The Implications of CIP Deviations for International Capital Flows*

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Abstract

We study how deviations from covered interest rate parity affect international capital flows using novel data that combine euro-area FX derivatives with securities holdings statistics. Non-bank investors hedge nearly half of their USD exposures, primarily with short-term derivatives, creating a significant maturity mismatch with their bond holdings. Consistent with a currency-hedging channel, USD bond holdings decline following a widening of the USD–EUR cross-currency basis, especially for investors with larger hedging rollover needs. These bond-demand shifts significantly affect U.S. and euro-area bond prices. Our findings establish a new determinant of international capital flows with important consequences for financial stability.

Keywords: Institutional Investors, Currency Hedging, FX Swap, Derivatives, Foreign Exchange.

JEL Classification: G23, G22, G3, G32, G12

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Since the Global Financial Crisis, deviations from covered interest rate parity (CIP) have become large and persistent in major currency pairs. These deviations are commonly measured by the cross-currency basis (CCB): the wedge between the return of a cash investment in dollars and the synthetic dollar return obtained by swapping euros into dollars in the FX swap market.[1] The literature has established that intermediary balance-sheet constraints and segmentation in FX swap markets can generate such wedges (Du et al., 2018; Avdjiev et al., 2019). Yet the primary macro-finance concern is not whether CIP holds as an arbitrage condition, but how violations of CIP reshape global portfolios and transmit stress across borders. When the CCB widens, foreign investors face a higher effective cost of hedging dollar assets; if hedging is integral to portfolio choice, CIP deviations can move international capital flows and, through investor demand, asset prices.

This paper studies the consequences of CIP deviations for international capital flows and bond prices through the lens of currency hedging. We focus on euro-area (EA) investors, who are among the largest holders of dollar assets globally and who heavily rely on FX derivatives for currency risk management. We document two institutional features that make CIP deviations particularly relevant for their portfolio allocations. First, hedging is implemented predominantly with short-maturity derivatives that are rolled over frequently, while the underlying bond portfolios are long-dated. Second, many investors operate under explicit or implicit hedging mandates, which restrict their ability to adjust hedge ratios when hedging becomes more expensive. Together, these features imply that a widening basis does not merely reprice a marginal arbitrage trade but also changes the effective expected return and risk of holding dollar bonds for a large investor class, potentially generating sizable capital flows.

To organize our empirical analysis, we first develop a one-period partial-equilibrium portfolio model in which the CCB represents a wedge in FX forward pricing. In this model, a euro-based investor allocates wealth between a USD bond and a EUR risk-free asset and uses FX forwards to hedge currency risk. Hedging is costly: selling USD forward contracts entails an expected cost proportional to the CCB, and positions carry a convex cost capturing margin and balance-sheet frictions. The key implication is that a wider CCB raises the marginal cost of hedging, leading investors to reduce forward positions and—because less hedging leaves more residual currency exposure—to also reduce USD bond holdings. If investors face hedging mandates, hedge ratios must remain constant. Consequently, investors with hedging mandates are restricted in their ability to adjust their FX hedging and resort to selling more USD-denominated assets. The model, therefore, predicts a higher sensitivity of bond demand to fluctuations in the CCB among

[1] If CIP holds, the domestic risk-free rate equals the foreign risk-free rate hedged back into domestic currency via an FX swap (a spot exchange plus a forward contract that fixes the future exchange rate). When CIP fails, the implied synthetic dollar rate differs from the cash dollar rate, and the difference is the cross-currency basis.

mandated investors, accompanied by a lower sensitivity of their FX derivatives demand.

Guided by this theory, we investigate the role of FX derivatives market frictions in international capital markets. To this end, we assemble a unique dataset containing confidential information on the entire universe of euro-area FX derivatives positions and bond holdings at the security level, merging several data sources available at the European Central Bank (ECB). We document several novel facts about currency hedging: (i) total gross notional outstanding in the USD-EUR FX derivatives market amounts to about EUR 8 trillion, comparable in magnitude to the roughly EUR 10 trillion European repo market; (ii) FX positions have substantially shorter maturities than bond holdings, with an average residual maturity of 2.2 months for FX positions versus 9.7 years for USD bond holdings; and (iii) hedge ratios are substantial and heterogeneous across investors: under a broad definition that scales net FX positions by USD bond and equity holdings, investment funds hedge on average 17% of their USD exposure, insurance companies 27%, and pension funds 76%. In contrast, banks are net suppliers of hedging in FX derivatives, with an average hedge ratio of −102%, and banks with access to direct USD funding (e.g., via internal capital markets or USD-denominated wholesale funding) account for most of this net supply.

Our main empirical analysis links euro-area investors' bond portfolios to the USD-EUR CCB. We find that when the basis widens, euro-area investors systematically reduce their holdings of USD-denominated bonds relative to EUR-denominated bonds. This result is robust across specifications and persists in security-level regressions with rich fixed effects that absorb time-varying macroeconomic conditions as well as investor-specific exposures to aggregate shocks. Nevertheless, OLS estimates may still be confounded by currency-specific forces that jointly move the basis and investors' relative demand for USD assets. For example, an increase in the interest-rate differential between the US and the euro area may both raise the attractiveness of USD-denominated bonds and widen the cross-currency basis, thereby biasing a simple OLS comparison.

