Hunting for Dollars

Pēteris Kloks[1] Edouard Mattille[2] Angelo Ranaldo[3]

[1] University of St.Gallen

[2] University of St.Gallen, Columbia Business School

[3] University of Basel, Swiss Finance Institute

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Motivation: Why Does Dollar Funding Matter?

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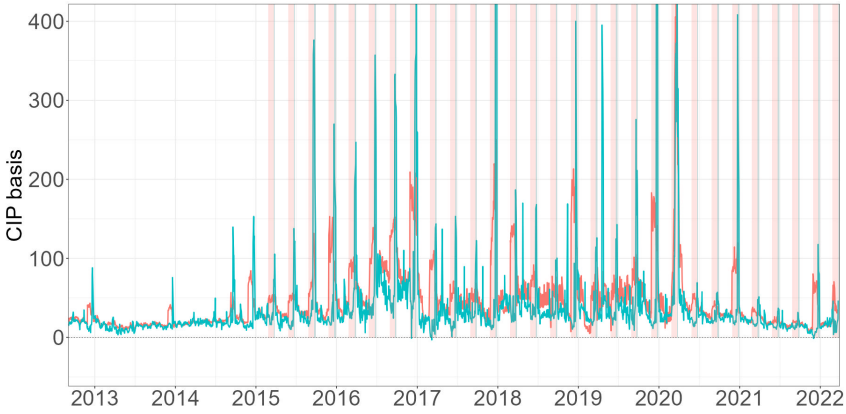
  - **Dollar funding markets** (growing reliance on synthetic funding).
- These distortions raise fundamental questions about the **structure, cost, and resilience** of global USD funding markets.

Post-2015 quarterly CIP deviations (USDJPY, 1W/1M)



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

Key Research Questions: Dollar Funding and Regulation

Our study addresses critical questions about how regulation and market frictions affect dollar funding and pricing dynamics.

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2. **What is the impact of regulation?** Do banking regulations create unintended consequences for USD funding?
3. **Do regulatory frictions distort FX markets?** How do these frictions contribute to pricing inefficiencies?

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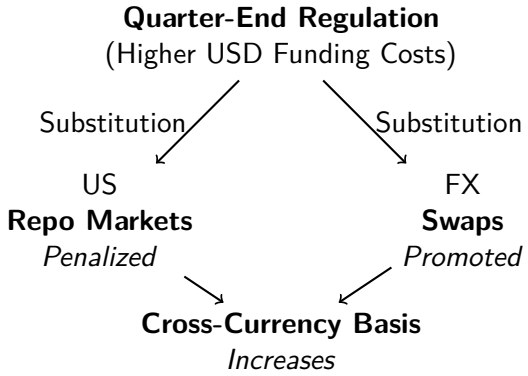
2. **Repo-to-Swap Substitution:** Facing these costs, banks shift from **USD repo borrowing** to **FX swaps** as a cheaper alternative.
3. **Market Impact:** This substitution, driven by **inelastic demand**, significantly increases **FX swap volumes** and amplifies the **cross-currency basis**.

Contributions: Mechanism Overview



Literature

- **Deviations from CIP**: Du, Tepper, and Verdelhan (2018), Borio, Iqbal, McCauley, McGuire, and Sushko (2018), Cenedese, Della Corte, and Wang (2021), Rime, Schrimpf, and Syrstad (2022), Wallen (2022), Becker, Schmeling, and Schrimpf (2023), Ben Zeev and Nathan (2024), Kubitza, Sigaux, and Vandeweyer (2024)
- **Global dollar funding**: Ivashina, Scharfstein, and Stein (2015), Aldasoro, Ehlers, and Eren (2022), Correa, Du, and Liao (2022), Bräuer and Hau (2022), Du and Huber (2024)
- **Intermediary balance sheet constraints**: Gabaix and Maggiori (2015), Duffie (2017), Andersen, Duffie, and Song (2019), Du, Hébert, and Li (2023)
- **Microstructure of FX forwards**: Syrstad and Viswanath-Natraj (2022), Krohn and Sushko (2022), Kloks, Mattille, and Ranaldo (2023)

Background

The literature has argued that Basel III regulation imposes a **supply constraint** on banks' ability to obtain USD funding at quarter-end (Du et al. (2018); Cenedese et al. (2021)).

