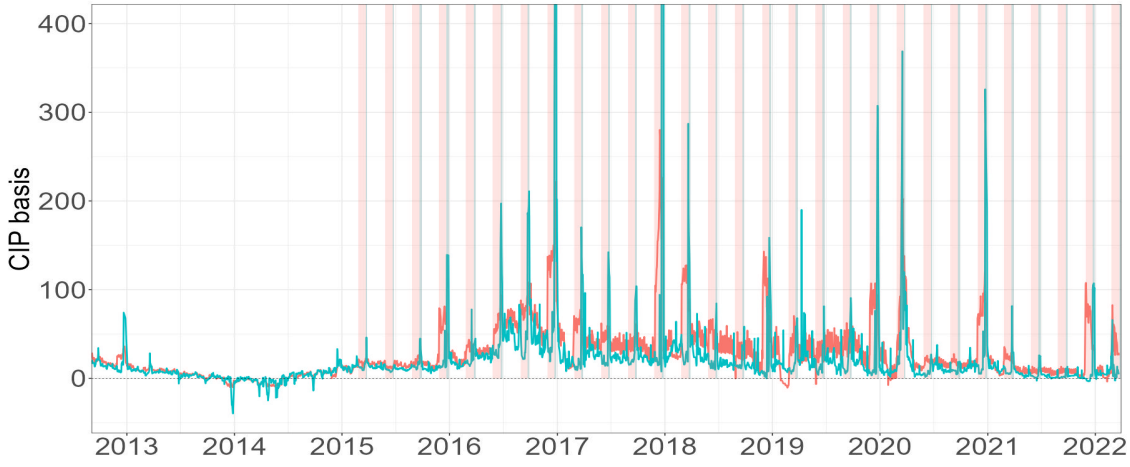
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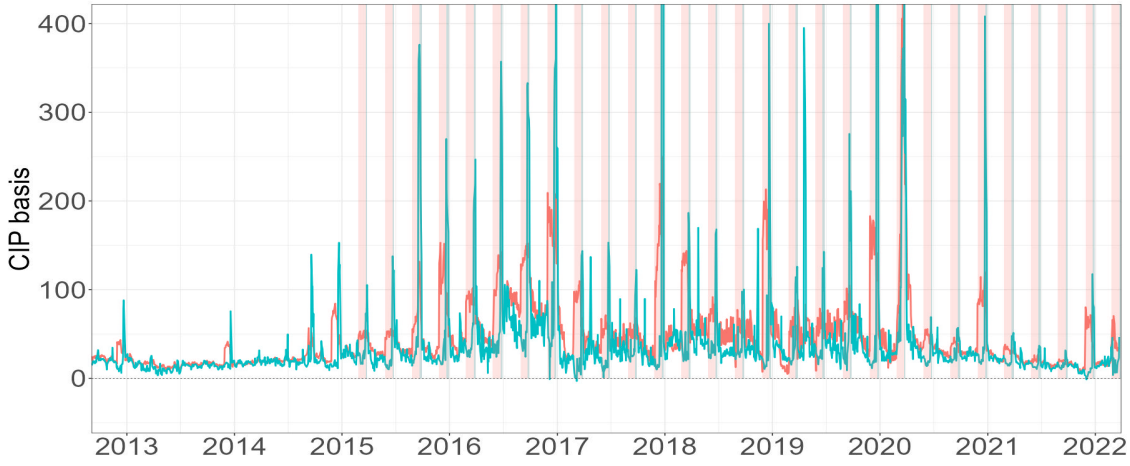
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Appendix A



(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
UK	54	54	16
US	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 US$ 500 billion surge, representing 3% of the outstanding market.