We address this identification challenge with two complementary strategies that exploit the granularity of our data. First, we use investor-level heterogeneity in exposure to the CCB that arises from the need to roll over outstanding FX hedges. We measure an investor's FX rollover need as the share of previously outstanding hedging positions maturing in the current period. When rollover needs are higher, a larger fraction of the hedge portfolio must be renewed at the prevailing hedging price, and then we expect investors to respond more strongly to movements in the CCB.

Second, we construct a granular instrumental variable (GIV) for the CCB by isolating idiosyncratic shocks to FX positions. We begin with daily investor-level FX positions and purge them of aggregate, sector, and country shocks, as well as their interactions, thereby removing heterogeneous exposures to potentially confounding global and local factors. Because the FX derivatives market is highly concentrated, the remaining idiosyncratic variation does not wash out in the aggregate (Gabaix, 2011). Following Gabaix and Koijen (2024), we then optimally aggregate these residual demand shifts using a size-weighted average. The resulting series induces economically and statistically meaningful movements in the CCB, supporting the relevance of our instrument.

We validate the GIV approach by estimating the demand elasticity of FX positions. We find that a 1 bp widening of the CCB (approximately 7.5% of its standard deviation) reduces FX derivatives positions by an average of 0.69%. This estimated coefficient indicates that FX demand is relatively inelastic. The FX demand elasticity is substantially larger for investors with higher rollover needs, indicating that these investors are particularly exposed to CCB fluctuations.

Applying the instrumental variable approach to our main specification, we find a significant elasticity of USD bond demand with respect to the CCB. A 1 basis point widening in the CCB is estimated to reduce euro-area investors' holdings of the average USD bond by 0.32% relative to comparable EUR-denominated bonds. The IV estimate slightly exceeds the corresponding OLS estimate, likely reflecting the correction of simultaneity bias due to reverse causality between USD bond demand and the CCB.

The estimated elasticity aligns with existing estimates of bond price elasticity and suggests that EA investors view currency-hedged USD and EUR bonds as close substitutes. Moreover, this estimate implies economically significant capital flows in response to large movements in the CCB. Specifically, we estimate that the largest 5% of observed CCB shocks correspond to a reduction of approximately EUR 82 billion in EA investors' USD bond holdings.

To assess the robustness of our estimate, we re-estimate our specification using two alternative instrumental variables. The first alternative instrument additionally purges the GIV of *investor-specific* exposures to common factors. The second leverages plausibly exogenous variation from investment-fund share class closures. When a share class closes, investors must either migrate to another class or redeem their holdings. This reallocation mechanically alters the fund's demand for FX derivatives, especially when a large fraction of its share classes carry currency-hedging mandates. The estimated elasticity of USD bond demand with respect to the CCB remains almost unchanged using either of these alternative instruments.

To further sharpen the empirical identification, we exploit cross-sectional variation in investors' FX rollover needs. We document that the bond holdings of investors who face higher rollover needs in their FX derivatives portfolios are more sensitive to the CCB. The differential response between investors with high and low rollover needs is statistically significant and robust to the inclusion of granular bond-by-time fixed effects, which ensure that the estimate compares investors holding identical bonds at the same point in time. This result reinforces the interpretation that currency hedging motives, rather than omitted macroeconomic factors, drive the observed relationship between bond demand and the CCB.

While our baseline analysis is conducted at the bond level, we demonstrate that our results remain consistent when estimated at the portfolio level. The estimated elasticities also remain robust to additional controls for exchange rate levels and volatility, alternative constructions of the instrument that account for size-specific elasticities to common factors, and excluding crisis episodes from the sample.

We next investigate the role of hedging mandates. To this end, we augment our analysis with detailed data on mutual-fund-level bond holdings. Guided by our model's predictions, we hypothesize that funds subject to explicit FX hedging mandates reduce their FX derivatives positions to a lesser degree but exhibit a greater sensitivity to the CCB. This heightened sensitivity occurs because the mandate restricts these funds from reducing their FX exposure without concurrently decreasing their USD bond holdings. Consistent with this hypothesis, we find that hedging mandates reduce the sensitivity of FX positions but increase the sensitivity of USD bond holdings to a widening of the CCB.

Finally, we examine the implications of CCB-driven portfolio rebalancing on asset prices. Market segmentation implies that shifts in investor demand are likely to be directly reflected in bond prices (Chaudhary et al., 2023; Kubitza, forthcoming). As our findings imply lower demand for USD bonds following a widening in the CCB, we expect yields on exposed USD bonds to increase. To test this hypothesis, we primarily focus on the secondary market yields of USD-denominated corporate bonds issued by U.S. entities, which constitute over half of euro-area investors' USD bond portfolio. Exploiting information on each bond's investor base, we distinguish between bonds whose EA investors have higher rollover needs—which are more exposed to the CCB—and other bonds. This cross-sectional approach allows us to include time fixed effects in regressions, absorbing any aggregate factors that drive bond prices. Consistent with the hypothesis, we find that the yield spreads of U.S. corporate bonds whose investor base faces higher rollover needs increase by 0.55 bps per 1 bp widening in the CCB, relative to bonds whose investor base faces lower rollover needs. In contrast, EA government bond yields decline by 0.45 bps per 1 bp widening in the CCB for bonds with high relative to low rollover-need investor bases, consistent with rebalancing from USD toward EUR bonds in response to higher hedging costs. Our findings show that CIP deviations significantly impact international asset prices, highlighting the cross-currency investor demand channel.