Our contribution: We demonstrate that regulation drives up the **demand** for synthetic dollar funding.

Key open questions we address:

- **CIP deviations:** Why do CIP violations persist when only **1%** of FX swaps count towards the leverage ratio? (Borio et al. (2018); BCBS (2014))

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- **Quarter-end surges:** Why do FX swap volumes **surge** at quarter-end?
- **Cross-currency basis spikes:** If European banks are constrained, why does demand drive up the cost of USD funding (favoring the *US dollar*)?

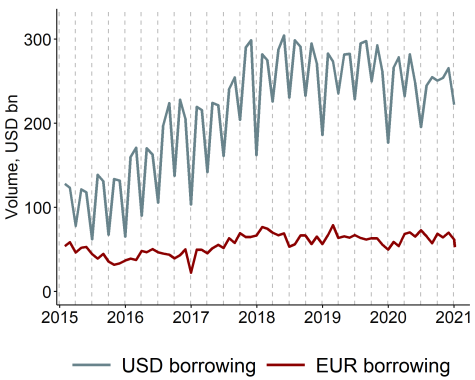
First step: construct data

- Bespoke data on global FX settlement from CLS which shows FX swap trading flows and prices per category.
- We manually sort 4,169 banks, as well as their customers, into nationality buckets: US, Eurozone, UK, CH, Japan, and ROW. We further distinguish between G-SIBs, regular banks, and non-banks.
- Crucial: if a JP Morgan entity is trading in London, it is classified as an American G-SIB.
- Combine this with bank-level data on European and American wholesale money markets.

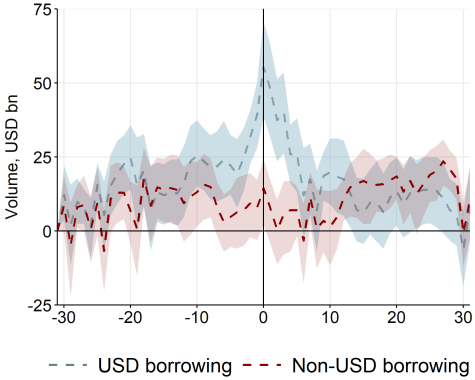
Synthetic dollar flows

Repo-FX swap substitution

Eurozone banks in:



(a) Repo markets...



(b) ... and FX swaps.

Our hypothesis

Why would European banks substitute USD repo funding with synthetic dollars at quarter-end?

Two unintended consequences of regulation combine for this effect:

1. **Differential treatment of funding instruments:**
   - Repo expands balance sheet, penalizing the leverage ratio (LR).
   - FX swaps are *off*-balance sheet, and thus only contribute 1% of their position to the LR. ⏩ See more.
2. **Heterogenous reporting requirements**
   - Majority of jurisdictions report results as a snapshot of their balance sheet at quarter-end - and thus can "window-dress."
   - UK and US two exceptions: report averages of quarter's daily values.

Treatment of repo vs. FX swaps

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Balance sheet	Assets		Liabilities		
	Bond	100 $	Equity	200 €	
	Cash	100 €	Debt	100 $	
	Cash	100 $			
Off-balance sheet					

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

Balance sheet	Assets		Liabilities		
	Bond	100 $	Equity	200 €	
	Cash	100 $			
Off-balance sheet					
	FX receivables	100 €	FX payables	100 $	

