Repo and FX Swap: A Tale of Two Markets*

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Abstract

Using actual transactions of large euro-area banks in US dollar-denominated repo and euro-dollar foreign exchange (FX) swap markets, we document new stylized facts about these two key segments of the global funding market. First, we show that for large euro-area banks, the repo and FX swap markets serve as close substitutes, with net borrowing in the repo market closely tracking net lending in the FX swap market. Second, the average spread between borrowing and lending rates in the repo market is significantly wider than in the FX swap market, reflecting the higher balance sheet costs of repos for dealers. Third, dealers exercise market power in both markets, as evidenced by significant price dispersion across counterparty types despite similar balance sheet usage. We interpret these findings through the lens of a simple two-market model and use the model's predictions to test dynamics between the two markets during stress days.

*The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank or the Eurosystem. The authors thank Quentin Batista for exceptional research assistance, and Lorena Keller and seminar participants for comments and suggestions.

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1 Introduction

Repo and foreign exchange (FX) swaps are two of the most important short-term funding markets for US dollar liquidity. Disruptions in these markets can have significant spillover effects on broader financial markets, often necessitating central bank interventions. European banks play a crucial role in both markets, acting as borrowers of dollar funding and global intermediaries. Using the first dataset with actual transaction and position data at the institution level for both the repo and FX swap markets, this paper provides a detailed account of dollar funding activities in Europe, with a focus on the role of large euro-area banks. Our analysis highlights two key financial market frictions, balance sheet costs and dealer market power, in drive dynamics of pricing and trading patterns across the two markets.

While repo and FX swap markets share similarities, they also exhibit key differences. In an FX swap transaction, market participants obtain dollar funding by lending euros and buying euro forwards at a predetermined forward exchange rate. In a frictionless market, the implied dollar funding cost in the FX swap market, combining the cost of euro funding and the FX swap, should equal the direct dollar funding cost, such as borrowing in the repo market. This relationship, known as covered interest rate parity (CIP), has shown persistent deviations since the 2008-09 Global Financial Crisis (GFC) (Du, Tepper, and Verdelhan (2018)). For the euro-dollar pair, the implied dollar funding cost has been typically higher than the direct dollar funding cost, with deviations spiking during periods of financial distress such as the GFC, the European debt crisis, and the peak of the Covid-19 pandemic. Despite higher funding costs, FX swaps offer broad market access, serving non-U.S. banks with dollar funding gaps, institutional investors with hedging needs, and non-financial firms managing currency risk. Large global banks and FX swap dealers act as counterparties to these participants, facilitating market clearing.

In the repo market, participants pledge collateral, such as U.S. Treasury bonds, to borrow dollars. Compared to FX swaps, access to the repo market is more restricted. Large cash lenders in the repo market, such as the U.S. government money market funds (MMFs), primarily lend to top-tier global banks based on credit ratings and maintain stable lending relationships. Participants without direct access to large cash lenders often have to borrow only indirectly from repo dealers – at a higher cost. Therefore, large dealers are able to pocket the difference between borrowing and lending rates in the repo market. Studies on the U.S. repo market indicate that the spread between the General Collateral Financing (GCF) repo rate (a proxy for large lenders' lending rates to smaller dealers and banks) and the triparty repo rate (a proxy for large dealers' borrowing costs from MMFs) has widened significantly since the GFC. (Du, Hebert, and Huber, 2023).

Using confidential supervisory data from the European Central Bank (ECB), we analyze repo and FX swap transactions at the institutional level. FX swap data come from the Money Market Statistical Reporting (MMSR), while repo data come from the Securities Financing Transactions Regulation (SFTR). Both datasets provide full transaction details, including transaction date, counterparty identity, sector classification, and transaction price. MMSR data, collected since 2016, cover euro-dollar FX swaps from now 46 MMSR-reporting banks (henceforth "MMSR banks"), the largest participants in European money markets. SFTR data, collected in full since 2021, include near-universal reporting of secured financing transactions, including US dollar-denominated (USD) repos, from a broad range of financial institutions in the European Economic Area (EEA). We focus on transactions involving an MMSR bank on either side of the trade and maturities of up to one year. The overlap of the two samples during 2021–2024 allows us, for the first time, to link MMSR banks' full activities in both repo and FX swap markets at the transaction level.

During this period, the daily FX swap trading volume of MMSR banks in the euro-dollar FX swap market with maturities of up to one year averaged €212 billion, representing about 23% of global euro-dollar FX swap turnover based on the 2022 triennial FX survey by the Bank for International Settlements (BIS). The average daily volume of USD repos with maturities of up to one year and with MMSR banks as a counterparty was €781 billion. While precise estimates of global USD repo market size are unavailable due to data gaps, estimates for total repo positions for U.S. domiciled banks and dealers range from $3.5 to $5 billion between 2022 and 2024 (Hempel, Kahn, and Shephard (2025)).

Although our data do not capture the full global activity in FX swaps and repos, they provide a comprehensive view of MMSR banks' activities. By examining both markets side by side, we uncover important trading patterns. On aggregate, MMSR banks are net borrowers of dollars in the repo market (EUR 100-300 billion) and net lenders in the FX swap market (€100-200 billion). Their combined net position across both markets is typically close to zero, rarely exceeding €100 billion. This contrasts sharply with their gross exposure of €1.9 trillion across both markets, underscoring the critical role of MMSR banks as global financial intermediaries for dollar funding.

In terms of counterparty breakdown, interbank trades dominate FX swap transactions, followed by significant activity with non-bank financial institutions (NBFIs) on both the dollar borrowing and lending sides. While interbank trades also play a role in the repo market, MMSR banks' most important counterparties in repo transactions are NBFIs, particularly MMFs and hedge funds. This aligns with the prevailing narrative that large banks borrow repos from MMFs and lend repos to hedge funds.

Geographically, MMSR banks borrow dollars in the FX swap market from a diversified base: one-third from the U.S., one-third from Europe, and the remainder from the U.K. and other regions. They lend 53% of their FX swap dollars to European counterparties and 23% to the U.S.. In the repo market, MMSR banks borrow 60% of dollars from the U.S. and lend 56% to offshore financial centers, primarily hedge funds and other NBFIs.

Beyond trading volumes and positions, a detailed pricing analysis provides new insights into market structure and competition. Volume-weighted median funding rates in both markets closely track public benchmarks. The median deviation between MMSR FX swap rates and Bloomberg quotes is less than 0.3 basis points for benchmark maturities, while repo rates track the Secured Overnight Financing Rate (SOFR) with minimal deviation.

However, significant price dispersion exists due to balance sheet constraints, dealer market power, and other frictions. Our micro-level data allow us to disentangle these effects. Repo transactions are more balance sheet-intensive than FX swaps due to regulatory capital requirements, particularly under the Basel III leverage ratio rule. Since FX swaps are off-balance-sheet, they impose lower balance sheet costs. Additionally, in many European jurisdictions, the leverage ratio constraint is binding primarily at quarter-end, making repo transactions significantly costlier during these periods.

We find that balance sheet costs are consistently reflected in transactions. Outside quarter-ends, the average repo borrowing rate of MMSR banks is 8 basis points lower than their average repo lending rate, with the gap widening to 19 basis points at quarter-end. By contrast, FX swap spreads are much narrower: MMSR banks' average implied dollar borrowing cost is only 1 basis point below their lending rate. Matching repo and FX swap borrowing and lending within the same bank, we estimate that MMSR banks earn an average spread of 10 basis points by borrowing in the repo market and lending in the FX swap market, compensating them for the balance sheet costs of on-balance-sheet repo borrowing. This spread increases to 34 basis points at quarter-ends, reflecting elevated balance sheet costs and additional regulatory pressures, such as capital surcharge for Global Systemically Important Banks (G-SIBs).

To explain our main empirical findings, we develop a stylized model of the repo and FX swap markets that incorporates dealer balance sheet constraints and market power in both markets. The model shows how price dispersion across sectors reflects differences in dealers' markups over marginal costs, which in turn depend on clients' demand elasticities. It also generates predictions for gross and net borrowing and lending when leverage ratio constraints tighten. Specifically, the model predicts that dealers reduce lending in both repo and FX swap markets, with the relative magnitude of contraction determined by demand elasticities in each market. At the same time, while dealers' repo borrowing contracts, their FX swap borrowing expands in response to the tightening of balance sheet constraints, leading to an increase in net repo lending and a contraction in net FX swap market lending. Using event study analysis around quarter-ends, we show that model's predictions on the gross and net lending positions are well supported in the data.

Our paper contributes to the extensive literature on CIP deviations (see Du and Schreger (2022) for a survey of earlier research and Du, Hebert, and Huber (2023), Augustin et al. (2024) and Dávila et al. (2024) for recent contributions). A growing body of work leverages micro-level data from the FX derivatives market to better understand the drivers of CIP deviations, including Bräuning and Puria (2017), Cenedese, Della Corte, and Wang (2021), Rime, Schrimpf, and Syrstad (2022), Syrstad and Viswanath-Natraj (2022), and Moskowitz et al. (2024). Relatedly, Hacioğlu-Hoke et al. (2024) provides a detailed analysis of the FX derivatives market structure for U.K.-domiciled banks, focusing on trading volume and positioning.

Kubitza, Sigaux, and Vandeweyer (2025) combine FX derivatives data with portfolio allocation data to jointly examine demand for dollar assets and currency hedging practices of European investors.

While most studies concentrate on the FX swap market, fewer explore interactions between FX swaps and repos. Correa, Du, and Liao (2025) use daily balance sheet data from U.S. Global Systemically Important Banks (G-SIBs) to examine liquidity provision by the largest U.S.-domiciled banks, offering a complementary view of market activity and quarter-end dynamics across the repo and FX swap markets. Khetan (2024) and Kloks, Mattille, and Ranaldo (2024) find evidence of repo-FX swap substitution over quarter-end periods using global FX swap data from Continuous Linked Settlement (CLS), highlighting European banks as key drivers of these effects. Our paper advances this literature by linking transaction-level data from both repo and FX swap markets at the individual institution level, enabling a detailed examination of price dispersion and granular trading patterns across different counterparty types.

Our findings on price dispersion relate to studies demonstrating that dealers exert significant market power in OTC derivatives and money markets. Examples include Hau, Hoffmann, Langfield, and Timmer (2021) for FX forwards using EMIR data, Huber (2023) for the U.S. tri-party repo market, Eisenschmidt, Ma, and Zhang (2022) for the European repo market, and Du et al. (2024) for the credit default swap market. Wallen (2022) further argues that large spikes in CIP deviations can, in part, be attributed to dealer price discrimination.

Finally, our segmented-market model is in the tradition of Gabaix and Maggiori (2015) and Itskhoki and Mukhin (2021) – see Maggiori (2022) for a survey. It is closest to the continuous-time models of d'Avernas et al. (2024) and Kubitza, Sigaux, and Vandeweyer (2025). Like in the former, the household obtains liquidity services from both deposits and repos. Like in the latter and in Jermann (2020), the intermediary is constrained. Yet, instead of quadratic balance sheet costs, we consider a classic leverage constraint that is stronger at quarter-ends and a liquidity constraint that applies to off-balance sheet swaps at year-ends and focus on the equilibrium prices and quantities on the repo and FX swap markets.