Related Literature This paper builds on recent studies documenting persistent deviations from CIP since the Great Financial Crisis, driven by limits to intermediation capacity (Du et al., 2018; Andersen et al., 2019; Avdjiev et al., 2019; Correa et al., 2020; Cenedese et al., 2021; Rime et al., 2022; Du et al., 2023; Augustin et al., 2024; Moskowitz et al., forthcoming). Under such limits to arbitrage, international demand for USD funding and hedging has been shown to be a significant driver of the CCB (Aldunate et al., 2025; Kloks et al., 2024; Khetan, 2024; Ben Zeev and Nathan, 2024), which emphasizes the importance of the USD as the international reserve currency (Coppola et al., 2024).[2] We extend this literature by investigating the consequences of CIP deviations for capital markets rather than their causes and focus on the interplay of institutional investors' currency hedging, portfolio allocations, and bond yields. Three closely related papers study consequences of CIP deviations—namely, for corporations' currency choice in bond issuances (Liao, 2020); foreign currency bank lending (Ivashina et al., 2015; Keller, 2024); and the impact of U.S. monetary policy shocks on EA investors' risk-taking (Ahmed et al., 2021). Our paper focuses on the currency allocation of bond market investors in response to CCB fluctuations.

Our analysis also connects to the literature on global capital allocation, surveyed by Florez-Orrego et al. (2024). Starting with French and Poterba (1991), a large literature documents the home bias of international investors (Coeurdacier and Rey, 2013). Maggiori et al. (2020) attribute home bias among investment funds to currency preferences, whereas Faia et al. (2025) examine the effects of currency preferences on yield differentials. Cesa-Bianchi et al. (2025) document that margin calls on FX derivatives resulted in fire sales of USD bonds by UK insurers during the Covid-19 crisis. Our finding that the CCB affects portfolio allocations suggests that frictions in FX derivatives markets may contribute to currency preferences. We also complement the literature that links investor demand and exchange rates (Hau and Rey, 2004, 2006; Bruno and Shin, 2015; Camanho et al., 2022; Bräuer and Hau, 2023; Koijen and Yogo, 2024) by focusing on the CCB.

Prior literature has been constrained by the scarcity of available data on investor currency hedging activity.[3] Du and Huber (2024) and Sialm and Zhu (2024) make a significant contribution by estimating industry-level and fund-level hedge ratios based on hand-collected publications and SEC filings, respectively. In a similar vein as Sialm and Zhu (2024), Opie and Riddiough

[2]Dávila et al. (2024) estimate the social cost of those CIP deviations based on price elasticity in the FX futures market.

[3]Alfaro et al. (2021) and Hommel and Piquard (2025) use granular regulatory data on FX derivatives to study the currency hedging of nonfinancial firms.

(2024) and Bräuer and Hau (2025) examine the risk–return trade-off associated with currency hedging, focusing on U.S. equity funds and European investment funds, respectively. Both studies document a correlation between larger hedging and wider CCB across currency pairs, which is consistent with our first-stage estimate showing that idiosyncratic FX demand shifts widen the USD-EUR CCB in the time series. Using transaction-level data on UK FX derivatives, Hacioglu Hoke et al. (2026) also show that hedging-driven order flow from non-banks is central to FX derivatives markets and study its implications for exchange rates. Complementing these results, we focus on the impact of CCB shocks on portfolio allocation.

Prior work on international macro-finance models also highlights the importance of currency risk in portfolio allocation (Campbell and Viceira, 2002; Campbell et al., 2010; Coeurdacier and Gourinchas, 2016). Traditionally, these models have studied optimal portfolios, assuming that currency risk is either fully hedged or unhedged. We contribute to this literature by jointly modeling currency portfolio allocation and hedging intensity in a model in which hedging is subject to endogenous CIP deviations, which generates cross-currency rollover risk.

1 Data

We create a novel panel dataset that provides a complete account of euro-area investors' bond investments and their FX derivatives positions by combining detailed filings submitted to European regulatory authorities. All financial variables are winsorized at the 1st and 99th percentiles. Details on data construction, variable definitions, and additional datasets not discussed here—for example, supervisory data on bank funding structures—are provided in the Internet Appendix. Appendix Table IA.1 provides an exhaustive overview of variable definitions and sources. The rest of this section describes the main data sources and variables.

FX Derivatives The European Market Infrastructure Regulation (EMIR) requires that all investors report their derivatives transactions to European authorities. From the EMIR repository, made available to the ECB, we obtain contract-level information on all USD-EUR forward and swap positions of all euro-area investors starting in December 2018 (when data quality becomes sufficient) and ending in March 2024. We apply several filters to clean the data, detailed in Appendix A. In particular, we homogenize information on swaps and forwards by converting each FX swap into two forward contracts. We identify individual investors by their Legal Entity Identifier (LEI), which we use to obtain information on their domicile and sector following Lenoci and Letizia (2021). In most of the analyses, we focus on the FX market's most important financial sectors: banks (including dealers), investment funds, insurance companies, and pension funds. These include more than 18,000 entities, which collectively account for nearly 90% of the total gross positions in the euro area.