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

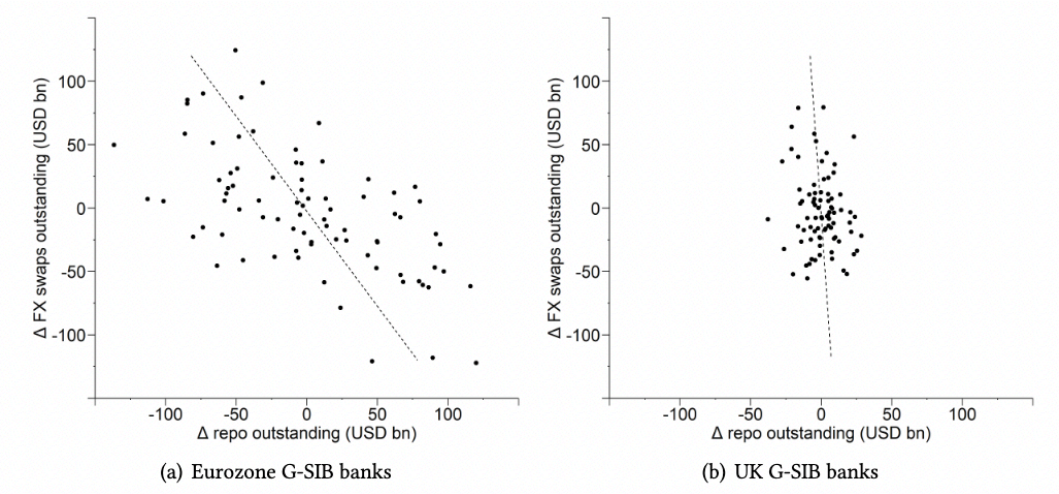
Repo-FX swap substitution: motivation

We hypothesize that regulatory concerns drive this substitution dynamic.

Thus, we run a differences-in-differences regression comparing banks with a quarter-end snapshot requirement (EZ, CH, JP) with those reporting daily averages (US, UK).

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

Visual evidence...



(a) Eurozone G-SIB banks

(b) UK G-SIB banks

	Snapshot vs. daily average reporters		
	FX swap (logs)	Repo (logs)	Swap Share (%)
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

Further evidence for substitution:

- **Nationality**: Those nationalities decreasing repo the most, correspondingly increase synthetic usage the most. ⏩ Nationality
- **Currency**: substitution is specific to the USD. ⏩ Currency
- **Year-ends**: as FX swaps count towards the year-end G-SIB score, substitution reverts at year-end. ⏩ Year-ends
- **Secured v. unsecured funding**: window-dressing occurs (virtually) only for repo, which requires collateral. Unsecured borrowing is relatively unaffected. ⏩ Secured v. unsecured
- **The 2016 US money market reform**, which converted USD borrowing from unsecured to secured. ⏩ US MMF Reform

What are the implications for pricing?

- When an agent wishes to borrow dollars, he may do so through wholesale (direct) borrowing, or synthetically, by converting local currency with FX swaps.
- **CIP** tells us that these two methods must have an equal cost: law of one price!

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

- However, wholesale borrowing through repo is penalizing for the balance sheet **LR**.
- Direct borrowing also requires securing **collateral**, which may be difficult to source.
- These constraints imply **shadow costs** for wholesale borrowing in money markets.
- On the other hand, FX swaps count little for the LR, and do not require collateral.

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

Plugging in the basis shows that CIP deviations are driven by the *relative shadow cost of USD wholesale funding vs. raising domestic funds*:

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

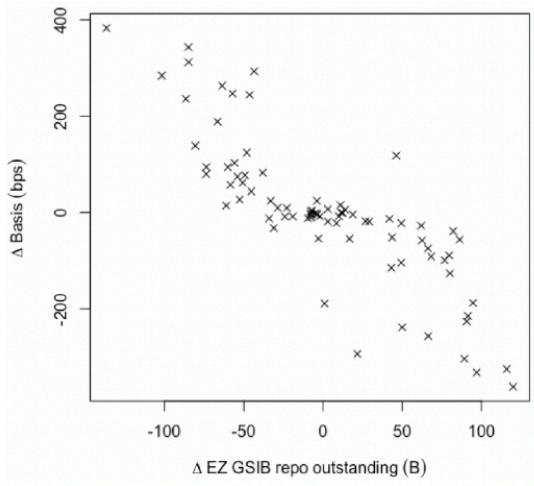
At the **quarter-end**, repo borrowing from US MMFs is penalized by regulation, and requires a collateral.