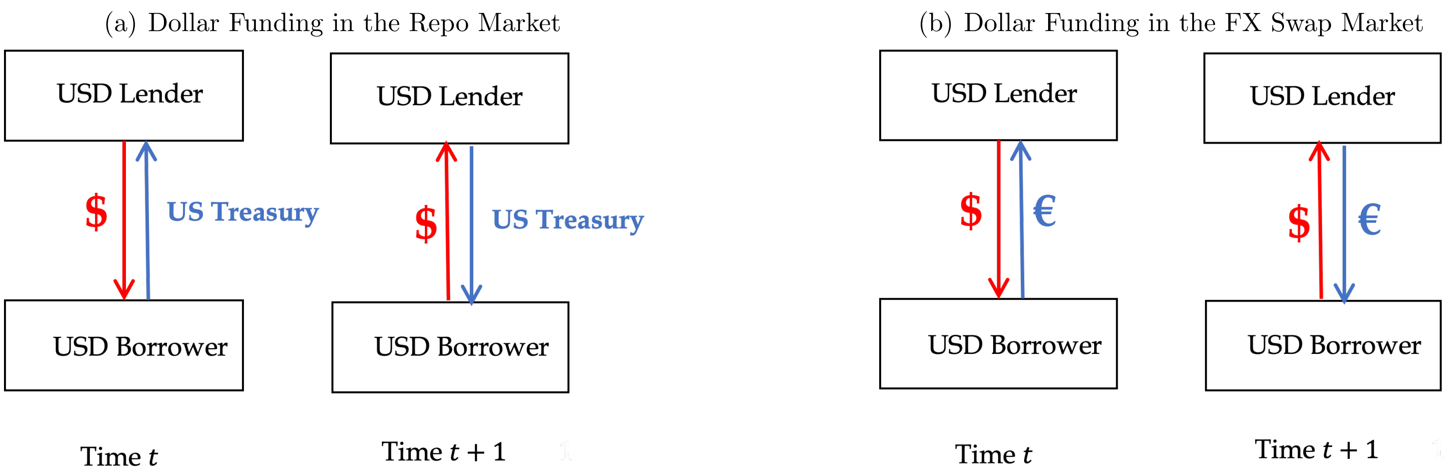
This remainder of the paper proceeds as follows. Section 2 describes the repo and FX swap markets. Section 3 introduces our datasets. Section 4 presents key summary statistics for the two markets. Section

5 examines the dispersion in funding rates across markets and participants. Section 6 presents a stylized model connecting the repo and FX swap markets. Section 7 tests the model's predictions on substitution between the markets during stress days. Section 8 concludes.

2 Repo and FX Swap Markets

Repos and FX swaps are the two key short-term dollar funding instruments. We first describe the mechanics and cash flows of these instruments, along with the differences in their regulatory treatment.

Figure 1: Dollar Funding in the Repo and FX Swap Market

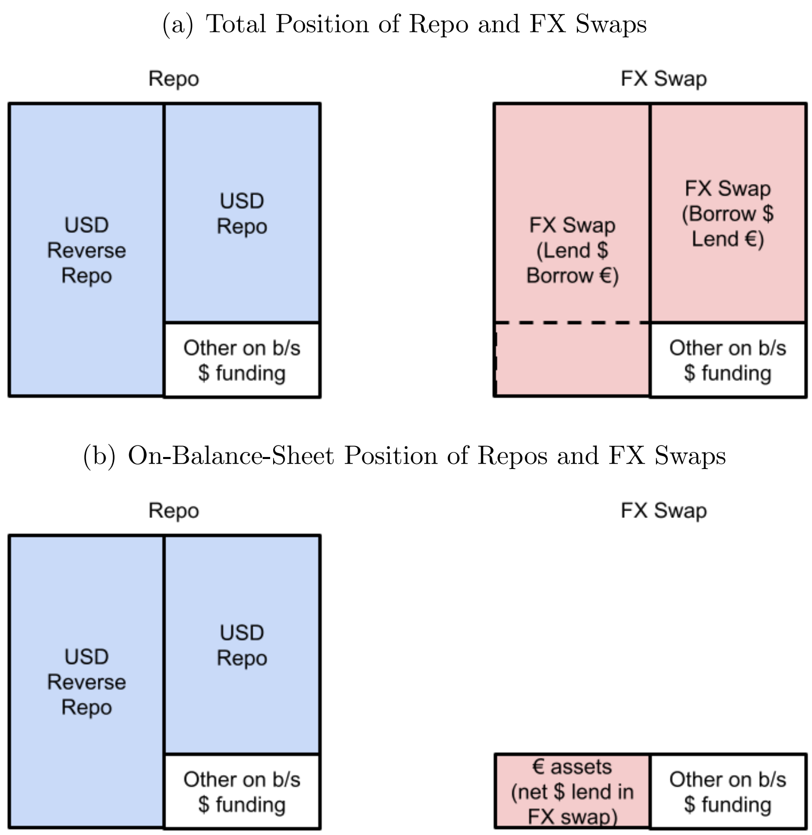


Notes: Panel (a) shows the cash flows of a repo contract. Panel (b) shows the cash flows of a EUR-USD FX swap contract.

Figure 1 schematically illustrates these two types of dollar funding – in panel (a) via the repo market and in panel (b) via the FX swap market. In Panel (a), at the inception of a repo loan, the lender provides US dollar cash to the borrower, while the borrower pledges collateral — typically U.S. Treasury bonds — to the lender. At loan maturity, the borrower repays the principal and interest, and the lender returns the Treasury collateral to the borrower.

Panel (b) depicts an FX swap transaction. At the inception of the transaction, the dollar borrower exchanges euro cash flows for dollar cash flows with the dollar lender. At maturity, the borrower returns the borrowed dollars to the lender in exchange for euros at a predetermined forward exchange rate. From the perspective of the dollar borrower, the FX swap functions as a dollar funding instrument, with the euro cash flow effectively serving as collateral for the dollar borrowing.

Figure 2: Balance Sheet Implications of Repos and FX Swaps



Notes: Panel (a) illustrates the total repo and FX swap positions of a bank. The bank has a net positive lending position in both repo and FX swap markets. Panel (b) illustrates the on-balance-sheet positions.

Repo and FX swap positions have distinct balance sheet implications for banks. Under Basel III, repo transactions cannot be netted out when calculating the leverage ratio. As shown in Figure 2, the matched-book gross repo position in Panel (a) translates dollar for dollar into an on-balance-sheet position in Panel (b). In contrast, matched-book FX swap activities remain largely off-balance-sheet, except for the initial and variation margins, which constitute only a small percentage of the trade's total notional value. If FX swap market borrowing matches FX swap market lending, balance sheet usage increases only by the margins. However, if net FX swap lending is financed through other on-balance-sheet borrowing — such as repos, as illustrated in Panel (b) of Figure 2 — this net lending appears on the balance sheet. Specifically, if a bank is a net lender of dollars in the euro-dollar FX swap market, it receives euro cash flows today and invests in euro-denominated assets. These euro assets, associated with dollar swap lending, appear on the bank's balance sheet.

Beyond the leverage ratio calculation, repos and FX swaps also have distinct implications for the Global Systemically Important Bank (G-SIB) capital surcharge. The G-SIB framework assesses systemic risk using multiple indicators, including size, interconnectedness, and complexity. Since repos remain on balance sheet and contribute directly to a bank's total exposures, they can increase the size-based score and interconnectedness measures, potentially raising a bank's G-SIB surcharge. Meanwhile, even though FX swaps are largely off-balance-sheet and their direct impact on size-based metrics is more limited, FX swap activities can affect a host of other systemic risk indicators, such as complexity and cross-jurisdictional activity, especially when they involve a broad network of counterparties. As a result, FX swap activities can be more costly than repos from the perspective of the G-SIB capital surcharge.

3 Data and Sample

We utilize two transaction-level datasets from the European Central Bank (ECB) to study repo and foreign exchange (FX) swap markets: the Money Market Statistical Reporting (MMSR) dataset and the Securities Financing Transactions Regulation (SFTR) dataset.

3.1 MMSR Reporting

For FX swaps, our analysis relies on transaction-level data collected under the MMSR framework, established by the ECB in 2016. Under MMSR reporting (until 2024), up to 46-51 major euro area banks submit daily transaction reports on their FX swap activities,[1] covering transactions with maturities of up to one year (defined as transactions maturing within 397 days after the settlement date). The reporting requirement includes FX swaps where euros are exchanged against a foreign currency on a near-term value date, with an agreement to reverse the trade at a pre-agreed future maturity date. These transactions are reported when conducted with financial corporations (excluding central banks where the transaction is not for investment purposes), general government entities, and non-financial corporations classified as "wholesale" under the Basel III liquidity coverage ratio (LCR) framework.[2]

We focus on euro-dollar swap contracts within the MMSR reporting framework. Each transaction record includes day-stamped trade details, counterparty type, currency pair, notional amount, forward points, and maturity. Additionally, when available, the dataset provides counterparty identifiers, including Legal Entity Identifiers (LEI).

One limitation of the MMSR dataset is that it does not directly report counterparty positions. To address this, we reconstruct counterparty positions using transaction data. Given that our sample covers contracts with maturities of up to one year, we employ a one-year burn-in period to infer the hypothetical open positions that would exist if all contracts were held until maturity. As a result, reconstructed position data become observable starting from August 2017.

3.2 SFTR Reporting

For repo transactions, we utilize the ECB SFTR dataset, focusing specifically on US dollar-denominated repos. Gradually phased in from the year 2020 onward, the SFTR dataset provides a comprehensive and standardized collection of repo transaction and position data for the euro area. The dataset covers transaction-level details, including trade date, counterparty type, collateral characteristics, interest rates, haircuts, and trade life cycle events. Compared to MMSR reporting, SFTR has a broader scope in terms of counterparty

[1]In 2024, 24 banks were added to (and one dropped from) the set of reporting banks. To have time series of meaningful length, we focus in this paper on the the banks reporting since 2016.

[2]LCR denotes the liquidity coverage ratio. The list of reporting banks and the legal framework is available at https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/money_market/html/index.en.html. European Central Bank (2021) provides summary statistics.

coverage, as it applies to both financial and non-financial entities. Additionally, SFTR reporting generally requires that both sides of a transaction domiciled in Europe be reported, enhancing its comprehensiveness.

The US dollar-denominated repo transactions in SFTR data encompass both tri-party and bilateral repos, including both centrally cleared and non-centrally cleared transactions. This dataset represents the most comprehensive collection of dollar repo market activity available for European banks to date. In contrast, U.S. repo market data are more fragmented. In the United States, transaction and position data are only available for tri-party repos and centrally cleared bilateral repos, while non-centrally cleared bilateral repo transactions are not readily observable. In 2024 the U.S. Treasury's Office of Financial Research (OFR) initiated a pilot data collection effort for uncleared bilateral repo transactions. Given that non-centrally cleared bilateral repos can account for more than two-thirds of total repo volume, SFTR reporting provides a significantly more complete account of repo market activity than any other existing data source.

3.3 Sample Construction

Our primary sample consists of the FX swap and repo activities of euro-area banks that report to the MMSR dataset, referred to as "MMSR banks" throughout the paper. We include all transactions where at least one counterparty is an MMSR bank. Since MMSR data became available earlier than SFTR data, our sample period for FX swap activities extends from August 2017 to August 2024, while the combined sample of repo and FX swap activities covers the period from May 2021 to August 2024.

A key challenge in analyzing jointly both datasets is that large global banks often operate through multiple subsidiaries, which may engage in repo and FX swap transactions separately. To address this, we utilize data from the Global Legal Entity Identifier Foundation (GLEIF) to construct a comprehensive mapping of all subsidiary Legal Entity Identifiers (LEIs) for MMSR banks. By integrating subsidiary-level information, we consolidate repo and FX swap activities at the parent bank level, enabling a more comprehensive analysis of the interactions between these markets.

4 Measurements and Summary Statistics

This section presents key summary statistics both for the FX swap market and repo market.

4.1 Trading Volume and Positions in the FX Swap and Repo Markets

Looking first at the quantities, Table 1 presents the average daily trading volume and positions in dollar-euro FX swaps and dollar repos over the period 2021– 2024. Panel A considers the overall market, including transactions both between two MMSR banks and between MMSR banks and their clients, while Panel B provides a breakdown of MMSR banks' borrowing and lending activities by counterparty type.

We can see that the FX swap and U.S. repo markets are two sources of dollars that are comparable in magnitudes. The daily average volume in the FX swap market in our sample is about €212 billion. Since the latest 2022 BIS triennial survey reports a daily transaction volume of $1 trillion on the euro-dollar FX swap market (Table 3.6, page 19), our dataset for MMSR banks describes approximately 23% of the total euro-dollar FX swap market. The average daily volume of USD repos with MMSR banks as a counterparty is €781 billion.

While the repo market appears significantly larger than the FX swap market in terms of average transaction volume, repo transactions pertain to shorter maturities, and thus need frequent roll-over, making positions a more informative measure. Average outstanding FX swap positions (€2,353 billion) actually exceed those in repos (€1,515 billion), underscoring the critical role of the FX swap market in dollar liquidity management. The importance of the FX swap market appears not just on average but every day of our sample. Figure 3 shows the gross dollar borrowing and lending in the FX swap market over the 2017–2024 period. Both gross borrowing and gross lending positions in the FX swap exceed €1 trillion for most of the sample period and continuously so since 2022. Figure 4 shows the analogous gross US dollar repo borrowing and lending over the 2021–2024 period. Both borrowing and lending positions show an upward trend since 2023, but the repo gross positions remain smaller than the corresponding FX swap positions, in particular for US dollar lending.