Throughout the paper, we define *buy* FX positions as those that require the investor to buy EUR against USD in the future. With a buy position, the investor gains from a future weakening of the USD against the EUR. Hence, a buy position hedges the currency risk of USD-denominated assets. This is achieved either via a forward contract to buy EUR or via the forward leg of a swap, whereby the investor who buys USD at the spot date commits to sell back the USD against EUR at maturity. We define an investor's net FX position, after splitting swaps into two forwards, as the difference between buy and sell positions.

Unless noted otherwise, we measure the notional outstanding of each FX contract in EUR. For contracts whose notional is originally denominated in USD, we convert the notional into EUR such that it is equal to the EUR amount exchanged at contract maturity. This methodology ensures that FX positions do not mechanically respond to exchange rate fluctuations.

Securities Holdings Our main analysis uses Securities Holdings Statistics by Sector (SHS-S) available to the ECB, which provides confidential security-level information on the bond holdings of each euro-area country-sector pair (e.g., Dutch pension funds and German insurers). From SHS-S, we obtain the nominal value and market value of positions in EUR- and USD-denominated bonds of euro-area country-sectors at quarterly frequency from 2019Q1 to 2024Q1. Securities are identified by their International Security Identification Number (ISIN), which we use to enrich our data with information on the securities (e.g., currency denomination, issuance, and maturity dates) and their issuers (e.g., their industry and credit rating) from the ECB's Centralised Securities Database (CSDB). We exclude bonds with missing or multiple currency denominations, holdings reported in or after the quarter of bond maturity, and holdings reported before issuance. When combining FX positions and bond holdings, we exclude four pension fund–country pairs and two investment fund–country pairs from the analysis due to unrealistically large hedge ratios (in absolute value), which are driven by negligible USD bond holdings (as detailed in Appendix A.2).

We complement country-by-sector holdings from SHS-S with fund-level data from LSEG Lipper, which provides holdings data at market values at the fund-by-bond level at quarterly frequency. We consider EUR and USD bond holdings of funds that are domiciled in the EA with EUR as their operating and reporting currency and that have ever invested in USD assets. Importantly for our analysis, Lipper indicates whether a fund's share classes are mandated to hedge the foreign currency risk of holdings that are not denominated in the base currency.[4] We aggregate

[4]Funds may have one or several share classes through which investors invest in the fund. Fund investments

this indicator at the fund level, and define funds with an FX hedging mandate for at least 10% of outstanding shares on average as funds with a hedging mandate.

Bond Yields We retrieve the market yields of USD-denominated U.S. corporate bonds at daily frequency from the Trade and Reporting Compliance Engine (TRACE), which records the near universe of U.S. corporate bond transactions. The data are cleaned of cancellations, corrections, and reversals following Dick-Nielsen (2014). We aggregate bond yields from the transaction level to daily frequency using the daily median yield. To remove variation in risk-free rates, we focus on yield spreads, defined as the difference between the daily market yield and the nominal Treasury yield with the same residual maturity, interpolated from the Gürkaynak et al. (2007) yield curve model.[5] Because TRACE data are available only from April 2019, the final sample ends in September 2023. Finally, we use Mergent FISD to obtain information on maturity dates and credit ratings.

We also consider daily U.S. and EA government bond yields. U.S. Treasury yields are from FRED for constant remaining maturities of 3 months and 1, 5, 10, and 20 years. EA yields are given by benchmark bond yields from Refinitiv for constant remaining maturities of 3 months and 1, 5, 10, 15, and 20 years (including Austria, Belgium, Cyprus, Germany, Spain, Finland, France, Greece, Ireland, Italy, Lithuania, Malta, the Netherlands, Portugal, Slovenia, and Slovakia).

Cross-currency Basis We use Money Market Statistical Reporting (MMSR) to the ECB to extract information on spot and forward rates in the EA FX market. MMSR provides confidential information on all USD-EUR swap transactions by major EA banks. Using this data, we compute the daily transaction-volume-weighted median USD-EUR spot and forward rates for each maturity.

We measure the level of deviations from covered interest rate parity as the cross-currency basis (CCB). Following convention (Du et al., 2018), the τ-months CCB of EUR vis-à-vis the U.S. dollar at time t, denoted by $\text{CCB}_{t,\tau}$, equals the difference between the actual dollar interest rate and the synthetic dollar interest rate, obtained by converting the EUR interest rate into USD in the FX market:

$$\text{CCB}_{t,\tau} = r_{t,\tau}^{USD} - \underbrace{\left(r_{t,\tau}^{EUR} - \frac{12}{\tau} \log \frac{F_{t,\tau}}{S_t} \right)}_{\text{Synthetic USD rate}}, \tag{1}$$

are pooled at the fund level across share classes.