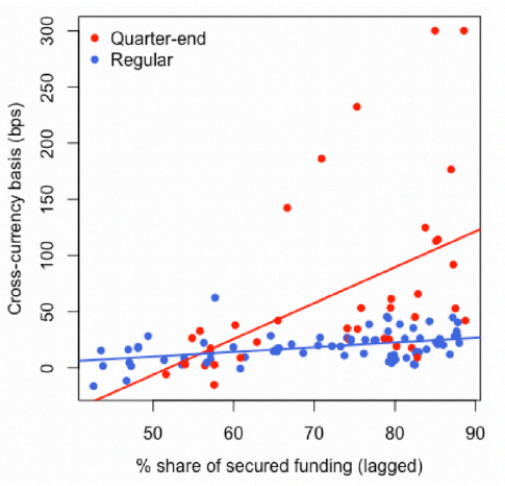
But non-US banks can raise **domestic** funds easily, especially in post-2015 era of loose monetary policy.

Synthetic dollar funding commands a **premium** because obtaining it through its substitute, wholesale funding, is expensive.

Pricing effects: CIP deviations correlate with:

- **L.h.s.:** Severity of Eurozone withdrawals from US MMF
- **R.h.s.**: Share of US MMF borrowing requiring collateral





Granular instrumental variable

The idiosyncratic shocks to major actors in FX swaps (i.e. dealer-banks) are a valid IV:

- **Relevance**: idiosyncratic shocks are big enough to impact the price.
- **Exclusion restriction**: can only impact price through flow because common shocks are removed, i.e. they are idiosyncratic.

We take the flows of non-US-G-SIB actors (17 total) and construct the GIV as the **size-minus-equal** weight of their dollar purchase shares. We form four different variants of the GIV.

Want to test whether:

- Non-US agents' flows impact the basis
- Non-US agents have inelastic demand for synthetic dollar funding

Panel A: First Stage - Prices on GIV

Dep. variable:	$\Delta\chi^{t,m,x}$, %			
	$Z^{P/F}$	Z^{F}	Z^{preci}	Z^{equi}
Z^{GIV}	0.15*	0.21**	0.23**	0.24**
	(0.08)	(0.08)	(0.08)	(0.09)

Panel B: Second Stage - Demand

Dep. variable:	Y_E^{preci}			
	$Z^{P/F}$	Z^{F}	Z^{preci}	Z^{equi}
$\Delta\chi_t^{x\|y,m}$, %	−0.41***	−0.35***	−0.33***	−0.18***
Controls	Yes	Yes	Yes	Yes
FE/clustering	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$	$\alpha + \tau$
Obs.	48,740	48,740	48,740	48,740

Pricing and Cost Efficiency

Our CLS data also show **prices** paid by each nationality and institution type:

- Quarter-end cross-currency basis spikes cost non-US G-SIBs around **4.7 billion USD annually**.
- Eurozone G-SIBs' 50 billion USD of repo-FX swap substitution "**only**" costs 37 million USD suggesting an efficient regulatory optimization.
- Eurozone G-SIBs pay 1.6 billion USD for quarter-end dollar purchases but sell 1.7 billion USD. This indicates that dealers pass shadow costs on to their **customers** through their role as intermediaries; a regulatory/banking friction thus impacts "real economy" agents.