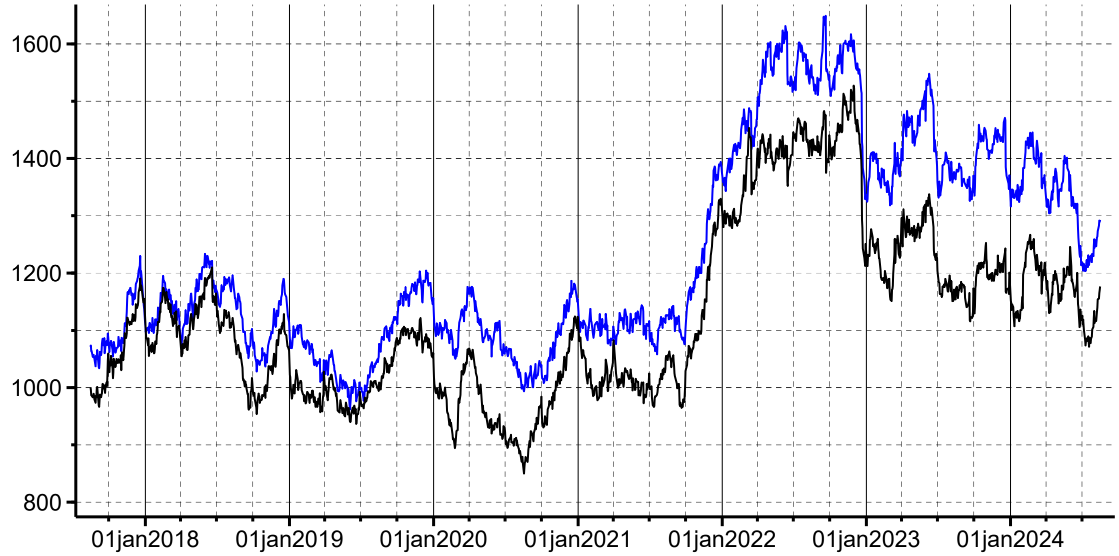
Table 1: Average daily volume and position in dollar-euro FX swaps and repos (2021-2024)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FX swap market				Repo market			
	Transactions		Positions		Transactions		Positions	
	bn	%	bn	%	bn	%	bn	%
Panel A: Overall market								
MMSR banks borrowing USD from non-MMSR	77.5	36	975	41	432.9	47	614	41
MMSR banks lending USD to non-MMSR	103.4	48	1112	47	200.3	22	437	29
MMSR banks on both sides	31.6	16	266	11	148.2	16	267	18
no MMSR bank involved	n.a.	n.a.	n.a.	n.a.	136.6	15	196	13
total	*212.5*	*100*	*2353*	*100*	*918.0*	*100*	*1515*	*100*
Panel B: Client-facing market								
MMSR banks borrowing USD from …								
… non-MMSR banks	51.8	67	556	57	29.3	7	71	12
… pension & insurance	1.7	2	17	2	7.5	2	10	2
… other non-bank fin. inst.	16.5	21	258	26	311.9	72	430	70
… non-financial corporations	4.8	6	86	9	35.1	8	42	7
… governments & central banks	2.6	3	58	6	5.5	1	10	2
total	*77.5*	*100*	*975*	*100*	*389.3*	*90*	*563*	*93*
MMSR banks lending USD to …								
… non-MMSR banks	62.2	60	474	43	15.5	8	65	15
… pension & insurance	5.1	5	148	13	2.8	1	16	4
… other non-bank fin. inst.	28.7	28	363	33	166.3	83	314	72
… non-financial corporations	5.7	5	81	7	5.0	3	11	2
… governments & central banks	1.6	2	46	4	2.8	1	15	3
total	*103.4*	*100*	*1112*	*100*	*192.4*	*96*	*421*	*97*
MMSR banks borrowing USD from …								
… U.S.	23.7	31	307	31	295.8	68	372	60
… U.K.	9.0	12	104	11	14.8	3	29	5
… Europe, excluding U.K.	26.3	34	311	32	57.1	13	82	14
… rest of world	18.5	24	253	26	63.8	15	129	21
total	*77.5*	*100*	*975*	*100*	*431.5*	*100*	*612*	*100*
MMSR banks lending USD to …								
… U.S.	32.1	31	256	23	86.2	43	149	34
… U.K.	9.6	9	99	9	6.1	3	21	5
… Europe, excluding U.K.	35.9	35	587	53	4.1	2	18	4
… rest of world	25.8	25	170	15	102.0	51	246	56
total	*103.4*	*100*	*1112*	*100*	*198.4*	*99*	*434*	*99*
MMSR banks borrowing at maturity …								
… 1 day	35.6	46	37	4	260.5	60	303	49
… 2–14 days	20.6	27	65	7	108.7	25	152	25
… 15–32 days	9.7	13	183	19	18.6	4	47	8
… 33–362 days	11.5	15	692	71	45.1	10	112	18
total	*77.5*	*100*	*975*	*100*	*432.9*	*100*	*614*	*100*
MMSR banks lending at maturity …								
… 1 day	52.1	50	53	5	114.0	57	139	32
… 2–14 days	26.0	25	74	7	52.1	26	89	20
… 15–32 days	12.4	12	236	21	13.5	7	53	12
… 33–362 days	12.9	12	751	67	20.6	10	156	36
total	*103.4*	*100*	*1112*	*100*	*200.2*	*100*	*437*	*100*

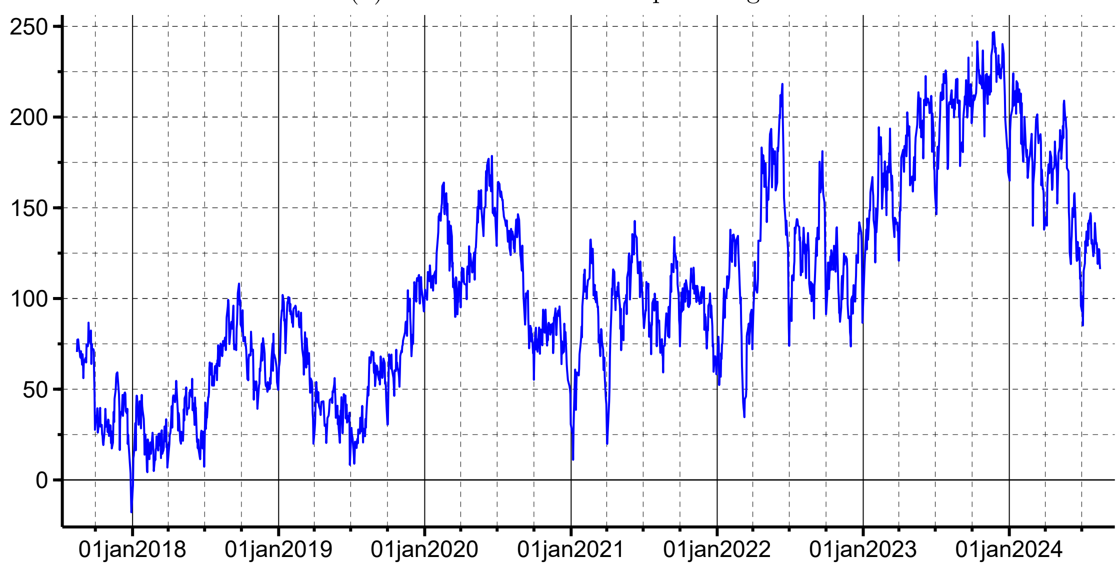
Notes: This table reports the average daily volume and position on regular trading days (808 for FX swap, 806/800 for repo) in contracts with a maturity at initiation of up to 362 days. Columns (1) to (4) cover dollar-euro FX swap contracts as reported by MMSR banks, columns (5) to (8) dollar-euro securities financing transactions (in particular repurchase transactions) as reported by the financial counterparties established in the European Union (EU), their foreign branches, or by the EU branches of foreign financial counterparties. Columns (1) and (5) report transaction volumes, columns (3) and (7) positions – all in billions of euros – with the respective percentages in the remaining columns. Category breakdowns do not sum to 100 percent due to rounding and unclassified transactions. Panel A covers all reported contracts, while Panel B only contracts between MMSR banks and non-MMSR clients. Sample period 15 May 2021 to 15 August 2024. Including intra-company trades. UK overseas territories are included under "rest of world".

Figure 3: US dollar FX swap lending and borrowing positions of MMSR banks (in billions of euros)

(a) Gross US dollar FX swap lending and borrowing



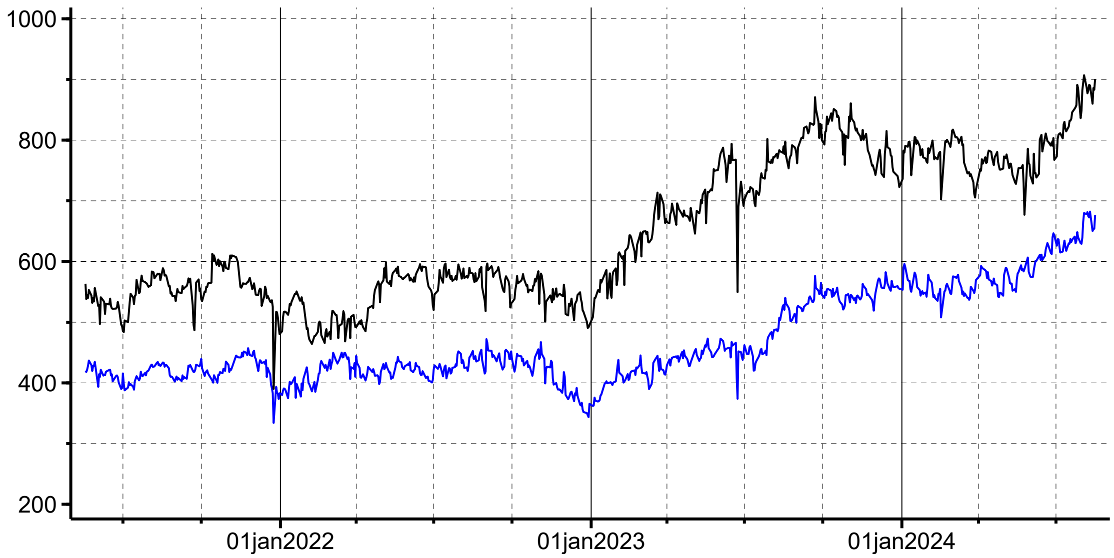
(b) Net US dollar FX swap lending



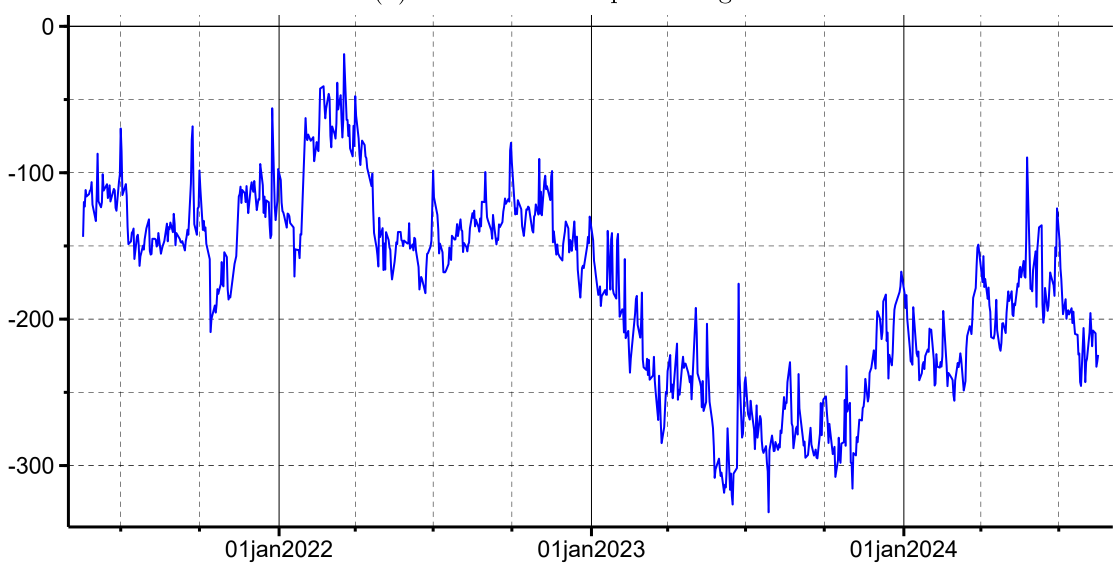
Notes: The upper panel reports the US dollar FX swap lending (in blue) and the US dollar FX swap borrowing (in black) positions of MMSR banks on regular FX trading days. The lower panel plots the US dollar FX swap net lending positions. The dataset comprises contracts with a maturity of up to one year and the positions are estimated from transaction data. The graphs show the implied positions from August 15, 2017 to August 15, 2024.