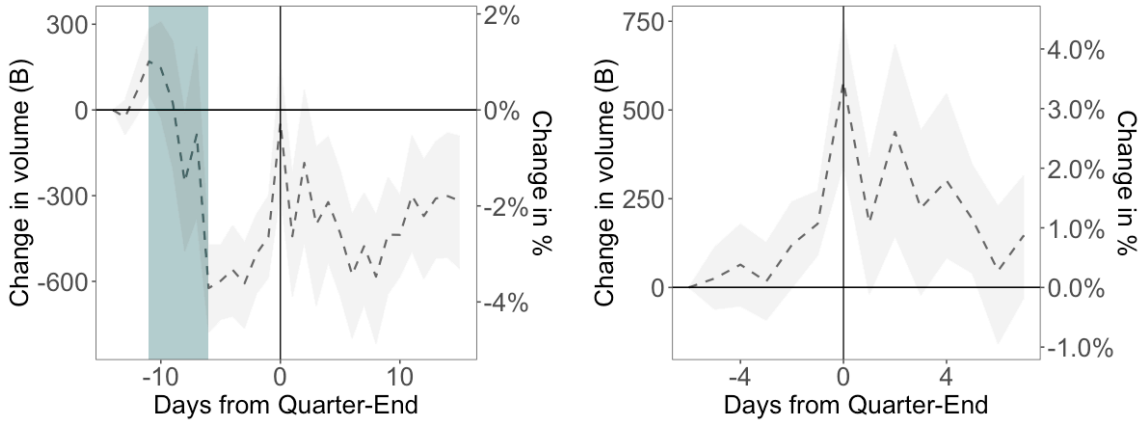
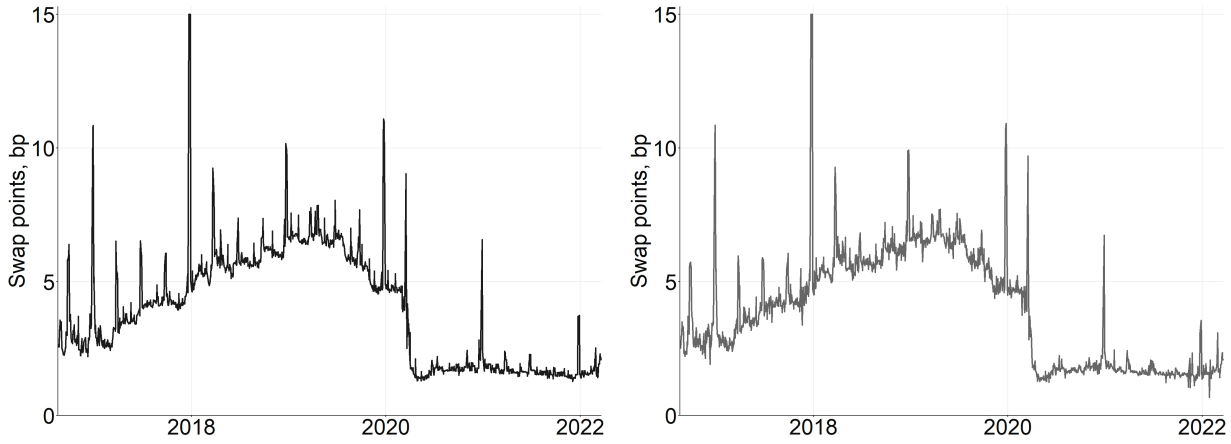


Fig. C1: Event studies around regulatory quarter-ends (year-ends not included) for all tenors combined. L.h.s. panel shows the influence of IMM dates (shaded blue) when many swaps expire. R.h.s. panel starts the event study after the IMM date and shows a US$ 500 billion increase. For both panels, the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

Appendix D

Figure (D1) shows the settled prices charged by US 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 US 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.

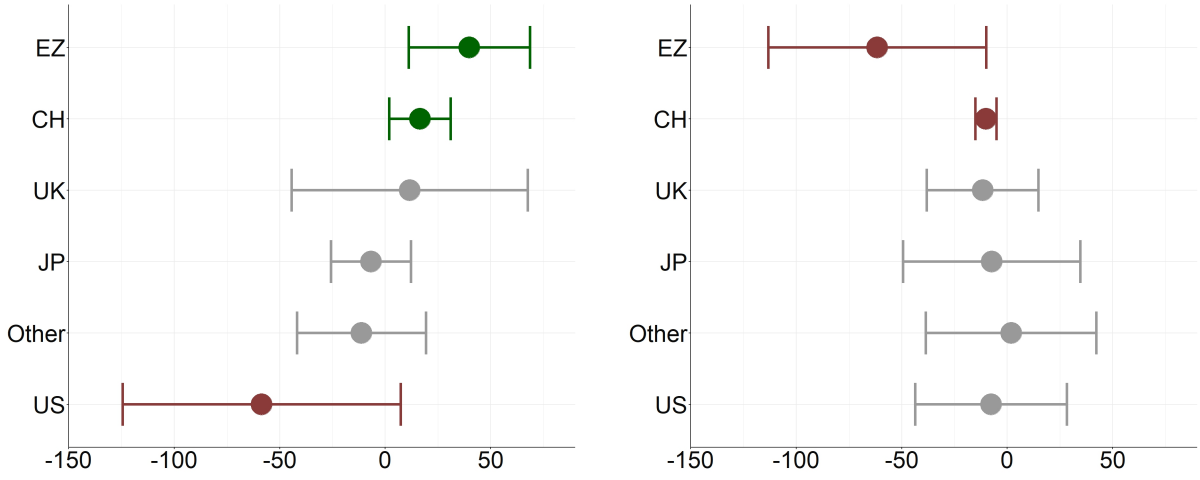


(a) Quoted swap points (Bloomberg)

(b) Traded swap points (CLS)

Fig. D1: EURUSD 1W swap points based on *quoted* swap points (Bloomberg, l.h.s.) vs. volume-weighted daily average *traded* swap points charged by US banks (CLS, r.h.s.). Note that the values of both series are capped at 15 basis points for better visualization purposes. Data is daily from January 2017 until March 2022.