[5] Obtained from `https://www.federalreserve.gov/data/nominal-yield-curve.htm`.

where $r_{t,\tau}^{USD}$ is the τ-months continuously compounded U.S. dollar interest rate (USD LIBOR), $r_{t,\tau}^{EUR}$ the τ-months continuously compounded EUR interest rate (EURIBOR), S_t the USD-EUR spot exchange rate, and $F_{t,\tau}$ the τ-months USD-EUR forward rate.[6] We express exchange rates in units of EUR per USD—i.e., an increase in S_t is a depreciation of EUR relative to USD.

The CIP condition requires that $\text{CCB}_{t,\tau} = 0$—i.e., that the return on direct USD investments corresponds to that of a synthetic USD investment. However, since the 2007–2008 financial crisis, $\text{CCB}_{t,\tau}$ is typically negative (Du et al., 2018). Our sample confirms this pattern: $\text{CCB}_{t,\tau}$ is negative most of the time throughout our sample horizon (2018-2024) (see Figure 2). In this case, directly investing in USD generates a lower return than swapping the EUR interest rate into USD. Hence, the more negative the $\text{CCB}_{t,\tau}$, the higher the cost for euro-area investors (with EUR funding) to hedge their USD investments.

2 Stylized Facts

We first use our novel dataset to document salient facts about FX derivatives markets and USD bond holdings in the EA.

2.1 USD-EUR FX Derivatives Market

We compute the size of the USD-EUR FX derivatives market as the total gross notional amount outstanding of all USD-EUR FX contracts with at least one EA counterparty. The market has expanded from around EUR 6 trillion in 2019 to EUR 8 trillion in 2023 (see Appendix Figure IA.8). This approximately matches the size of the entire European repo market, which was EUR 10 trillion in 2022 (ICMA, 2023). The share of the FX market volume traded over the counter (OTC) is between 60% and 70% and is relatively stable throughout the sample horizon (see Appendix Figure IA.8).

Gross FX Positions Figure 1 (a) illustrates the distribution of gross positions in USD-EUR FX contracts across EA sectors. Banks dominate the market by accounting for approximately 70% of gross positions, followed by investment funds (14%) and nonfinancial companies (7%). Financial investors (banks, investment funds, insurers, and pension funds) jointly account for nearly 90% of gross positions. Since the purpose of this paper is to study the hedging of financial assets, we focus on these four sectors.

[6] Due to the cessation of LIBOR, LIBOR was replaced by the Secured Overnight Financing Rate (SOFR) in July 2023, which was adjusted to take the difference between secured and unsecured spreads into account.

FX Derivatives Maturity The average residual (time to) maturity of FX contracts in the sample is 2.2 months. It is slightly larger for banks (3.3) and insurers (2.5), and smaller for pension funds (1.9) and investment funds (1.2). These findings are consistent with anecdotal evidence from investment fund managers that the typical maturity used for currency hedging is 3 months. Motivated by this evidence, we focus on the 3-month segment in our baseline analysis, while extending to other segments in additional results. The relatively short FX maturities contrast with longer maturities of USD bond holdings of 9.7 years on average (see Table 1). This maturity mismatch requires investors to frequently roll over existing FX positions to maintain their hedges. Under this rollover-hedging strategy, the maturity mismatch between FX derivatives and hedged USD assets does not reintroduce spot FX risk. Instead, it primarily converts currency risk into rollover (basis) risk through time variation in hedging costs (see Internet Appendix D). Decomposing the variation in FX derivatives maturities, we find that FX maturity choice is neither driven by the maturity of USD-denominated assets nor by market-wide factors (such as liquidity) but, instead, by country-sector-specific preferences (see Table IA.6). Sector-specific maturity preferences are highly persistent over time and are reflected in the original (time to) maturity of FX positions (see Figure IA.11). The maturity of USD bonds does not significantly affect FX derivatives maturity (Table IA.6), indicating that investors do not match asset and hedge maturities in the cross-section.

Net FX Positions We further report each financial sector's net FX position in Figure 1 (b).[7] In contrast to gross positions, net positions are dominated by the investment fund sector, with a positive aggregate net position of more than EUR 600 billion. The pension fund sector has the second-largest net position of approximately EUR 200 billion. From 2019 to 2022, investment and pension funds steadily increased their net positions, whereas banks switched from being net buyers to net sellers. The banking sector is the largest and only net-selling sector, with a negative net position of EUR 500 billion at the end of the sample.

Global Banks as Intermediaries Some global banks access direct USD funding either through internal capital markets or through USD-denominated funding to hedge their net-sell FX positions. We document this behavior by splitting the sample according to three dimensions that proxy for access to direct USD funding. First, we split the sample into non-EA and EA banks based on the location of their parent companies. Banks with EA parents exhibit a total net FX position of close to zero. In contrast, banks with non-EA parents exhibit a negative

[7] According to the EMIR regulation, FX contracts with maturities less than 3 days are considered spot contracts and therefore do not have to be reported (although they often are). This is the predominant reason for the spikes in net FX positions (especially for investment funds) in Figure 1 (b).

net position of close to EUR 500 billion (see Figure IA.9). Second, we use supervisory data on the denomination of (retail and wholesale) funding. We find that net negative FX positions are driven by banks with a non-negligible share of USD funding relative to USD and EUR funding (see Figure IA.10 a). Finally, we use supervisory data on the location of counterparties for (retail and wholesale) deposit funding. Consistent with the prior results, we find that net negative FX positions are driven by banks with a non-negligible share of U.S. counterparties (see Figure IA.10 b). Overall, these results highlight the important role of banks' direct access to USD funding for supplying USD hedging in the EA.