Figure 4: US dollar repo lending and borrowing positions of MMSR banks (in billions of euros)

(a) Gross US dollar repo lending and borrowing



(b) Net US dollar repo lending



Notes: The upper panel reports the US dollar repo lending (in blue) and the US dollar repo borrowing (in black) positions of MMSR banks on regular FX trading days. The lower panel plots the US dollar repo net lending positions. The dataset comprises contracts with a maturity of up to one year and excludes intragroup positions. The graphs show the implied positions from August 15, 2017 to August 15, 2024.

MMSR banks' gross positions in both markets are significantly larger than net positions. MMSR banks are net lenders of dollars in the FX swap market, with a net lending position of 1,112 - 975 = €137 billion. Conversely, they are net borrowers of dollars in the repo market, with a net borrowing position of 614 - 437 = €177 billion. The lower panels of Figures 3 and 4 illustrate similar trends over time. Gross positions in both markets are of comparable magnitudes and significantly larger than net positions.

The total amount of dollars obtained in the repo market closely tracks the total amount of dollars lent in the FX swap market. Figure 5 shows the net US dollar lending on the FX swap and repo markets for the overlapping sample period. In that figure, the red line denotes the sum across markets of these two net positions. The position data reveal that on aggregate, MMSR banks are net borrowers of US dollars in the repo market (€100–300 billion) and net lenders in the FX swap market (€100–200 billion) during the period 2021–2024. Their combined net position across both markets is typically close to zero, rarely exceeding €100 billion. This contrasts sharply with their gross exposure of €1.9 trillion across both markets,[3] underscoring the critical role of MMSR banks as global financial intermediaries for dollar funding.

In terms of counterparty breakdown, we aggregate MMSR-counterparties in five broad sectors: (i) non-MMSR banks, i.e. deposit-taking corporations that do not report to MMSR, (ii) pension funds and insurance companies, (iii) other non-bank financial institutions (e.g., investment funds, money market funds, financial intermediaries excluding pension funds and insurance companies, financial auxiliaries, and captive financial institutions), (iv) non-financial corporations, and (v) government and central banks.

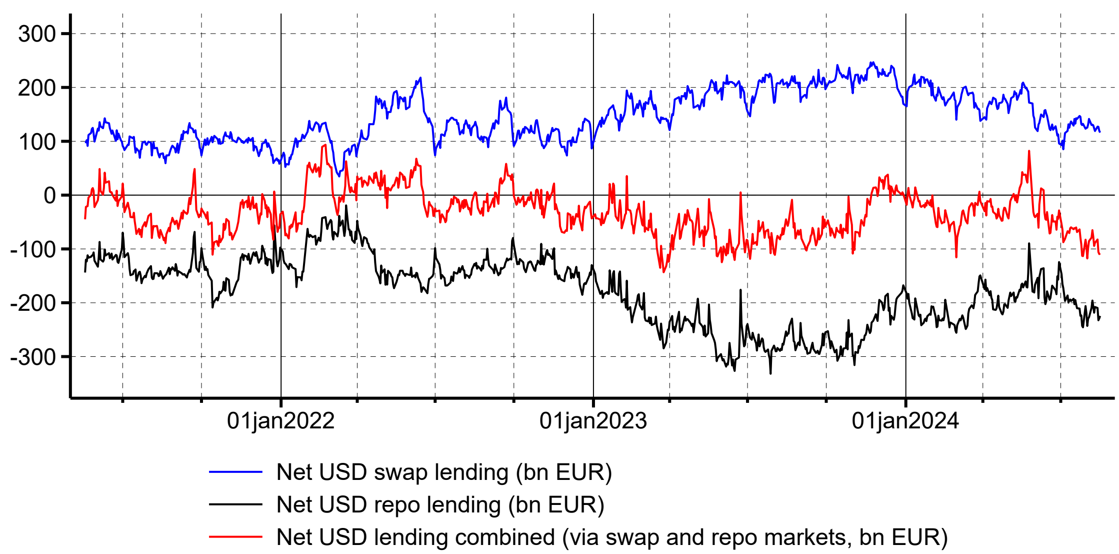
Transactions among MMSR banks account for 11% and 18% of the FX swap and repo markets, respectively. The remainder of the activity involves MMSR banks dealing with other non-MMSR counterparties. When transacting with non-MMSR counterparties, MMSR banks primarily borrow dollars from non-MMSR banks (€556 billion, 57% of the total dollar borrowing by MMSR banks on their FX swap client-facing market) and other non-bank financial institutions (€258 billion, 26%), while in the repo market, they mainly borrow from non-bank financial institutions (€430 billion, 70%), predominantly U.S. money market funds. On the lending side, MMSR banks provide dollars to non-MMSR banks (€474 billion, 43%), other non-bank

[3] E.g. for the borrowing side in Table 1 we get €975 + €614 + (€266 + €267)/2 = €1855. The analogous number for the lending side is only marginally smaller.

financial institutions (€363 billion, 33%), and pension and insurance firms (€148 billion, 13%) in the FX swap market. In the repo market, they primarily lend to non-bank financial institutions (€314 billion, 72%). Non-financial corporations account for around €5 billion of FX swap transactions per day on average and accumulate borrowing positions up to €80 billion. Their presence is much more limited on the repo market: they lend for €42 billion but their total borrowing position is only €11 billion on average.

On net and in average, in the FX swap market, MMSR banks borrow dollars from non-MMSR banks (556-474 = €82 billion) and lend dollars to pension and insurance firms (148-17 = €131 billion) and non-bank financial institutions (363-86 = €277 billion). In the repo market, they mainly borrow dollars from non-bank financial institutions (430-314 = €116 billion), again primarily from U.S. money market funds. To sum up, inter-bank trading accounts for the majority of the FX swap trading, while non-bank financial institutions are key on the repo market. MMSR banks intermediate repo funding from money market funds to other non-bank financial institutions, such as hedge funds.

Figure 5: Net US dollar lending: swap and repo, and their sum (in billions of euros)



Notes: The figure shows the US dollar swap net lending (in blue) and the US dollar repo net lending (in black) positions of MMSR banks on regular FX trading days. The red line shows the combined net lending position on both markets. The dataset comprises contracts with a maturity of up to one year. The graph shows the positions from May 15, 2021 to August 15, 2024.

Let us turn now to the geography and maturity dimensions of the FX swap and repo markets. The geographical distribution of MMSR activity across regions (U.S., U.K., Europe excluding the U.K., and the rest of the world) shows that MMSR banks source 60% of their repo dollars from the U.S., while their swap-based dollar funding is more geographically diversified. Their swap-based dollar lending is concentrated in Europe (53%), while a large share of their repo lending is with the rest of the world (56%), primarily hedge funds and other non-bank financial institutions domiciled in offshore financial centers. Finally, Table 1 also provides further details on transactions by maturity. On average, FX swaps have longer maturities in our sample than repos. 74% of MMSR repo borrowing positions are in short-term contracts of less than 14 days, whereas 88% of their swap-based lending is at maturities exceeding 14 days.

4.2 Pricing in the FX Swap and Repo Markets

To analyze pricing in the FX swap spread, we first express the forward points observed in the MMSR data as CIP deviations or as implied dollar funding costs. We define the CIP deviation as the difference between the implied dollar funding cost, $y^{€}_{t,t+n} + \rho_{t,t+n}$, and the direct dollar funding cost $y^{\$}_{t,t+n}$:

$$x_{t,t+n} = (y^{€}_{t,t+n} + \rho_{t,t+n}) - y^{\$}_{t,t+n}. \tag{1}$$

When CIP holds, $x_{t,t+n}$ is zero. The FX premium is derived from the spot and forward exchange rates:

$$\rho_{t_0,t_m} = \frac{360}{ACT(t_s, t_m)} \frac{\Phi_{t,t_m}}{S_t}, \tag{2}$$

where $ACT(t_s, t_m)$ denotes the number of calendar days between the spot settlement date t_s and the forward settlement date t_m. The forward point $\Phi_{t,t_m} = F_{t,t_m} - S_t$ represents the difference between the forward rate F_{t,t_m} and the spot rate S_t.

CIP deviations inferred from MMSR bank transactions closely track Bloomberg's quote-based CIP deviations. While our dataset includes both bespoke (e.g., nine-day) and benchmark maturities (e.g., one

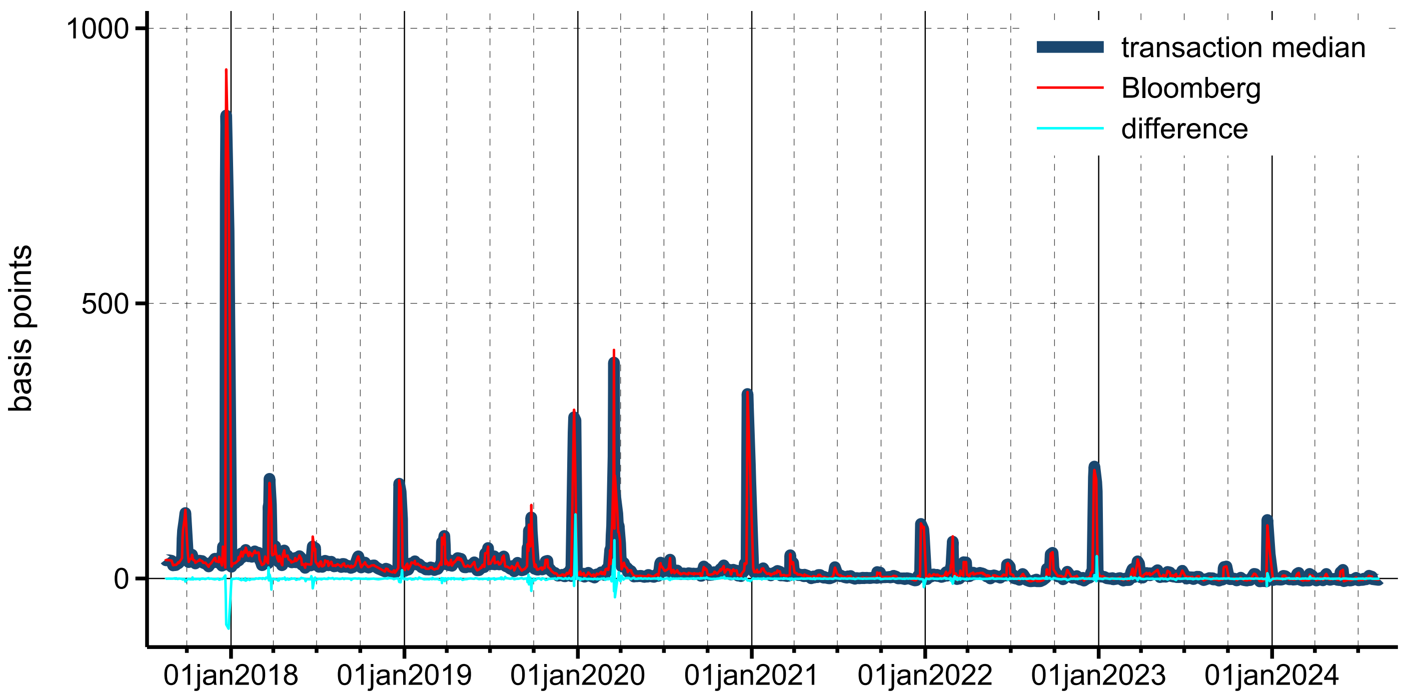
Table 2: Difference between transaction- and quote-based CIP deviations (volume-weighted, in basis points)