Appendix E



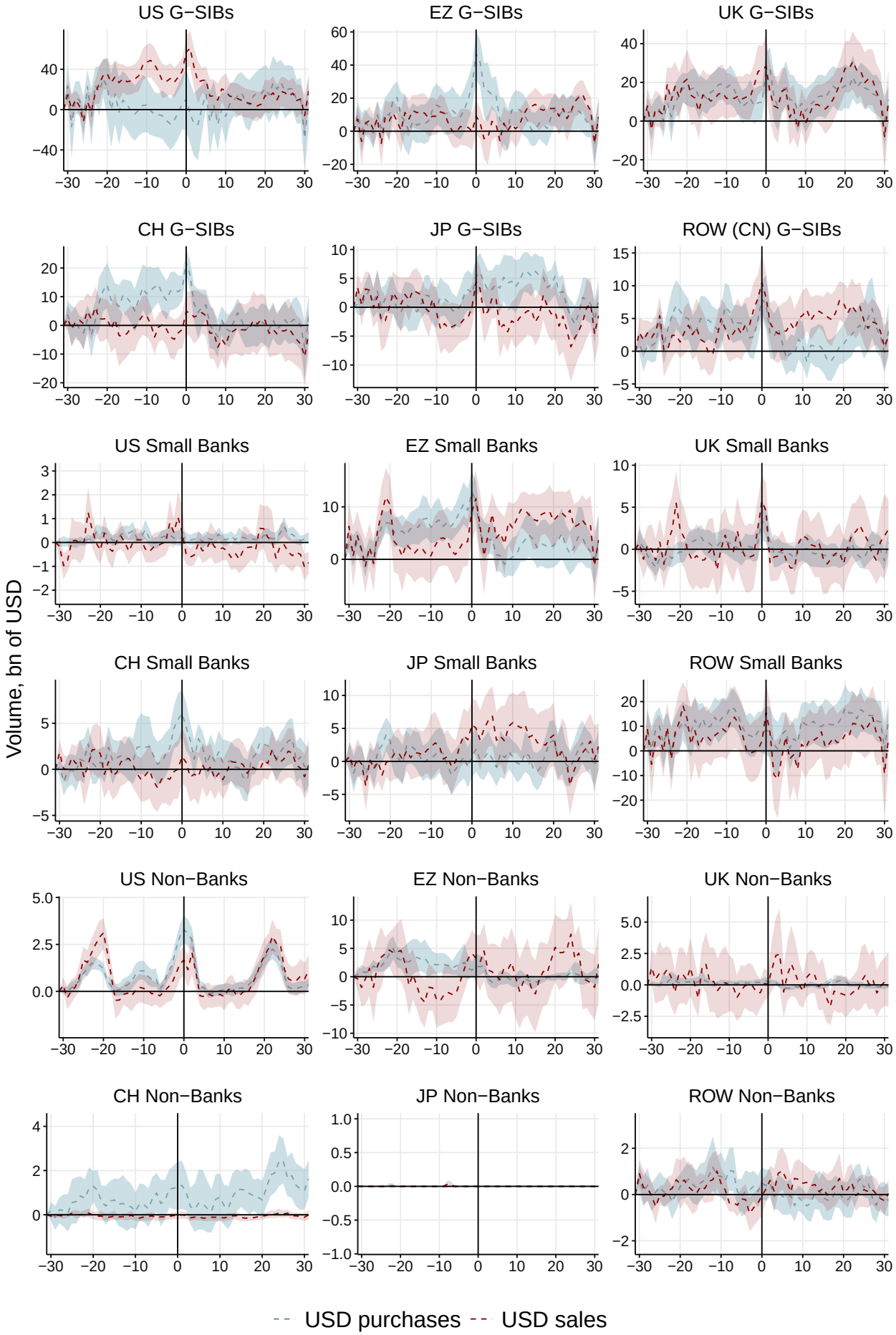
(a) Net USD FX swap borrowing, Δ bn USD

(b) Gross USD repo borrowing, Δ bn USD

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} quarter- and year-end time dummies respectively. In the l.h.s. Y_t is the net borrowing of USD in FX swaps; in the r.h.s. panel, it is the gross borrowing of USD from US MMFs. 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% significance level whereas gray coloring indicates no significance. The dots refer to the point estimates of the β_1; line bars add and subtract three times its standard deviation. Regulatory quarter-ends serve as the basis of the event study, which is run on data from December 2015 to September 2021.

Appendix F

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.


US G−SIBs
EZ G−SIBs
UK G−SIBs
CH G−SIBs
JP G−SIBs
ROW (CN) G−SIBs
US Small Banks
EZ Small Banks
UK Small Banks
CH Small Banks
JP Small Banks
ROW Small Banks
US Non−Banks
EZ Non−Banks
UK Non−Banks
CH Non−Banks
JP Non−Banks
ROW Non−Banks
Volume, bn of USD
USD purchases
USD sales

Appendix G

	Swap Share (%)				
	EZ	CH	JP	UK	US
β_0	41.59***	84.28***	33.36***	68.94***	70.41***
	(2.20)	(2.04)	(4.42)	(2.81)	(0.99)
Q^{end}	12.05***	9.01***	5.95***	4.59***	−0.46
	(1.71)	(1.53)	(1.26)	(1.03)	(0.72)
$Q^{end} : Y^{end}$	−5.64	−3.94	−2.95	−8.99***	−11.52***
	(3.48)	(2.43)	(2.65)	(2.90)	(2.09)
Obs.	82	82	82	82	82
Adj. R^2	0.23	0.22	0.01	0.06	0.32

Table G1: 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. (9). 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 US MMFs. $***$, $**$ and $*$ indicate significance at the 1%, 5%, and 10% significance levels respectively.