Pricing and Cost Efficiency

	Effective cost γ (bp)			CIP income (mn of USD)				
	excl.Q^{end} (1)	at.Q^{end} (2)	Δ bp (3)	Net (4)	Δ Buy (5)	Δ Sell (6)	Δ Net (7)	Δ $Net_{Rp\text{-}Swp}$ (8)
Non-US G-SIB banks	26	56	30	3,562	(4,674)	4,476	(197)	(74)
Eurozone	25	52	27	2,429	(1,604)	1,735	131	(37)
Swiss	24	55	31	692	(820)	699	(121)	(17)
Japan	37	78	41	(5,197)	(399)	277	(122)	(15)
UK	24	50	27	3,893	(1,557)	1,378	(179)	(11)
China	23	49	26	1,745	(294)	387	93	6
Other non-US banks	22	48	26	6,497	(1,672)	2,158	486	10
Non-Banks	22	46	24	(17,220)	(859)	744	(115)	(2)
US G-SIB banks	24	52	26	7,261	(3,911)	3,936	25	65

Conclusion

- Distortions in FX swap markets driven by regulation penalizing non-US banks' wholesale USD borrowing.
- Important frictions: USD demand is inelastic, and cost is passed on to the customer.
- Policy implications: consequences of quarterly window reporting, differential balance sheet treatment of instruments, and structure of (US) wholesale funding markets.

APPENDIX

Quarter-end volume surge

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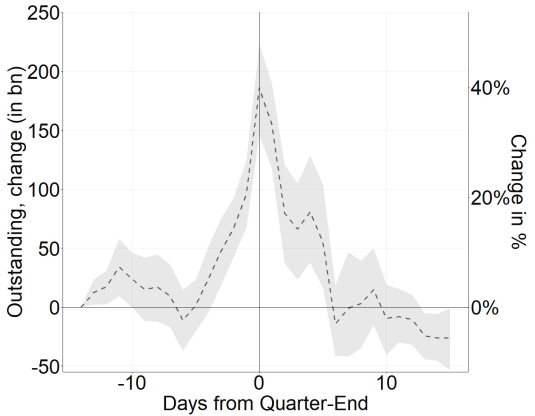

Outstanding swap volumes, SN to 1W tenor point, all currencies.

Treatment of repo vs. FX swaps

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Nationalities

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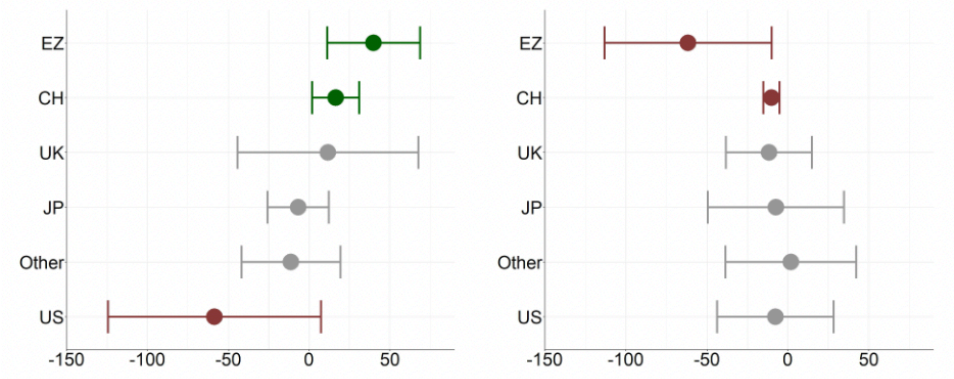

(a) Net USD FX swap borrowing, Δ bn USD

(b) USD repo borrowing, Δ bn USD

Dollar uniqueness

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	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)
QE	0.213	0.064	−0.078	−0.020	6.082	0.022
	(0.158)	(0.040)	(0.296)	(0.046)	(13.414)	(0.065)
QE: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						
QE:YE	−1.829***	−0.274***	−2.504**	−0.311*	−64.020***	−0.257***
	(0.493)	(0.075)	(0.859)	(0.158)	(22.880)	(0.111)
QE:YE: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

Year-ends

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	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

Secured v. unsecured borrowing

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	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