		All days				Period-end crossing days			
		TN	1W	1M	3M	TN	1W	1M	3M
(a) 2017–2021									
median	avg.	-0.1	-0.6	-0.2	-0.1	17.6	-3.5	-0.4	-0.2
	std.	9.4	7.0	2.6	1.7	50.5	22.5	4.3	1.5
p10	avg.	-5.3	-3.3	-2.1	-1.2	-58.2	-14.7	-4.0	-1.5
	std.	19.9	9.0	5.3	3.0	108.7	24.5	8.7	1.9
p90	avg.	5.8	2.4	1.7	0.9	81.0	11.5	3.4	1.1
	std.	26.5	12.4	5.2	2.8	121.0	31.9	8.4	2.2
CIP level	*avg.*	*21.8*	*28.8*	*35.0*	*35.5*	*153.3*	*119.4*	*56.5*	*45.8*
Funding cost	*avg.*	*149.9*	*156.6*	*162.7*	*163.6*	*282.2*	*242.1*	*181.9*	*177.2*
(b) 2021–2024									
median	avg.	-0.2	-0.3	-0.1	-0.1	1.2	0.1	-0.1	-0.2
	std.	2.0	2.1	0.8	0.9	5.4	6.7	1.3	0.8
p10	avg.	-2.0	-1.5	-1.1	-0.9	-11.4	-5.6	-1.9	-1.2
	std.	3.0	3.2	3.0	1.3	8.8	9.0	4.7	1.2
p90	avg.	2.0	0.9	0.9	0.8	19.6	5.0	1.6	1.2
	std.	6.3	3.3	1.9	2.6	22.4	10.2	2.8	4.5
CIP level	*avg.*	*1.9*	*4.9*	*9.2*	*13.7*	*46.8*	*39.3*	*18.9*	*28.1*
Funding cost	*avg.*	*310.8*	*317.5*	*327.7*	*343.4*	*350.7*	*344.5*	*324.0*	*349.2*

Notes: This table reports the difference, in basis points, between the MMSR transaction-based and the Bloomberg quote-based CIP deviations on the dollar-euro FX swap transactions for four benchmark maturities: tomorrow-next, one week, one month, and three months. The left columns cover all days in the sample, while the right columns focus on days when the respective swap contracts cross a quarter end (respectively a year end for three-months contracts). The first pair of rows in each panel reports the averages and standard deviations of the daily median differences between the transaction-based and the Bloomberg quote-based CIP deviations. The second and third pairs of rows report the same summary statistics on the 10th and 90th percentiles of these differences. The last two rows of each panel report the average across days of the daily CIP level median for the given tenor, and the respective average implied dollar funding cost, i.e. the CIP level plus the USD OIS rate. All quantities are in basis points. The percentiles are based on volume-weighted observations within a given business day. The sample in panel (a) runs from 15 August 2017 to 15 May 2021, and in panel (b) from 15 May 2021 to 15 August 2024.

week, one month, three months), Bloomberg quotes only cover benchmark maturities. Table 2 reports the difference between CIP deviations obtained from Bloomberg quotes and those derived from MMSR transactions, focusing on four benchmark tenors: tomorrow-next (one day), one week, one month, and three months. Bloomberg reports median quotes on spot, forward, and overnight interest swap (OIS) rates, which we use to compute CIP deviations as defined in Equation (1) in order to match the maturity of the forward contract.

Figure 6: Deviations from CIP: transaction-based medians of FX swaps vs. Bloomberg quotes



Notes: The dark blue line plots the the median value of all CIP deviations in one-week contracts in the EUR-USD FX swap market of MMSR banks on regular FX trading days. The transactions are volume-weighted and the CIP deviation is in basis points. For confidentiality reasons, some trade dates are suppressed. The thin red line is the corresponding CIP deviation according to Bloomberg. The light blue line shows the difference between the the actual median value and the Bloomberg counterpart. The sample period runs from August 15, 2017 to August 15, 2024.

Figure 6 plots the transaction-based, volume-weighted median CIP deviations in the FX swap market, for the one-week benchmark tenor, along with their Bloomberg counterpart over the 2017-2024 period. Figure 8 plots the transaction-based, volume-weighted median repo rate (over maturities up to one year), along with the Secured Overnight Financing Rate (SOFR) counterpart over the 2021-2024 period.

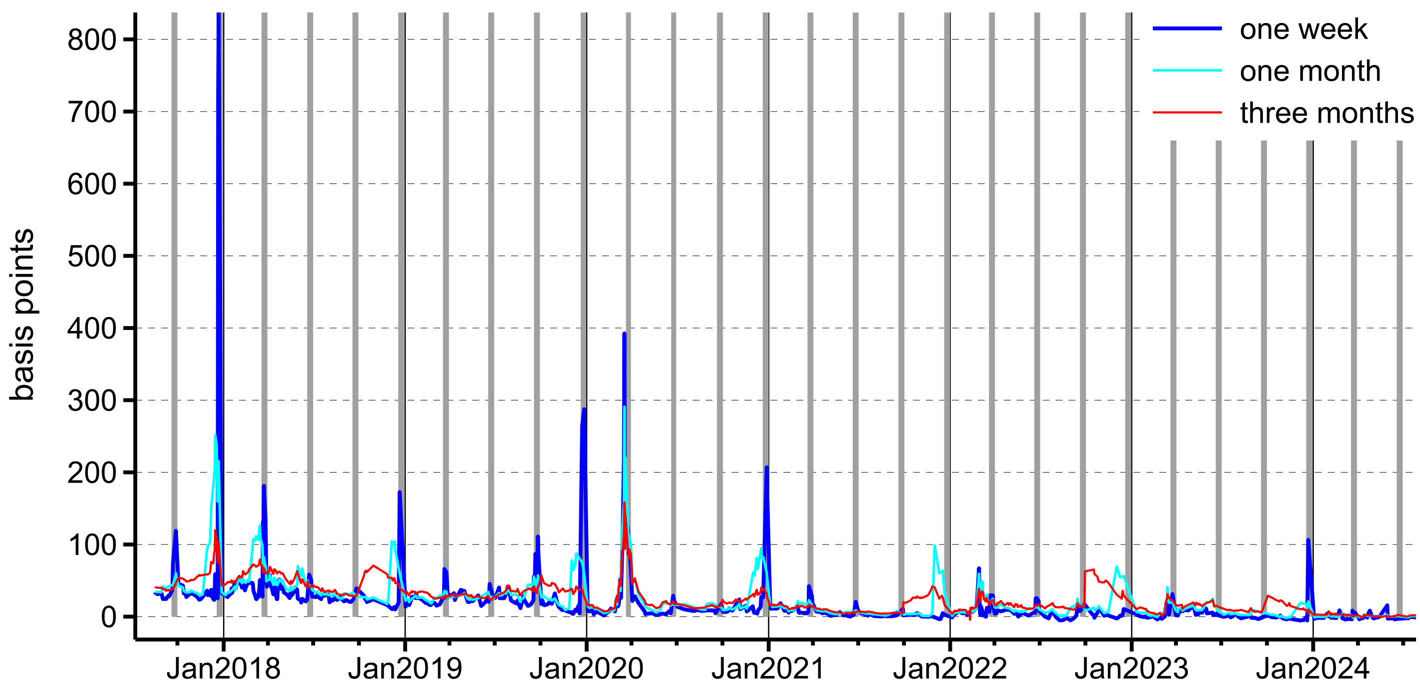
Our dataset closely replicates the patterns observed in Bloomberg quotes. As Table 2 reports, the median difference between quote-based and transaction-based CIP deviations ranges from 0.1 to 0.4 basis point on average across all sample days. As Figure 6 shows for the one-week contract, the quote-based and transaction-based CIP deviations lie nearly on top of each other. This comparison confirms the quality of MMSR data, particularly its timestamps and implied contract maturities. Larger discrepancies appear for contracts crossing quarter-end dates when prices spike: the median difference ranges from 0.2 basis point at the one-month horizon to 9 basis points at the overnight horizon.

While Bloomberg provides only the median quote, our dataset offers a much richer view by capturing all MMSR bank transactions. This enables an analysis of the full distribution of CIP deviations on any given day. At the 10th and 90th percentiles, the differences between actual transactions and Bloomberg's median quote range from 2 to 9 basis points on average, with standard deviations between 4 and 34 basis points. The largest differences between quote- and transaction-based CIP deviations occur at shorter maturities.

Furthermore, the CIP deviations based on transaction prices also match the quarter-end dynamics documented in the literature. Du et al. (2018) show that pattern using Bloomberg quotes from the 2014–2016 period. Figure 7 replicates their findings with actual transactions based on the MMSR data. One-week CIP deviations spike during the last week of each quarter, one-month deviations spike during the last month of the quarter, while three-month CIP deviations tend to be more stable. The largest spikes occur at year-ends, for the shortest maturities.

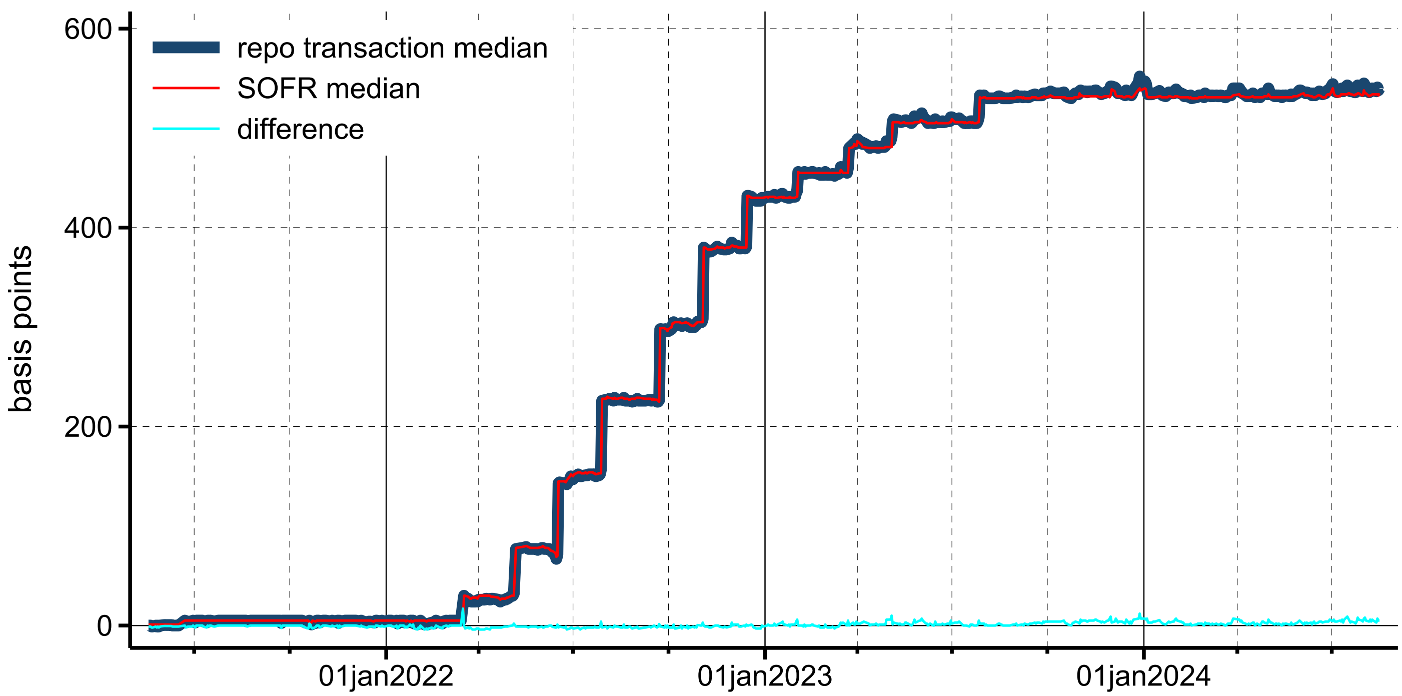
For repo rates, Figure 8 shows that the median repo rate closely tracks the SOFR rate, the volume-weighted median rate of all repo transactions in the U.S. Table 3 reports the dispersion in repo rates across transactions, measured as the spread over the OIS rate for a given maturity. Compared to the implied funding rates in the FX swap market, repo rates exhibit greater dispersion, particularly for contracts longer than one week. While the median repo rate is within five basis points of the OIS rate for the corresponding maturity, the 10th and 90th percentiles can diverge by 30–40 basis points from the OIS rate.

Figure 7: Short-term deviations from covered interest rate parity



Notes: The figure plots the daily CIP deviations for the euro vs the US dollar for one-week, one-month, and three-month contracts, shown, respectively, as blue, light blue, and red line. Daily transaction volume weighted medians. For confidentiality reasons many trade dates are suppressed. The sample period runs from 15 August 2017 to 15 August 2024.