Appendix H

We estimate a bank-level difference-in-differences model comparing the outstanding amount of secured vs. unsecured US dollar borrowing by the various G-SIB banking groups at the quarter-end. $Funding^{\$}_{i,t}$ is the outstanding amount of US dollars borrowed from US 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.

$$\begin{aligned} Funding^{\$}_{i,t} = \beta_1 \cdot Q^{end}_t \; + \; \beta_2 \cdot Secured_{i,t} \; + \; \beta_3 \cdot Q^{end}_t \cdot Secured_{i,t} \; + \; \beta_4 \cdot Q^{end}_t \cdot Y^{end}_t \\ + \; \beta_5 \cdot Q^{end}_t \cdot Y^{end}_t \cdot Secured_t + \; \alpha_i \; + \; u_{i,t} \end{aligned} \tag{H.1}$$

where α_i are G-SIB fixed effects. Table (H1) shows results. We estimate bank-level regressions on European, UK, and US 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 UK and US 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		UK GS-SIBs		US GS-SIBs	
	bn USD	log	bn USD	log	bn USD	log
	(1)	(2)	(3)	(4)	(5)	(6)
Secured	16.18**	0.72	8.42	−0.62	10.18*	0.86
	(6.71)	(0.41)	(7.86)	(1.32)	(4.33)	(0.88)
Q^{end}	−1.00	−0.04	−0.22	−0.14	−0.13	0.03
	(0.71)	(0.03)	(0.48)	(0.13)	(0.32)	(0.10)
$Secured : Q^{end}$	−8.68***	−0.34**	−1.46	0.01	−0.28	0.01
	(2.08)	(0.11)	(1.62)	(0.09)	(0.41)	(0.09)
Controls						
$Q^{end} : Y^{end}$	−0.88	−0.08	0.25	0.08	0.85	0.13
	(0.64)	(0.10)	(0.40)	(0.14)	(0.45)	(0.12)
$Secured : Q^{end} : Y^{end}$	−2.21	0.02	−5.21*	−0.40**	−1.11	−0.14
	(2.80)	(0.08)	(1.72)	(0.06)	(0.95)	(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 H1: 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 I

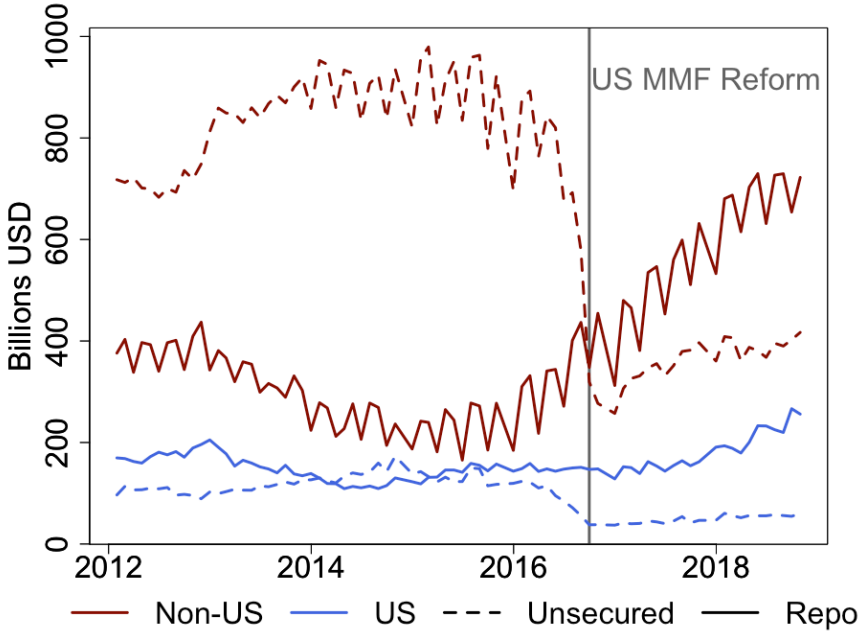


Fig. I1: Plot of US and non-US secured (repo) and unsecured funding volumes around the 2016 US MMF reform.

Appendix J

	Dependent variable: Dealers' net positions with US dealers					
Dealer:	EZ	UK	CH	JP	ROW	US
Customers' net positions with...						
EZ dealers	**0.44*****	0.07	0.08	-0.08	-0.01	-0.19
	(0.11)	(0.04)	(0.05)	(0.05)	(0.07)	(0.12)
UK dealers	-0.06	**0.26*****	0.01	-0.03	-0.01	-0.05
	(0.05)	**(0.09)**	(0.02)	(0.02)	(0.01)	(0.04)
CH dealers	-0.06	0.16	**0.18*****	-0.04**	-0.04**	0.01
	(0.08)	(0.10)	**(0.04)**	(0.02)	(0.01)	(0.05)
JP dealers	-1.92***	-1.31***	0.79***	**1.56*****	-0.16***	1.88***
	(0.11)	(0.06)	(0.05)	**(0.04)**	(0.04)	(0.09)
ROW dealers	-0.12	0.001	0.02	0.01	**0.28*****	0.04
	(0.11)	(0.04)	(0.05)	(0.05)	**(0.04)**	(0.07)
US dealers	-0.22***	-0.10***	-0.04**	-0.02**	-0.08***	**0.20*****
	(0.03)	(0.02)	(0.02)	(0.01)	(0.01)	**(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 J1: The table displays results of a regression of dealers' net dollar position with US dealers on their customers' net position. For example, column (1) regresses EZ dealers' net position with US dealers on customers' net position with EZ dealers, and with other dealers (which act as controls for a broad-based dollar movement). For US dealers in column (6), the dependent variable is their net position with non-US 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 K