Hedging Costs Lastly, we quantify the hedging costs implied by CIP deviations. We compute the CCB-implied hedging cost borne by each investor based on their individual trades in a given quarter, expressed on an annualized basis.[8] The net hedging cost borne by EA investors fluctuates around EUR 1 billion. While the majority of EA investors pay the CCB, some are net receivers, reflecting positions that involve selling future EUR. Net payers experience a peak in hedging costs of close to EUR 3.5 billion in 2022Q4.

2.2 USD Investments and FX Hedging

EA insurers, banks, and investment and pension funds collectively hold approximately EUR 2.3 trillion in USD-denominated bonds. These USD holdings account for 17% of combined EUR- and USD-denominated bond portfolios and consist primarily of corporate bonds (61%). Non-bank institutions exhibit a larger USD bond share (22%) and allocate a greater fraction of their USD bond portfolios to corporate bonds (65%). In terms of geographical location, USD bond holdings comprise U.S. Treasuries and U.S. corporate bonds, each accounting for close to 30%, as well as significant exposures to non-EA and non-U.S. corporate bonds (20%) and government bonds (10%) (see Appendix Figure IA.12).

Hedge Ratio To estimate the share of investors' USD bond investments that is currency hedged, we follow the literature and compute the ratio of net FX derivatives positions to USD bond holdings.[9] We interpret this hedge ratio as a market-value (spot-exposure) hedge measure,

[8] Specifically, we first compute each trade h's hedging cost as $\mathcal{C}_h = N_h\big(\exp(-\tau_h \ \mathrm{CCB}_{t,\overline{\tau}}) - 1\big)$, where N_h denotes notional, t the trade date, τ the (original) time to maturity, and $\overline{\tau}$ the corresponding maturity bucket (either 1 day, 1 week, or 1, 3, 6, or 12 months). The (forward EUR) buyer pays $\mathcal{C}_h$, whereas the (forward EUR) seller receives $\mathcal{C}_h$. For each investor, we aggregate hedging costs $\mathcal{C}_h$ across all trades executed in a given quarter to compute the net hedging cost, and annualize by multiplying with 4. Based on this net cost, investors are sorted into net receivers or payers. Figure IA.8 reports the resulting time series of aggregate hedging costs.

[9] To construct hedge ratios, we use the USD cash flow to be exchanged at FX contract maturity in the numerator and the USD market value of USD-denominated bond holdings in the denominator. The results are

rather than as a cash-flow matching measure.[10] The resulting hedge ratio is 95% on average across EA non-bank sectors and time (see Table 1). The magnitude of this estimate suggests that investors may hedge not only bond exposures but also (some) equity exposures. We therefore also compute an alternative hedge ratio that includes equity investments in the denominator. Under this broader definition, the average hedge ratio for EA non-bank investors is 40%, consistent with the findings of Du and Huber (2024). In contrast, banks exhibit a negative average hedge ratio of −102%, reflecting their role as intermediaries in FX markets. A negative hedge ratio indicates that banks take the opposite side of the hedging demand of long-USD bond investors in FX forward markets. This hedge-ratio measure summarizes the hedging of investment positions and does not incorporate currency risk associated with banks' funding; hence, the negative value reflects their intermediary role in FX markets as described above.

There is substantial heterogeneity across non-bank sectors (see Table 2). Pension funds display the highest hedge ratio (76%), followed by insurers (27%) and investment funds (17%). These estimates compare with an average hedge ratio of 18% for U.S. fixed-income mutual funds documented by Sialm and Zhu (2024), and with hedge ratios of 21% for global fixed-income mutual funds, 44% for global insurers, and 35% for global pension funds reported in Du and Huber (2024).

FX Hedging in the Time Series Figure 3 provides additional insight into the FX hedging activity of EA investors. Panel (a) plots net FX positions against USD bond holdings at the sector-by-quarter level. Both variables are scaled by total EUR- and USD-denominated bond holdings to account for differences in sector size. The sectors with the largest USD bond shares—investment funds and pension funds—also hold larger net FX positions than insurers and banks. Moreover, all non-bank sectors exhibit a positive time-series relationship between net FX positions and USD portfolio shares, consistent with FX positions hedging foreign-currency bond exposures.

FX Hedging in the Cross Section Figure 3 (b) presents a binned scatter plot of net FX positions and USD investments in the cross section of non-banks. The figure plots net FX positions against USD-denominated bond holdings at the country-by-sector-by-quarter level, with both variables scaled by combined USD and EUR bond holdings and purged of aggregate

robust to using nominal bond holdings or, alternatively, EUR cash flows from FX contracts and the EUR value of USD-denominated bond holdings.