US money market reform

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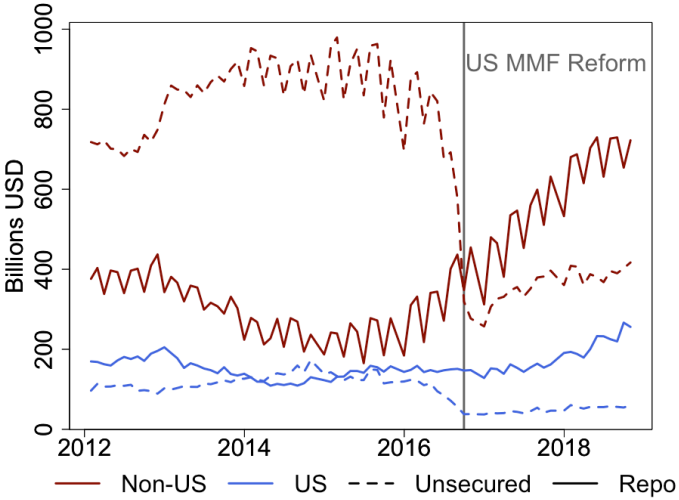

References I

Aldasoro, I., Ehlers, T., Eren, E., 2022. Global banks, dollar funding, and regulation. Journal of International Economics 137.

Andersen, L., Duffie, D., Song, Y., 2019. Funding value adjustments. Journal of Finance 74(1), 145–192.

BCBS, 2014. Basel III leverage ratio framework and disclosure requirements. Basel Committee on Banking Supervision. Discussion paper.

Becker, J., Schmeling, M., Schrimpf, A., 2023. Global bank lending and exchange rates. BIS Working Papers, No. 1161.

Ben Zeev, N., Nathan, D., 2024. The widening of cross-currency basis: When increased FX swap demand meets limits of arbitrage. Journal of International Economics 152.

Borio, C., Iqbal, R., McCauley, P., McGuire, P., Sushko, V., 2018. The failure of covered interest parity: FX hedging demand and costly balance sheets. BIS Working Papers No 590.

Bräuer, L., Hau, H., 2022. Can time-varying currency risk hedging explain exchange rates? Swiss Finance Institute Research Paper No. 22-77 .

References II

Cenedese, G., Della Corte, P., Wang, T., 2021. Currency mispricing and dealer balance sheets. Journal of Finance 76(6), 2763–2803.

Correa, R., Du, W., Liao, G., 2022. U.s. banks and global liquidity Working paper.

Du, W., Huber, A., 2024. Dollar asset holding and hedging around the globe. Jacobs Levy Equity Management Center for Quantitative Financial Research Paper.

Du, W., Hébert, B., Li, W., 2023. Intermediary balance sheets and the treasury yield curve. Journal of Financial Economcs 153(3).

Du, W., Tepper, A., Verdelhan, A., 2018. Deviations from covered interest rate parity. Journal of Finance 73(3), 915–957.

Duffie, D., 2017. Post-crisis bank regulations and financial market liquidity. Banca d'Italia.

Gabaix, X., Maggiori, M., 2015. International liquidity and exchange rate dynamics. Quarterly Journal of Economics 130, 1369-1420.

Ivashina, V., Scharfstein, D., Stein, J., 2015. Dollar funding and the lending behavior of global banks. Quarterly Journal of Economics 130(2), 1241–1282.

References III

Kloks, P., Mattille, E., Ranaldo, A., 2023. Foreign exchange swap liquidity. Swiss Finance Institute Research Paper No. 23-22 .

Krohn, I., Sushko, V., 2022. FX spot and swap market liquidity spillovers. Journal of International Money and Finance 120 (February), 102476.

Kubitza, C., Sigaux, J.-D., Vandeweyer, Q., 2024. Cross-currency basis risk and international capital flows. Working paper.

Rime, D., Schrimpf, A., Syrstad, O., 2022. Covered interest parity arbitrage. Review of Financial Studies 35(11), 5185–5227.

Syrstad, O., Viswanath-Natraj, G., 2022. Price-setting in the foreign exchange swap market: Evidence from order flow. Journal of Financial Economics 146(1), 119–142.

Wallen, J., 2022. Markups to financial intermediation in foreign exchange markets. Working paper.