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}	0.22***	0.25**	0.31***	0.33***
	(0.07)	(0.09)	(0.10)	(0.11)
Panel B: Second Stage - Supply				
Dep. variable:	$\check{Y}_S$			
	Z^{preci}	Z^{equi}	Z^{preci}	Z^{equi}
	(1)	(2)	(3)	(4)
$\Delta\chi_t^{x\|y,m}$, %	3.70***	4.06**	2.68***	2.99***
	(1.21)	(1.46)	(0.83)	(1.00)
Panel C: Second Stage - Demand				
Dep. variable:	$\check{Y}_E$			
	Z^{preci}	Z^{equi}	Z^{preci}	Z^{equi}
	(1)	(2)	(3)	(4)
$\Delta\chi_t^{x\|y,m}$, %	-1.01**	-0.20*	-0.71**	-0.14**
	(0.40)	(0.10)	(0.27)	(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	48,740	48,740
MOP effective F-statistic	11	9	12	10

Table K1: The table shows GIV estimation of eq. (18)-(20). The specifications are panel regressions over 4 currency pairs and 5 tenors, with currency pair-tenor (α) and date (τ) fixed effects and clustering. $\mathbf{X} = \{\mathcal{A}_{t,x,m}, s_{t,x}, Q^{end}_{t,m}, Y^{end}_{t,m}, PCA_1, PCA_2, PCA_3\}$ where $\mathcal{A}_{t,x,m}$ is the currency-tenor specific realized illiquidity measure of Kloks et al. (2023), $s_{t,x}$ are log spot returns, $Q^{end}_{t,m}$ ($Y^{end}_{t,m}$) 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)-(2) are performed over the whole sample, (3)-(4) repeat the exercise for the post-2015 period. $***$, $**$ and $*$ indicate significance at the 1%, 5%, and 10% significance levels respectively.

Appendix L

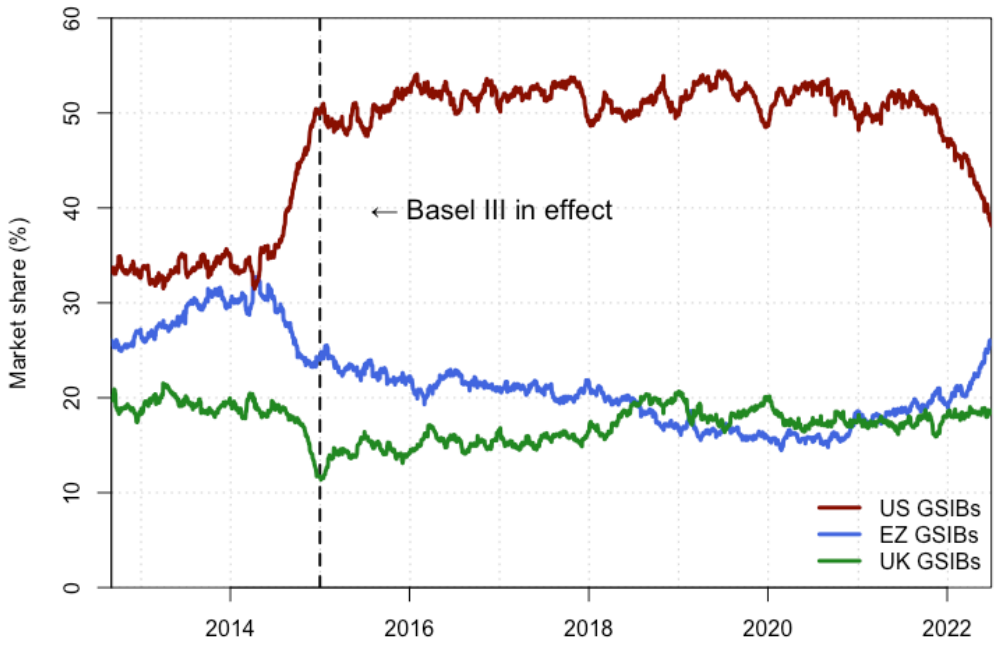


Fig. L1: Market share of US, EZ, and UK G-SIBs in long-term (>1M) FX swap trading. Market share is defined as the percentage share of customers with each group (where customers are all non-G-SIB entities). Values are *outstanding* FX swap positions as a share of the total market (Japanese, Swiss, and Chinese G-SIB market shares are omitted for visualization purposes).