[10] Our discussions with market participants indicate that institutional investors typically manage currency risk by rolling short-tenor FX forwards or swaps to hedge the portfolio's contemporaneous spot sensitivity. Under such a rolling strategy, the maturity mismatch primarily shifts risk from spot exchange-rate movements to fluctuations in hedging costs at roll dates (rollover or basis risk). See Internet Appendix D for a formal derivation.

shocks using time fixed effects. The positive correlation indicates that country-sector pairs with larger USD portfolio shares exhibit larger net FX hedging positions.[11]

3 Conceptual Framework

This section presents a one-period partial-equilibrium model that proposes a transparent mechanism through which a widening USD cross-currency basis affects (i) FX forward positions and (ii) rebalancing between USD and EUR bond holdings. Whereas we consider the basis wedge as an exogenous shock below, in Internet Appendix F, we develop a dynamic extension in the spirit of d'Avernas et al. (2024) in which the basis is endogenous, and shocks are anticipated, yielding the same qualitative results.

Setup We consider a mean-variance representative euro-area investor who is endowed with one unit of wealth. She allocates a share $w \in [0,1]$ to a USD bond and $1 - w$ to the EUR risk-free asset. She can hedge USD currency risk by selling USD forward contracts with notional $\alpha \geq 0$ (in units of wealth). The residual USD currency exposure is therefore $w - \alpha$. The USD bond offers an expected excess return (in EUR) $\varsigma > 0$ and is subject to an idiosyncratic USD risk with variance $\sigma_a^2 > 0$, orthogonal to exchange-rate risk. The USD/EUR exchange-rate shock has variance $\sigma_x^2 > 0$. Preferences are mean–variance with risk aversion $\gamma > 0$.

Currency hedging has two types of costs. First, selling one unit of USD forward entails an expected cost b, interpreted as the cross-currency basis (a higher b means it is more expensive to hedge USD into EUR).[12] Second, there is a convex balance-sheet cost of FX forward positions (e.g., from posting margins) of $\frac{\kappa}{2}\alpha^2$ with $\kappa > 0$.

Portfolio Choice The investor chooses (w, α) to maximize her expected excess return net of hedging costs and risk:

$$\max_{0 \leq w \leq 1,\, \alpha \geq 0} \varsigma w - b\alpha - \frac{\kappa}{2}\alpha^2 - \frac{\gamma}{2}\Big(\sigma_x^2(w-\alpha)^2 + \sigma_a^2 w^2\Big). \tag{2}$$

The problem is strictly concave and, hence, the optimum is unique. We focus on the interior region in which $w^* \in (0,1)$ and $\alpha^* > 0$.

[11] This relationship is not mechanically driven by movements in spot exchange rates. By construction, variation in FX positions reflects investor activity but not re-valuation of contract size due to changes in exchange rates. Aggregate effects of exchange rate fluctuations are also absorbed by time fixed effects in Figure 3(b).

[12] We set $b \equiv -CCB_{t,\Delta}$, as defined in equation (1), so a widening USD basis (more negative $CCB_{t,\Delta}$) corresponds to an increase in b.

The (interior) first-order conditions are

$$0 = \varsigma - \gamma\Big(\sigma_x^2(w^* - \alpha^*) + \sigma_a^2 w^*\Big), \tag{3}$$

$$0 = -b - \kappa\alpha^* + \gamma\sigma_x^2(w^* - \alpha^*). \tag{4}$$

Solving equations (3) and (4) yields the optimal portfolio allocation, which is linear in b:

$$\alpha^*(b) = \frac{\sigma_x^2\varsigma - (\sigma_a^2 + \sigma_x^2)b}{\gamma\sigma_a^2\sigma_x^2 + \kappa(\sigma_a^2 + \sigma_x^2)}, \tag{5}$$

$$w^*(b) = \frac{\kappa\varsigma + \gamma\sigma_x^2(\varsigma - b)}{\gamma\big[\gamma\sigma_a^2\sigma_x^2 + \kappa(\sigma_a^2 + \sigma_x^2)\big]}. \tag{6}$$

Proposition 1 (Wider basis reduces hedging and USD exposure)**.** *For an interior optimum, a widening of the USD-EUR cross-currency basis ($b \uparrow$) reduces both FX forward positions and USD bond holdings:*

$$\frac{\partial\alpha^*}{\partial b} = -\frac{\sigma_a^2 + \sigma_x^2}{\gamma\sigma_a^2\sigma_x^2 + \kappa(\sigma_a^2 + \sigma_x^2)} < 0, \qquad \frac{\partial w^*}{\partial b} = -\frac{\sigma_x^2}{\gamma\sigma_a^2\sigma_x^2 + \kappa(\sigma_a^2 + \sigma_x^2)} < 0.$$

Moreover, the residual unhedged currency exposure rises:

$$\frac{\partial(w^* - \alpha^*)}{\partial b} = \frac{\sigma_a^2}{\gamma\sigma_a^2\sigma_x^2 + \kappa(\sigma_a^2 + \sigma_x^2)} \; > \; 0,$$

so the hedge ratio falls. Since EUR holdings equal $1 - w^*$, rebalancing into EUR assets increases with b.