Figure 8: Repo rate: transaction-based median vs SOFR benchmark



Notes: The dark blue line plots the repo rate of MMSR banks on regular FX trading days in basis points. It corresponds to the daily, volume-weighted median over maturities up to one year, focusing on repo contracts with USD government collateral only. For confidentiality reasons some trade dates are suppressed. The thin red line is the corresponding SOFR median rate. The light blue line shows the median difference between the median transaction-based value and the SOFR benchmark. The sample period runs from May 15, 2021 to August 15, 2024.

Table 3: Repo spread (volume-weighted, in basis points)

		All days				Period-end crossing days			
		≤4d	1wk	1m	3m	≤4d	1wk	1m	3m
median	avg.	-2.9	-0.7	4.2	3.8	-1.7	-0.9	12.0	-3.7
	std.	3.5	6.4	131.8	59.8	12.7	13.8	208.0	81.6
p10	avg.	-10.4	-12.8	-22.3	-32.1	-23.1	-23.8	-28.1	-55.8
	std.	5.3	39.9	84.7	119.8	53.1	83.0	104.1	175.5
p90	avg.	3.7	4.4	42.9	31.8	3.7	6.7	58.6	14.5
	std.	5.9	8.5	323.8	174.8	13.3	18.8	388.6	84.6
OIS rate	*avg.*	*309.4*	*312.4*	*318.2*	*330.1*	*278.9*	*299.8*	*309.3*	*321.5*

Notes: This table reports the difference between the repo transaction rate and the corresponding USD OIS rate on dollar-euro repo transactions for different maturities: up to four days, one or two weeks, one month, and three months. The left columns cover all days in the sample, while the right columns focus on days when the respective swap contracts cross a quarter end (respectively a year end for three-months contracts). The first pair of rows reports the averages and standard deviations of the median spread, and the second and third pairs of rows the same summary statistics on the 10th and 90th percentiles of these spreads. The last row reports the average USD OIS rate. All quantities are in basis points. The percentiles are based on volume-weighted observations within a given business day. Only repos with USD government collateral. The sample runs from 15 May 2021 to 15 August 2024.

5 Dispersion in Funding Rates

In this section, we formally examine the dispersion in funding rates across markets and participant types. We first analyze FX swap and repo markets separately before comparing price differences across counterparties.

5.1 Price Dispersion within Markets

We report evidence of price dispersion in the dollar-euro FX swap market. Our findings indicate that the dollar funding cost for a given maturity, on a given day, and for a given reporting MMSR bank, varies depending on the counterparty.

To isolate differences between counterparty types, we remove the effect of trading day, dealer bank, and maturity with the following regression specification:

$$y_{it} = \alpha_t + \alpha_r^R \mathbb{1}_{rcpg(i)=r} + \alpha_m^M \mathbb{1}_{mat(i)=m} + \gamma_{1s} \mathbb{1}_{cps(i)=s} + \gamma_{2s} \mathbb{1}_{cps(i)=s} \times q(t) + \epsilon_{it}, \tag{3}$$

where y_{it} denotes, for transaction i on trading day t, the implied USD interest rate (i.e., the CIP deviation plus the USD OIS rate) obtained from FX swaps or the repo rate, both reported in basis points. $cps(i)$ denotes the sector of the counterparty. All specifications include a time fixed effect, α_t, fixed effects α_r^R for the MMSR bank group pair ($rcpg(i)$) participating in the transaction, and maturity band $mat(i)$ fixed effects α_m^M. The indicator variable $q(t)$ equals one if the contract crosses the end of a period (quarter-end, or year-end for the three-month or longer-term contracts), and zero otherwise. Only repos with USD government collateral are used in the pricing analysis. Standard errors are clustered at the trading date × counterparty-sector level.

Table 4 presents OLS coefficient estimates of Equation (3). Columns (1) and (3) report transactions where MMSR banks borrow US dollars, while columns (2) and (4) cover transactions where MMSR banks lend dollars. We focus on transactions involving at least one MMSR bank. The omitted category includes transactions between MMSR banks in all specifications. Panel (a) displays volume-weighted regression results, while Panel (b) presents equal-weighted results.

Columns (1)–(2) reveal significant price dispersion in the FX swap market, while Columns (3)–(4) highlight similar dispersion in the repo market. MMSR banks exhibit a notable pricing advantage in FX swaps, both in borrowing and lending. When MMSR banks borrow in FX swaps, they pay rates that are, on average, 10–20 basis points lower than those charged to non-MMSR counterparties (Column 1). When lending in the FX swap market, MMSR banks generally maintain a pricing advantage, especially when trading with non-financial firms (Column 2). For other non-MMSR counterparties, MMSR banks lend at FX swap rates that are 2–5 basis points higher than the rates they extend to other MMSR banks. Comparing Columns (1) and (2), we observe that MMSR banks achieve the highest spreads when trading with non-financial firms: they borrow against non-financial firms at rates that are 20 basis points below those offered by other MMSR banks and lend at rates that are 7 basis points higher than those paid by other MMSR banks.

At quarter-ends, both borrowing and lending rates in the FX swap market rise across the board. Column (1) shows that MMSR banks borrow and lend to other MMSR banks at rates that are 27 basis points higher than on non-quarter ends. MMSR banks' borrowing costs from non-MMSR counterparties increase by 2–8

Table 4: FX swap and repo dispersion across sectors (repo with USD gov. coll.)

Counterparty	FX swap market borrowing	FX swap market lending	Repo market borrowing	Repo market lending
	(a) Volume-weighted			
Non-MMSR bank	-14.69**	1.72	-2.06***	3.18
Pension & insur.	-***	2.81	-	5.84*
Oth. non-bank fin.	-15.10***	2.06	-2.13***	6.31**
Non-financial	-20.16***	7.17**	+	+
Government & CB	-11.55**	5.21	5.22***	-1.65
MMSR bank (igrp) × QE			-0.82	-2.80
MMSR bank × QE	26.96***	26.97***	-0.68	0.02
Non-MMSR bank × QE	23.38***	25.80***	-3.67***	9.37***
Pension & insur. × QE	+***	17.43***	-	-6.12
Oth. non-bank fin. × QE	24.25***	23.29***	4.72***	13.99***
Non-financial × QE	18.78***	16.24***	+***	-
Government & CB × QE	19.37***	15.89***	14.45***	33.13***
Observations	965,384	951,681	2,606,147	2,234,262
Within R^2	0.08	0.05	0.002	0.001
	(b) Equal-weighted			
Non-MMSR bank	-2.00	4.72**	-8.06***	-1.27
Pension & insur.	-	8.08***	+	11.13***
Oth. non-bank fin.	-3.69**	8.02***	-3.53***	4.61
Non-financial	-21.69***	27.51***	+***	+
Government & CB	1.05	8.18***	-2.12***	-1.69
MMSR bank (igrp) × QE			-9.67***	-16.42***
MMSR bank × QE	17.12***	21.45***	-3.16	-8.51**
Non-MMSR bank × QE	14.15***	19.83***	-11.97***	5.39**
Pension & insur. × QE	+***	8.10***	+	7.90
Oth. non-bank fin. × QE	11.86***	14.45***	5.70***	6.18**
Non-financial × QE	15.75***	0.29	+***	-**
Government & CB × QE	12.43***	12.53***	8.42**	57.01***
Observations	965,384	951,681	2,606,147	2,234,262
Within R^2	0.04	0.03	0.001	0.001

Notes: This table reports the OLS coefficient estimates of the equation

$$x_{it} = \alpha_t + \alpha_r^R \mathbb{1}_{rcpg(i)=r} + \alpha_m^M \mathbb{1}_{mat(i)=m} + \gamma_{1s} \mathbb{1}_{cps(i)=s} + \gamma_{2s} \mathbb{1}_{cps(i)=s} \times q(t) + \epsilon_{it},$$

where x_{it} denotes for FX swaps the implied USD interest rate (CIP deviation + USD OIS) and for repos the repo rate of transaction i on trading day t in basis points and $cps(i)$ the sector of the counterparty. All specifications include a time fixed effect α_t, fixed effects α_r^R for the MMSR bank group pair ($rcpg(i)$) participating in the transaction, and maturity band $mat(i)$ fixed effects α_m^M. The indicator variable $q(t)$ equals one if the contract crosses the end of a period (quarter-end, or year-end for the three-month or longer-term contracts), and zero otherwise. Columns (1) and (3) cover transactions where MMSR banks borrow US dollars from their counterparties, while the other two columns cover transactions where MMSR banks lend. Only transactions with an MMSR bank on at least one side. Only repos with USD government collateral. The omitted category are transactions between different MMSR reporting banks. The coefficient on transactions without a reported counterparty sector basis points less than their borrowing costs from other MMSR banks, suggesting a modest increase in their pricing power on the borrowing side during quarter-ends. On the lending side, lending rates to non-MMSR counterparties generally rise less than those to MMSR banks, indicating that MMSR banks do not appear to gain additional pricing power in FX swap lending at quarter-ends.

Columns (3)–(4) repeat the analysis for the repo market. Due to limited trading activity by pension funds, insurance companies, and non-financial firms, some regression coefficients are unavailable due to data confidentiality requirements. Overall, MMSR banks also exhibit a pricing advantage in the repo market, borrowing at rates that are 2–5 basis points lower than those paid to other MMSR banks. On the lending side, MMSR banks charge significantly higher rates to non-bank financial institutions (NBFIs), including hedge funds.

The quarter-end results in the repo market are somewhat mixed. Inter-MMSR trades do not exhibit significant rate changes at quarter-ends compared to non-quarter-end periods. However, MMSR banks increase their pricing advantage over non-MMSR banks on both the borrowing and lending sides at quarter-ends. When transacting with NBFIs and government or central banks, MMSR banks' borrowing and lending rates both increase at quarter-ends, but the rise in borrowing rates is smaller than the rise in lending rates. This suggests that MMSR banks continue to earn higher intermediation spreads when trading with these counterparties at quarter-ends.

5.2 Price Dispersion Across Markets

In addition to examining price dispersion within each market, we link the FX swap and repo markets and calculate CIP deviations using the actual FX swap rates and repo rates for a given MMSR bank. Table 5 reports panel regression results for dollar funding rates by pooling repo and FX swap transactions and controlling for the MMSR bank, trading date and maturity fixed effects.

Column 1 of Table 5 shows that the implied dollar funding cost in the FX swap market is on average 6.4 basis points higher than in the repo market without controlling for the direction of the trade. In column 2, we use transactions for which MMSR banks are borrowers as omitted category, and show that MMSR's repo

Table 5: Implied USD funding cost for MMSR bank groups by counterparty sector

MMSR bank lending from / borrowing to counterparty	(1)	(2)	(3)
FX swap	6.35***		
repo lending		7.75***	
repo to non-MMSR bank			3.04***
repo to pension & insur.			-0.67
repo to OnbFI			8.44***
(repo to nfC)			-
repo to gov. & CB			6.51***
FX swap borrowing		9.07***	
FX swap from MMSR bank			9.65***
FX swap from non-MMSR bank			9.18***
(FX swap from pension & insur.)			-
FX swap from OnbFI			9.07***
FX swap from nfC			1.32***
FX swap from gov. & CB			13.20***
FX swap lending		9.94***	
FX swap to MMSR bank			9.80***
FX swap to non-MMSR bank			9.93***
FX swap to pension & insur.			7.76***
FX swap to OnbFI			9.44***
FX swap to nfC			12.78***
FX swap to gov. & CB			8.27***
Observations	5,181,779	5,181,779	5,181,779
Within R^2	0.002	0.01	0.01

Notes: Column (3) reports the OLS coefficient estimates of the equation

$$\begin{aligned} x_{it} &= \alpha_t + \alpha_r^R \mathbb{1}_{rag(i)=r} + \alpha_m^M \mathbb{1}_{mat(i)=m} + \beta \mathbb{1}_{dir(i)=len} \mathbb{1}_{mkt(i)=swp} \\ &+ \gamma_s^{LR} \mathbb{1}_{dir(i)=len} \mathbb{1}_{mkt(i)=repo} \mathbb{1}_{sec(i)=s} + \gamma_s^{LS} \mathbb{1}_{dir(i)=bor} \mathbb{1}_{mkt(i)=swp} \mathbb{1}_{sec(i)=s} + \epsilon_{it}, \end{aligned}$$

where x_{it} denotes for FX swaps the implied USD interest rate (CIP deviation + USD OIS) and for repos the repo rate of transaction i on trading day t in basis points. All specifications include a time fixed effect α_t, fixed effects α_r^R for the reporting agent ($rag(i)$) in the transaction, and maturity band fixed effects α_m^M. The subscript $mkt(i)$ reflects the respective market (swap or repo), the subscript $dir(i)$ the direction of trading (borrowing or lending) from the MMSR bank's perspective and the subscript $sec(i)$ the sector of the counterparty. The specification in column (2) omits the interaction with the counterparty sector, and in column (1) additionally the trade direction. Only transactions with an MMSR bank on at least one side. Only repos with USD government collateral. Excluding transactions without a reported counterparty sector. The estimated fixed effects are not reported. Standard errors are clustered at the trading date × counterparty sector - level. Observations are weighted by notional amount. For confidentiality reasons, some estimates are suppressed and marked by "-". The significance is denoted by stars, where *** means $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$. The sample runs from 15 May 2021 to 15 August 2024.

lending rate is on average 7.8 basis point above the repo borrowing rate. We interpret the spread between repo borrowing and lending rate as the cost of balance sheet usage associated with repo intermediation. In contrast, for FX swaps, we find that the average FX swap borrowing rate is 9 basis point above the average repo borrowing rate and the average FX swap lending rate is 10 basis points higher than the average repo borrowing rate. In other words, MMSR banks' average implied dollar borrowing cost is only 1 basis point lower than the implied lending rate in the FX swap market. The low spread between borrowing and lending rate within FX swap market is consistent with the view that a matched-book FX intermediation is relatively costless from the balance sheet perspective, so the effective bid-offer in the market is very tight.