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 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+	∑
G-SIBs	US	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
	UK	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
	∑	1,200	256	437	774	3,301	2,736	4,289	8,317	21,310
Small banks	US	4	1	1	6	55	17	23	47	154
	EZ	90	16	33	46	127	130	268	506	1,217
	UK	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
	∑	461	76	152	259	885	841	1,489	2,785	6,947
Non-Banks	US	3	1	6	27	410	241	195	385	1,268
	EZ	11	3	6	10	149	63	216	87	546
	UK	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
	∑	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	∑
G-SIBs	US	3,039	2,056	1,316	434	741	396	1,296	9,280
	EZ	1,782	817	485	193	265	136	609	4,287
	UK	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
	∑	7,048	4,685	2,935	1,173	1,539	775	3,155	21,310
Small banks	US	36	24	40	5	30	4	14	154
	EZ	773	90	82	82	28	20	141	1,217
	UK	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
	∑	2,265	974	758	400	710	629	1,210	6,947
Non-Banks	US	433	319	192	30	101	29	164	1,268
	EZ	448	18	41	10	10	4	15	546
	UK	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
	∑	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					
		US	EZ	UK	JP	CH	ROW (CN)	US	EZ	UK	JP	CH	ROW	US	EZ	UK	JP	CH	ROW
G-SIBs	US	–	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
	UK	-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
	ROW (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	US	-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.
	UK	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	US	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.
	UK	-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,

$$TradedVol_{i,t} = \beta_1 \cdot Tenor_i + \beta_2 \cdot PreQ_t^{end} + \beta_3 \cdot Tenor_i \cdot PreQ_t^{end} + \beta \cdot \mathrm{X_{i,t}} + \alpha_i + u_{i,t}\,, \quad \text{(IA.D.1)}$$

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, $\mathrm{X_{i,t}}$ 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)
$Tenor$	-1.92^{***}	-1.85^{***}	-2.45^{***}	-2.13^{***}	-2.42^{***}	-2.81^{***}
	(0.06)	(0.05)	(0.12)	(0.04)	(0.05)	(0.13)
$PreQ^{end}$	-0.05	-0.06	0.05	-0.05	-0.12^{**}	-0.01
	(0.06)	(0.05)	(0.04)	(0.05)	(0.05)	(0.02)
$Tenor : PreQ^{end}$	0.39^{***}	0.34^{***}	0.38^{**}	0.47^{***}	0.68^{***}	0.33^{***}
	(0.12)	(0.12)	(0.15)	(0.10)	(0.10)	(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 $Tenor_i \cdot PreQ_t^{end}$ is the difference-in-differences estimator. Controls are for month-ends and year-ends ($\beta \cdot \mathrm{X_{i,t}} = \beta_4 \cdot PreM_t^{end} + \beta_5 \cdot PreY_t^{end} + \beta_6 \cdot PreM_t^{end} \cdot Tenor + \beta_7 \cdot PreY_t^{end} \cdot Tenor$, 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.

	Eurozone G-SIB USD borrowing					
	vs. UK banks			vs. US banks		
	FX swap (logs)	Repo (logs)	Swap Share (%)	FX swap (logs)	Repo (logs)	Swap Share (%)
	(1)	(2)	(3)	(4)	(5)	(6)
β_0	4.983***	4.252***	67.06***	5.955***	5.120***	69.48***
	(0.037)	(0.103)	(1.26)	(0.040)	(0.040)	(0.89)
Q^{end}	0.038	−0.163***	4.11***	−0.052	−0.031	−0.39
	(0.056)	(0.052)	(1.48)	(0.055)	(0.044)	(0.93)
EZ	0.089**	1.264***	−27.82***	−0.848***	0.193***	−24.46***
	(0.039)	(0.061)	(0.87)	(0.048)	(0.026)	(2.11)
$Q^{end} : EZ$	0.156***	−0.117**	7.39***	0.199***	−0.307***	11.93***
	(0.057)	(0.049)	(1.53)	(0.054)	(0.067)	(1.68)
Controls						
$Q^{end} : Y^{end}$	−0.535***	−0.170	−7.93**	−0.532***	0.013	−12.51***
	(0.099)	(0.202)	(3.65)	(0.082)	(0.093)	(2.20)
$Q^{end} : Y^{end} : EZ$	0.040	−0.114	2.80	0.098	−0.150	5.53
	(0.106)	(0.114)	(2.38)	(0.100)	(0.103)	(3.92)
Observations	140	140	140	218	218	218
Adj. R^2	0.326	0.758	0.765	0.740	0.138	0.633

Table IA.E1: All models are OLS with Newey-West standard errors. The dependent variable is the amount of US dollars borrowed in swaps, in repo, and as a share as defined in eq. (9). Models (1)-(3) use UK G-SIBs as a control, (4)-(6) use US 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 UK (US) banks. Frequency is monthly; the sample starts at the 2015 year-end when considering UK banks and September 2012 when considering US banks, and ends in September 2021. FX swaps are volumes outstanding of dollars borrowed in CLS; repo volumes are amounts outstanding of USD borrowing from US MMFs. $***$, $**$ and $*$ indicate significance at the 1%, 5%, and 10% significance levels respectively.