The panel regression approach allows us to calculate true CIP deviations facing individual MMSR banks based on their actual repo and FX swap transactions. On average we find that the FX lending rate is 10 basis points higher than the repo borrowing rate, which implies MMSR banks earn 10 basis points on average by borrowing in the repo market on net and lending in the FX swap market. In contrast to the matched-book FX swap intermediation, where both dollar borrowing and lending are off balance sheet, a CIP arbitrage trade involves on-balance-sheet repo borrowing, so that the MMSR banks are compensated for using the balance sheet usage.

The rightmost Column 3 of Table 5 breaks down the average intermediation spreads by counterparty types. Consistent with the earlier evidence from Table 4, we can see that the borrowing and lending rates differ across counterparty types. The price dispersion across client counterparty types is considerably smaller once we control for the MMSR counterparty fixed effect.

6 A Two-Market Model

Based on the stylized facts presented so far, we now present a two-market model for the repo and FX swap markets. The model features a dealer who intermediates in both the repo and FX swap markets, facing a balance sheet leverage constraint, and exhibits market power in the lending market in response to sector-specific dollar funding demand. We use the model to derive comparative statistics with respect to the leverage constraint, which we then test in the data.

6.1 Repo and FX Swap Market

In the repo market, the dealer lends to sectors indexed by i, with demand:

$$q_{L,i}^{repo} = \beta_i (r_{L,i}^{repo})^{-\epsilon_i}, \quad \epsilon_i > 1,$$

where $r_{L,i}^{repo}$ denotes dealer's repo lending rate to sector i. In addition, the dealer borrows from the MMFs at r_B^{repo} as a price taker. For simplicity, on the borrowing side, we abstract from price dispersion in dealers' borrowing rates across different sectors. The supply of dollars in the repo market (e.g. from money market funds) is assumed to be upward sloping,

$$Q_B^{repo} = A(r_B^{repo})^{\sigma}, \qquad \sigma > 0.$$

The dealer also lends dollars in the FX swap market to sectors indexed by j , with demand:

$$q_{L,j}^{fx} = \gamma_j (r_{L,j}^{fx})^{-\eta_j},$$

where $r_{L,j}^{fx}$ denotes dealer's implied dollar lending rate in the FX swap market to sector j. In addition, the dealer borrows dollars from FX swap lenders (e.g. U.S. banks) as a price taker r_B^{FX}. We also assume that the supply of dollars in the FX swap market is upward sloping,

$$Q_B^{fx} = D(r_B^{fx})^{\tau}, \qquad \tau > 0.$$

6.2 Dealer's Problem

For now, we leave out the role of reserves and other types of funding to support dealer's repo and FX swap business. The dealer faces a dollar funding budget constraint, which requires total lending in the repo and FX swap market to all sectors to be equal to total borrowing in both markets:

$$\sum_i q_{L,i}^{repo} + \sum_j q_{L,j}^{fx} = Q_B^{repo} + Q_B^{fx}. \tag{4}$$

In addition to the budget constraint, the dealer also faces a balance sheet leverage constraint

$$\sum_i q_{L,i}^{repo} + \max\left(\sum_j q_{L,j}^{fx} - Q_B^{fx}, 0\right) \leq \frac{E}{\lambda}, \tag{5}$$

where E is the equity position of the bank, and λ is an exogenous parameter for the leverage constraint. The leverage constraint assumes that gross repo lending is on balance sheet. FX lending only shows up on balance sheet on the net basis, as net lending in the FX swap has to be financed via repo borrowing, which is on balance sheet. Therefore, the balance sheet constraint gives two regimes for the dealer's problem, net FX lending regime ($NetFX > 0$), and net FX borrowing regime ($NetFX < 0$), which we can analyze separately.

We assume that the dealer has monopoly power in the lending markets and chooses r_i^{repo} and r_j^{fx} to maximize profits:

$$\Pi = \sum_i r_{L,i}^{repo} q_{L,i}^{repo} + \sum_j r_{L,j}^{fx} q_{L,j}^{fx} - r_B^{repo} Q_B^{repo} - r_B^{fx} Q_B^{fx},$$

subject to the budget constraint (Equation 4) and the leverage constraint (Equation 5).

6.3 First-Order Conditions

Consistent with the data, we solve for the case that the dealer is a net borrower in the repo market and a net lender in the FX swap market. The leverage constraint (Equation 5) becomes

$$\sum_i q_{L,i}^{repo} + \sum_j q_{L,j}^{fx} - Q_B^{fx} \quad \leq \quad \frac{E}{\lambda}.$$

When the leverage constraint binds, we substitute the demand function and the budget constraint into the profit function and write out the Lagrangian as

$$\begin{aligned}\mathcal{L} \quad = \quad & \sum_i \beta_i (r_{L,i}^{repo})^{1-\epsilon_i} + \sum_j \gamma_j (r_{L,j}^{FX})^{1-\eta_j} - r_b^{repo}\left(\sum_i \beta_i (r_{L,i}^{repo})^{-\epsilon_i} + \sum_j \gamma_j (r_{L,j}^{FX})^{-\eta_j} - Q_B^{fx}\right) - r_B^{fx} Q_B^{fx} \\ & + \mu\left(\frac{E}{\lambda} - \sum_i \beta_i (r_{L,i}^{repo})^{-\epsilon_i} - \left(\sum_j \gamma_j (r_{L,j}^{fx})^{-\eta_j} - Q_B^{fx}\right)\right).\end{aligned}$$

The first-order conditions with respect to lending rates give the optimality conditions:

$$r_{L,i}^{repo} \quad = \quad \frac{\epsilon_i}{\epsilon_i - 1}(r_B^{repo} + \mu) \tag{6}$$

$$r_{L,j}^{fx} \quad = \quad \frac{\eta_j}{\eta_j - 1}(r_B^{repo} + \mu). \tag{7}$$

Therefore, we can see that the lending rates in both markets are equal to the sum of the repo borrow rate, the balance sheet cost from the leverage constraint, and a mark-up that depends on the elasticity of demand from a specific sector. The more inelastic the demand is (smaller ϵ_i and η_j), the higher the mark-up over the marginal cost. In the case of perfect competition ($\epsilon_i, \eta_j \to \infty$), the lending rates are equal to the repo borrowing rate plus the balance sheet cost, and the mark-up component converges to zero.

The dealer also chooses the funding mix between repo and FX swap borrowing, Q_B^{repo} and Q_B^{fx}, to finance lending in both markets. The first-order condition for an interior solution requires that

$$\frac{\partial \mathcal{L}}{\partial Q_B^{fx}} = r_B^{repo} - r_B^{fx} + \mu = 0.$$

The FX borrowing cost for the dealer must also be higher than the repo borrowing cost. This is because unlike repo borrowing, FX borrowing can be net out and does not incur the balance sheet cost in the $NetFX > 0$ regime, so that the FX borrowing rate has to be higher than the FX repo rate by exactly the balance sheet cost so that the dealer uses both types of funding:

$$r_B^{fx} = r_B^{repo} + \mu. \tag{8}$$

6.4 Equilibrium

We can solve for the equilibrium quantities by equalizing aggregate lending with borrowing across the two markets. In line with our empirical findings. We define the marginal on-balance-sheet cost of borrowing as

$$x \equiv r_B^{repo} + \mu,$$

which is the sum of the repo borrowing rate and the shadow cost of the leverage constraint.

We can write aggregate lending in repo and FX swap market as functions of x:

$$Q_L^{repo}(x) = \sum_i \beta_i \left(\frac{\varepsilon_i - 1}{\varepsilon_i \, x} \right)^{\varepsilon_i}, \qquad Q_L^{fx}(x) = \sum_j \gamma_j \left(\frac{\eta_j - 1}{\eta_j \, x} \right)^{\eta_j}.$$

The aggregate borrowing is equal to

$$Q_B^{repo} = A(r_B^{repo})^{\sigma} = \frac{E}{\lambda},$$
$$Q_B^{fx} = Dx^{\tau},$$

where we have used the fact that the total repo borrowing is pinned down by the leverage constraint in the net FX swap lending regime.

Therefore, the budget constraint becomes

$$\sum_i \beta_i \left(\frac{\varepsilon_i - 1}{\varepsilon_i\, x}\right)^{\varepsilon_i} + \sum_j \gamma_j \left(\frac{\eta_j - 1}{\eta_j\, x}\right)^{\eta_j} - Dx^{\tau} = \frac{E}{\lambda}. \tag{9}$$

From this equation, we can solve for equilibrium x, as well as rates and quantities in both markets.

6.5 Comparative Statics

To understand the dynamics of the model, we derive comparative statics of rates and quantities with respect to bindingness of the leverage constraint parameters, λ. First, we can first use apply the implicit function theorem to Equation (9) to derive that $\frac{\partial x}{\partial \lambda} > 0$. Thus, both repo and FX swap lending rates to all sectors increase with tighter. The repo borrowing rate declines with balance sheet constraint because the demand for repo is lower when the balance sheet constraint is tighter. The FX borrowing rate increases with balance sheet constraint.

Furthermore, We note that as the balance sheet constraint tightens, lending to all sector contracts, but the magnitude of contraction depends on the demand elasticity of the sector, ϵ_i and η_j:

$$\frac{\partial \ln q_{L,i}^{repo}}{\partial \lambda} = \frac{1}{q_{L,i}^{fx}} \frac{\partial q_{L,i}^{repo}}{\partial x} \frac{\partial x}{\partial \lambda} = -\frac{\epsilon_i}{x} \frac{\partial x}{\partial \lambda} < 0$$

$$\frac{\partial \ln q_{L,j}^{fx}}{\partial \lambda} = \frac{1}{q_{L,j}^{fx}} \frac{\partial q_{L,i}^{fx}}{\partial x} \frac{\partial x}{\partial \lambda} = -\frac{\eta_j}{x} \frac{\partial x}{\partial \lambda} < 0$$

The more elastic the demand elasticity, the greater the contraction in lending amounts to a given sector

To compare comparative statics across aggregate lending in two markets, we can calculate the average demand elasticity for the repo and FX swap market as:

$$\bar{\epsilon} \equiv \sum_i \omega_i \epsilon_i, \qquad \bar{\eta} \equiv \sum_j \omega_j \eta_j,$$

where $\omega_i \equiv q^{repo}_{L,i}/Q^{repo}_L$ and $\omega_j \equiv q^{fx}_{L,j}/Q^{fx}_L$ are quantity shares of an individual counterparty sector in the overall lending in repo and FX swap market, respectively. We can show that

$$\left|\frac{\partial \ln Q^{repo}_L}{\partial \lambda}\right| < \left|\frac{\partial \ln Q^{fx}_L}{\partial \lambda}\right| \quad \text{if} \quad \bar{\epsilon} < \bar{\eta}.$$

In other words, the contraction in dealer's repo lending is smaller than in FX swap if the the average demand elasticity is lower in the FX swap market than in the repo market.