	Swiss G-SIB USD borrowing					
	vs. UK banks			vs. US banks		
	FX swap (logs)	Repo (logs)	Swap Share (%)	FX swap (logs)	Repo (logs)	Swap Share (%)
	(1)	(2)	(3)	(4)	(5)	(6)
β_0	4.983^{***}	4.252^{***}	67.06^{***}	5.955^{***}	5.120^{***}	69.48^{***}
	(0.041)	(0.078)	(1.28)	(0.043)	(0.041)	(0.71)
Q^{end}	0.038	-0.163^{**}	4.11^{***}	-0.052	-0.031	-0.39
	(0.042)	(0.074)	(1.49)	(0.048)	(0.026)	(1.09)
CH	-0.437^{***}	-1.647^{***}	18.53^{***}	-1.40^{***}	-2.250^{***}	13.01^{***}
	(0.039)	(0.168)	(2.25)	(0.046)	(0.129)	(1.16)
$Q^{end} : CH$	0.076^{*}	-0.785^{***}	5.00^{***}	0.189^{***}	-0.616^{***}	7.79^{***}
	(0.045)	(0.151)	(1.93)	(0.055)	(0.133)	(1.47)
Controls						
$Q^{end} : Y^{end}$	-0.535^{***}	-0.170	-7.93^{**}	-0.532^{***}	0.013	-12.51^{***}
	(0.107)	(0.252)	(3.86)	(0.082)	(0.094)	(2.28)
$Q^{end} : Y^{end} : CH$	0.201^{*}	0.446	3.32	0.239^{**}	0.163	7.97^{***}
	(0.107)	(0.276)	(3.91)	(0.120)	(0.332)	(2.88)
Observations	140	140	140	218	218	218
Adj. R^2	0.531	0.796	0.703	0.881	0.843	0.607

Table IA.E2: All models are OLS with Newey-West standard errors. The dependent variable is the amount of US dollars borrowed in swaps, in repo, and as a share as defined in eq. (9). Models (1)-(3) use UK G-SIBs as a control, (4)-(6) use US 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 UK (US) banks. Frequency is monthly; the sample starts at the 2015 year-end when considering UK banks and September 2012 when considering US banks, and ends in September 2021. FX swaps are volumes outstanding of dollars borrowed in CLS; repo volumes are amounts outstanding of USD borrowing from US MMFs. $***$, $**$ and $*$ indicate significance at the 1%, 5%, and 10% significance levels respectively.

	Japanese G-SIB USD borrowing					
	vs. UK banks			vs. US banks		
	FX swap (logs)	Repo (logs)	Swap Share (%)	FX swap (logs)	Repo (logs)	Swap Share (%)
	(1)	(2)	(3)	(4)	(5)	(6)
β_0	4.983***	4.252***	67.058***	5.955***	5.120***	69.481***
	(0.039)	(0.092)	(1.168)	(0.045)	(0.041)	(0.934)
Q^{end}	0.038	−0.163**	4.108**	−0.052	−0.031	−0.385
	(0.054)	(0.065)	(1.652)	(0.044)	(0.030)	(0.957)
JP	−1.711***	−0.036	−38.587***	−2.542***	−1.426***	−26.010***
	(0.049)	(0.042)	(1.001)	(0.087)	(0.108)	(4.571)
$Q^{end} : JP$	0.116	0.047	1.837	0.175**	−0.104	5.963*
	(0.078)	(0.059)	(2.058)	(0.077)	(0.081)	(3.445)
Controls						
$Q^{end} : Y^{end}$	−0.535***	−0.170	−7.932**	−0.532***	0.013	−12.506***
	(0.082)	(0.221)	(3.631)	(0.082)	(0.093)	(2.134)
$Q^{end} : Y^{end} : JP$	0.330***	0.039	6.144***	0.181	−0.059	5.922
	(0.091)	(0.102)	(2.220)	(0.149)	(0.266)	(7.238)
Observations	140	140	140	218	218	218
Adj. R^2	0.883	0.002	0.863	0.927	0.586	0.366

Table IA.E3: All models are OLS with Newey-West standard errors. The dependent variable is the amount of US dollars borrowed in swaps, in repo, and as a share as defined in eq. (9). Models (1)-(3) use UK G-SIBs as a control, (4)-(6) use US 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 UK (US) banks. Frequency is monthly; the sample starts at the 2015 year-end when considering UK banks and September 2012 when considering US banks, and ends in September 2021. FX swaps are volumes outstanding of dollars borrowed in CLS; repo volumes are amounts outstanding of USD borrowing from US MMFs. $***$, $**$ and $*$ indicate significance at the 1%, 5%, and 10% significance levels respectively.

Appendix IA.F

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

$$SwapBorrowing_t = \delta_0 + \delta_1 \cdot USD_t + \delta_2 \cdot Q_t^{end} + \delta_3 \cdot Q_t^{end} \cdot USD_t + \delta \cdot \mathrm{X} + u_t \qquad \text{(IA.F.1)}$$

where $SwapBorrowing_t$ is the outstanding amount of FX swap borrowing undertaken on day t, Q^{end} (Y^{end}) is the day of the quarter-end, USD is a dummy variable indicating whether that FX swap borrowing was for US dollars or for foreign currency, and $\delta \cdot \mathrm{X} = \delta_4 \cdot Q^{end} \cdot Y^{end} + \delta_5 \cdot Q^{end} \cdot Y^{end}$ is a set of control variables. Results are displayed in Table (IA.F1).

	Volume					
	Eurozone G-SIBs		US G-SIBs		UK G-SIBs	
	bn	Log	bn	Log	bn	Log
USD	-20.72^{**}	-0.12^{**}	206.50^{***}	0.63^{***}	-45.88^{**}	-0.24^{*}
	(8.88)	(0.05)	(32.08)	(0.09)	(22.40)	(0.14)
Q^{end}	-0.06	0.005	29.07^{***}	0.12^{***}	2.82	0.02
	(4.86)	(0.03)	(9.80)	(0.04)	(6.64)	(0.04)
$USD : Q^{end}$	33.83^{***}	0.19^{***}	-50.02^{***}	-0.17^{***}	3.28	0.02
	(8.04)	(0.05)	(18.35)	(0.05)	(8.68)	(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.F1: 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^{end} is the day of the quarter-end, USD is a dummy variable indicating whether that FX swap borrowing was for US dollars or for foreign currency. Controls are for the year-end, i.e. $\mathrm{X} = \delta_4 \cdot Q^{end} \cdot Y^{end} + \delta_5 \cdot Q^{end} \cdot Y^{end}$. $***$, $**$ 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%. US G-SIBs increase their dollar lending to accommodate this demand. Crucially, however, these dynamics are not visible for UK 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.G

We aim to show that European banks active in both Euro and US 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 US (i.e. for EUR and USD respectively). Given the reporting frequency of US MMF data, we are limited to monthly observations. We run a difference-in-differences model as follows:

$$\begin{aligned} EZRepoBorrowing_{i,t} = \beta_1 \cdot USD_{i,t} \; + \; \beta_2 \cdot Q_t^{end} \; + \; \beta_3 \cdot USD_{i,t} \cdot Q_t^{end} \; + \; \beta_4 \cdot Y_t^{end} \\ + \; \beta_5 \cdot Q_t^{end} \cdot Y_t^{end} \cdot EZ_i \; + \; \alpha_i \; + \; u_{i,t} \end{aligned} \tag{IA.G.1}$$

where $EZRepoBorrowing_{i,t}$ is the outstanding amount of repo borrowing[51] of Eurozone bank i at time t, $USD_{i,t}$ is a dummy variable indicating whether that volume borrowed US dollars (euros), Q^{end} (Y^{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.G1) 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 US 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 an US$ 61 billion drop for all banks combined in our sample; this corresponds well with the visualization in Figure (4). Thus, our bank-specific data tells us that those European banks which are window-dressing in US MMFs do so less, if any, in Europe, where they instead window-dress through netting with CCPs.

[51] 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
USD	13.941^{*}	0.552^{*}	14.897^{*}	0.587^{*}	-62.978^{***}	-0.285^{***}
	(7.037)	(0.312)	(7.035)	(0.291)	(9.907)	(0.048)
Q^{end}	0.213	0.064	−0.078	−0.020	6.082	0.022
	(0.158)	(0.040)	(0.296)	(0.046)	(13.414)	(0.065)
$Q^{end} : USD$	-7.066^{***}	-0.346^{***}	-6.874^{**}	-0.259^{**}	-61.151^{***}	-0.353^{***}
	(2.460)	(0.106)	(2.524)	(0.092)	(18.971)	(0.092)
Controls						
$Q^{end} : Y^{end}$	-1.829^{***}	-0.274^{***}	-2.504^{**}	-0.311^{*}	-64.020^{***}	-0.257^{***}
	(0.493)	(0.075)	(0.859)	(0.158)	(22.880)	(0.111)
$Q^{end} : Y^{end} : USD$	−0.594	0.130	0.060	0.176	44.337	0.142
	(1.942)	(0.095)	(1.829)	(0.169)	(32.357)	(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.G1: 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 US 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 US 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.H

	Covered interest rate parity deviations (annualized bps)						
			G-SIBs			Non-G-SIBs	Non-banks
	EZ	CH	JP	UK	CN	Non-US	Non-US
Baseline	24.4	24.7	31.4	24.1	24.5	23.7	24.2
	(-)	(-)	(-)	(-)	(-)	(-)	(-)
$NonUS$	9.8	1.9	3.8	18.3	5.3	11.9	3.0
	(13.7)	(16.6)	(8.3)	(4.6)	(5.6)	(7.5)	(5.6)
Q^{end}	43.2***	40.5***	15.6***	44.8	42.1***	48.3***	40.4***
	(13.5)	(13.6)	(12.4)	(15.1)	(12.1)	(13.8)	(12.0)
Q^{end} : $NonUS$	−1.4	16.2	20.8	−8.9	29.2	4.7	−13.3*
	(15.1)	(17.4)	(11.3)	(15.5)	(21.5)	(11.0)	(6.9)
Controls							
Y^{end}	49.5***	49.9***	44.2***	49.7**	49.6***	49.8***	49.5***
	(12.6)	(12.6)	(12.6)	(21.1)	(12.6)	(12.5)	(12.5)
Y^{end} : $NonUS$	8.3	8.5	−2.8	2.5	−3.6	−2.8	−3.7
	(6.6)	(6.5)	(10.7)	(15.1)	(13.8)	(8.8)	(9.7)
CurrPair-Tenor FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	86,158	76,830	64,716	81,917	64,716	175,501	111,516
Adj. R^2	0.03	0.03	0.13	0.03	0.05	0.02	0.02

Table IA.H1: 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 US G-SIB and a non-US party (specified in the column name) and equal 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.