Since the overall repo borrowing is dictated by the leverage constraint $Q^{repo}_B = E/\lambda$, dealer's gross repo borrowing declines. In contrast, we have FX swap borrowing increases with λ. Combining with the contraction in FX lending, we must have that the net FX swap lending (gross lending minus borrowing) decreases with λ. Since changes in net repo and FX swap lending add up to zero, the net repo borrowing increases with λ.

We can summarize the comparative statics of rates and quantities with respect a tightening of the balance sheet constraint in the following proposition

Proposition 1. *In response to a tightening of the balance sheet constraint ($\lambda \uparrow$), dealer's repo and FX lending rates to all sectors increase, and meanwhile, dealer's repo borrowing rate declines and FX borrowing rate increases:*

$$\partial r^{repo}_{L,i}/\partial\lambda > 0, \qquad \partial r^{fx}_{L,i}/\partial\lambda > 0, \qquad \partial r^{repo}_{B}/\partial\lambda < 0, \qquad \partial r^{fx}_{B}/\partial\lambda > 0.$$

Dealer's lending volume in repo (Q^{repo}_L) and FX swap market (Q^{fx}_L) declines. The decline is larger for the market with higher demand elasticity of dollar funding. Dealer's borrowing from the repo market declines, and borrowing from the FX swap market increases. Finally, net repo lending increases, and net FX swap *lending declines.*

$$\partial Q_L^{repo}/\partial\lambda < 0, \qquad \partial Q_L^{fx}/\partial\lambda < 0, \qquad \partial Q_B^{repo}/\partial\lambda < 0, \qquad \partial Q_B^{fx}/\partial\lambda > 0$$

$$\partial(Q_L^{repo} - Q_B^{repo})/\partial\lambda > 0, \qquad \partial(Q_L^{fx} - Q_B^{fx})//\partial\lambda < 0.$$

7 Dynamics during Quarter-Ends

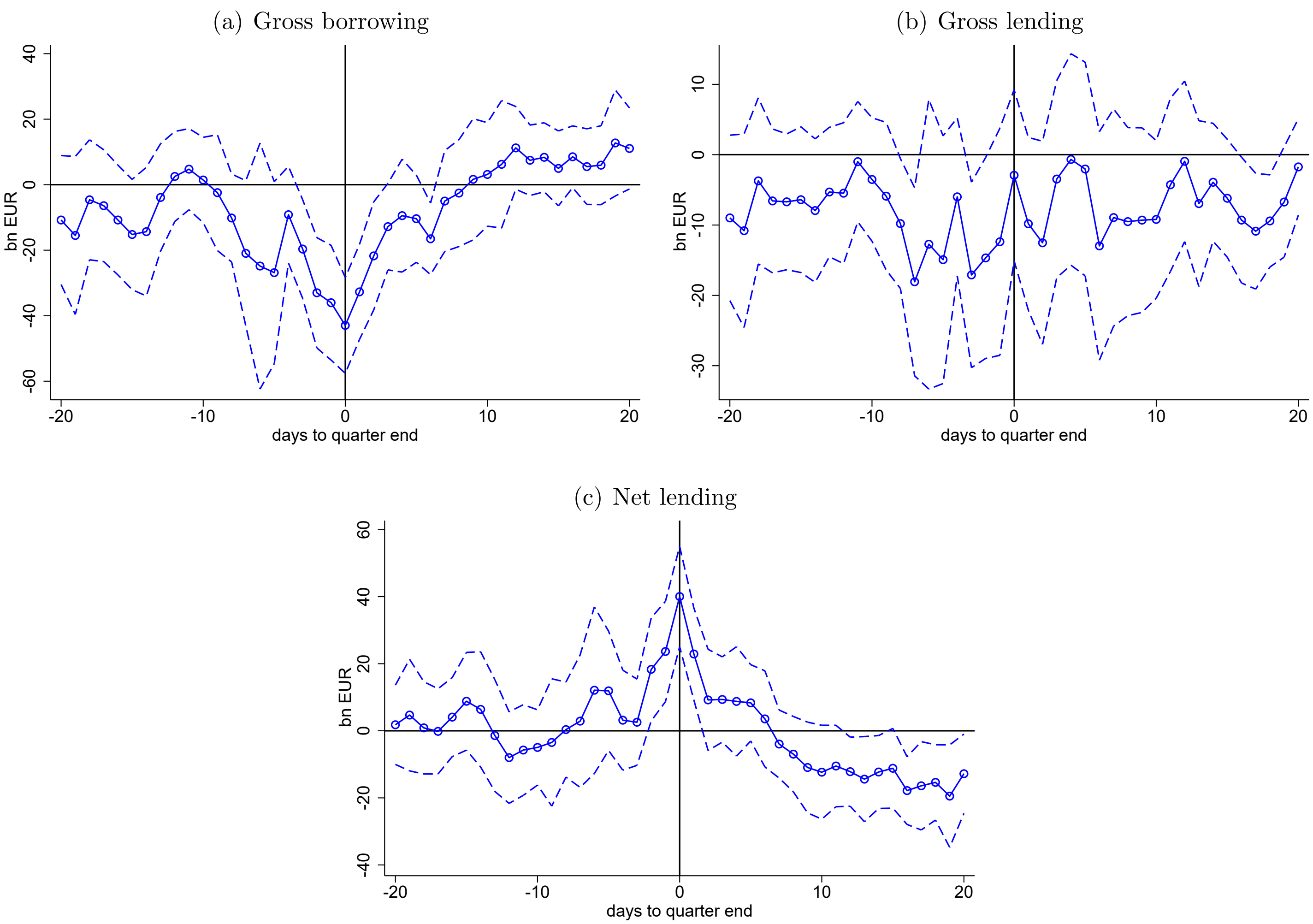
In this section, we test the model's predictions for dynamics in the two markets at quarter-ends in response to a tightening of the leverage constraint, as stated in Proposition 1. To focus on quarter-ends, we use event studies that compare MMSR positions at quarter-ends with their positions 20 days earlier. Our sample covers 16 quarter-ends between 2021Q1 and 2024Q4.

Figure 9 reports the dynamics of MMSR banks' repo positions around quarter-ends. Each dot corresponds to the estimated coefficient from a regression of MMSR positions on a quarter-end dummy. At the quarter-end (date 0 in the graphs), MMSR banks' gross repo lending contracted by €40 billion, while gross repo borrowing remained largely unchanged. As a result, net lending in the repo market increased by €40 billion.

Figure 10 shows the dynamics of MMSR banks' FX swap positions around quarter-ends. Borrowing positions in FX swaps are not significantly different from the average position outside the event window (20 days before and after the quarter-end). However, borrowing increases within the last week of the quarter. At the same time, lending in FX swaps contracts significantly by €40 billion, so that net lending decreases by the same amount. This exactly offsets the €40 billion increase in net repo lending.

Overall, the data broadly support the model. As balance sheet constraints tighten at quarter-ends, MMSR banks reduce repo borrowing to shrink their balance sheet footprint. However, substitution from on-balance-sheet repo borrowing to off-balance-sheet FX swap borrowing is limited, except locally in the final week of the quarter. Repo lending remains steady, but FX swap lending contracts sharply, which suggests lower elasticity of funding demand in the FX swap market.

Figure 9: Change in repo borrowing and lending around quarter ends (2021–2024, MMSR banks)



(a) Gross borrowing

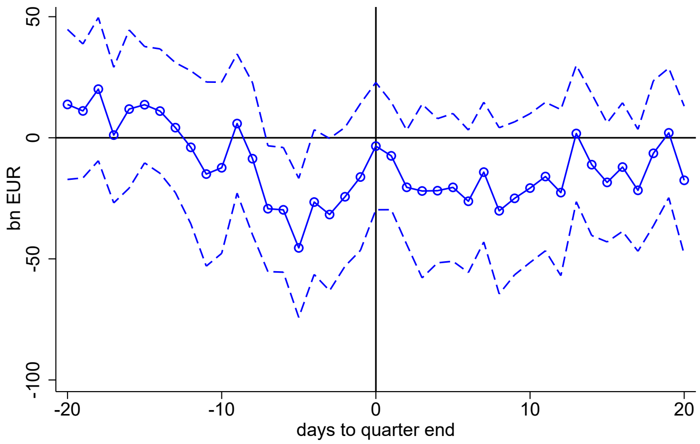
(b) Gross lending

(c) Net lending

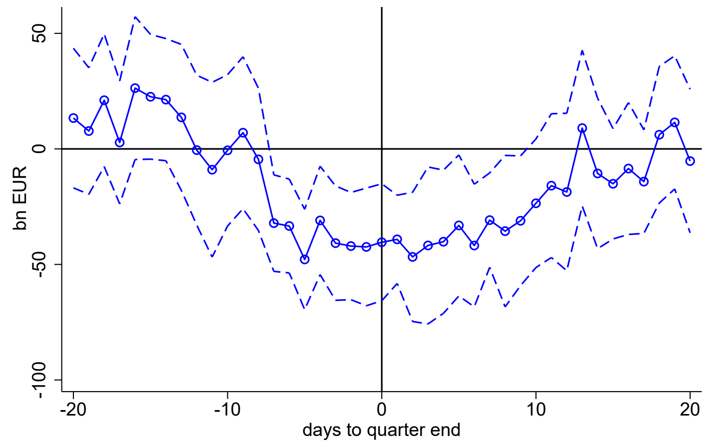
Notes: This figure plots the changes in daily positions of all MMSR banks against any counterparty (incl. *other* MMSR banks) from 20 days before to 20 days after the respective quarter end (day 0). Each dot corresponds to the estimated coefficient in a regression of MMSR positions on a dummy that corresponds to that day in a quarter. The sample runs from May 2021 to August 2024 and thus covers 13 quarters. The dashed lines correspond to 95% confidence bands. The change is plotted relative to the average off-quarter-end position, i.e. the average position on days -30 . . . -21 and +21 . . . +30 as counted from to the respective quarter end.

Figure 10: Change in FX swap borrowing and lending around quarter ends (2021–2024)

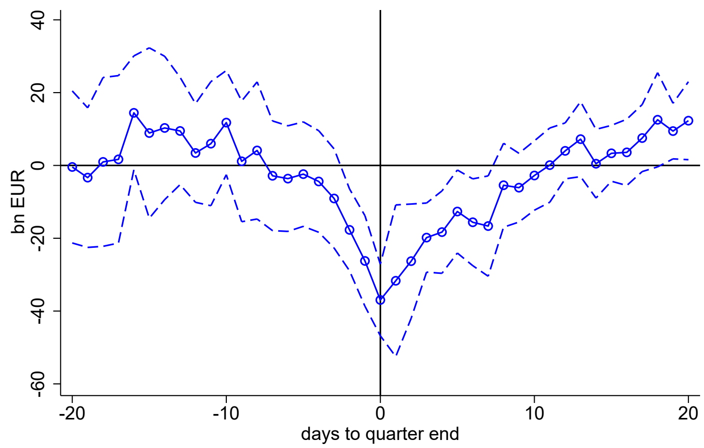
(a) Gross borrowing



(b) Gross lending



(c) Net lending



Notes: This figure plots the changes in daily positions of all MMSR banks against any non-intragroup counterparty from 20 days before to 20 days after the respective quarter end (day 0). Each dot corresponds to the estimated coefficient in a regression of MMSR positions on a dummy that corresponds to that day in a quarter. The positions are estimated from transaction data. The sample runs from May 2021 to August 2024 and thus covers 13 quarters. The dashed lines correspond to 95% confidence bands. The change is plotted relative to the average off-quarter-end position, i.e. the average position on days -30 . . . -21 and +21 . . . +30 as counted from to the respective quarter end.

8 Conclusion

Using transaction-level data from MMSR and SFTR, our study provides new insights into the structure, pricing, and frictions of the repo and FX swap markets, offering a unified view of global dollar funding activities in Europe. By linking transaction-level data across both markets, we shed light on how financial intermediaries navigate funding constraints, optimize balance sheet usage, and respond to regulatory constraints. Our findings have important implications for financial stability, central bank interventions, and the broader functioning of global dollar funding markets.

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