Proof. Differentiate equations (5) and (6) with respect to b and use that $\gamma\sigma_a^2\sigma_x^2 + \kappa(\sigma_a^2 + \sigma_x^2) > 0$. □

Proposition 2 (A full-hedging mandate shifts adjustment from derivatives to bonds)**.** *Suppose the investor must fully hedge USD exposure, $\alpha = w$. Substituting $\alpha = w$ into equation (2) yields*

$$w^{\text{mand}}(b) = \alpha^{\text{mand}}(b) = \frac{\varsigma - b}{\kappa + \gamma\sigma_a^2}, \qquad \frac{\partial w^{\text{mand}}}{\partial b} = \frac{\partial\alpha^{\text{mand}}}{\partial b} = -\frac{1}{\kappa + \gamma\sigma_a^2}.$$

Relative to Proposition 1, the mandate implies a larger adjustment in USD bond holdings but a smaller FX derivatives adjustment:

$$\Big|\frac{\partial w^{\text{mand}}}{\partial b}\Big| > \Big|\frac{\partial w^*}{\partial b}\Big|, \qquad \Big|\frac{\partial\alpha^{\text{mand}}}{\partial b}\Big| < \Big|\frac{\partial\alpha^*}{\partial b}\Big|.$$

Proof. With $\alpha = w$, the currency-risk term $\sigma_x^2(w-\alpha)^2$ vanishes and the objective is quadratic in w, so the stated solution follows from the first-order condition. For the slope comparisons, note that

$$\frac{1}{\kappa+\gamma\sigma_a^2} > \frac{\sigma_x^2}{\gamma\sigma_a^2\sigma_x^2+\kappa(\sigma_a^2+\sigma_x^2)} \iff \kappa\sigma_a^2 > 0,$$

and

$$\frac{1}{\kappa+\gamma\sigma_a^2} < \frac{\sigma_a^2+\sigma_x^2}{\gamma\sigma_a^2\sigma_x^2+\kappa(\sigma_a^2+\sigma_x^2)} \iff \gamma\sigma_a^4 > 0.$$

□

Mechanism and Empirical Implications Recall that a widening of the CCB (i.e., more negative CCB) corresponds to an increase in b. A rise in b increases the marginal cost of hedging via FX forwards. In the unconstrained problem, this cost increase acts directly on α, so the investor first reduces hedging by reducing the forward position. Doing so, however, mechanically increases the residual currency exposure $w-\alpha$ and therefore increases the variance disutility from exchange-rate risk. The investor trades off two margins: tolerating more currency risk by lowering the hedge ratio, or reducing the underlying USD holdings that generate that currency risk. The closed-form comparative statics show that both margins move: a higher b reduces both α^* and w^*, and the hedge ratio $h^* = \alpha^*/w^*$ declines. In other words, a widening basis simultaneously induces USD bond sales and a reduction in hedging intensity, increasing the unhedged share of remaining USD exposure.

Under a full-hedging mandate, the hedge ratio is fixed by construction, so the investor cannot respond to a higher b by lowering hedging intensity. The CCB therefore behaves like a reduction in the net return from holding the USD bond, from ς to $\varsigma - b$ per unit invested, and adjustment occurs primarily through larger USD bond sales. FX forward positions then move one-for-one with w to maintain full hedging. Hence, a widening of the basis should qualitatively lead to reductions in both USD bond holdings and FX positions for mandated and non-mandated investors alike. However, hedging mandates prevent investors from cutting FX forward hedges beyond what is implied by their remaining USD bond exposure. Therefore, when hedging costs rise, mandated investors end up selling more USD bonds than unconstrained investors, while reducing their FX forward positions by less.

4 Empirical Strategy

In this section, we describe the empirical strategy for identifying the impact of fluctuations in the CCB on EA investors' USD asset holdings.

4.1 Empirical Specification and Fixed Effects

Numerous observable and unobservable factors determine euro-area investor bond holdings. To focus on the impact of the CCB, we estimate the *differential* response of USD-denominated bonds relative to EUR-denominated bonds. Our baseline specification is at country-sector-by-bond level and regresses quarterly changes in bond holdings on the 3-month USD-EUR CCB interacted with an indicator for USD denomination of bonds:

$$\Delta \log \text{Held}_{i,b,t} = \alpha \ \Delta\text{CCB}_t \times \text{USD}_b + u_{i,t} + v_{i,b} + w_{\text{industry}(b),t} + \varepsilon_{i,b,t}, \tag{7}$$

where the dependent variable is the log growth in the amount of bond b held by a country-sector pair i at quarter t. ΔCCB_t is the quarterly change in the quarterly average 3-month USD-EUR cross-currency basis (in ppt). The sample includes all EUR and USD bond holdings by EA insurers, pension funds, banks, and investment funds and runs from 2019q2 to 2024q1. Our model predicts that investors reduce USD relative to EUR bond holdings in response to a more negative (i.e., wider) CCB—i.e., $\alpha > 0$. To ensure that the dependent variable reflects changes in portfolio holdings rather than changes in bond valuation, we measure bond holdings at nominal values and purge these of variation in spot exchange rates.[13] Specifically, we define changes in USD holdings as $\Delta \log \text{Held}_{i,b,t} = \log(\text{Held}_{i,b,t} \times S_{t-1}/S_t) - \log \text{Held}_{i,b,t-1}$, where S_t is the quarterly average spot exchange rate in units of EUR per USD. We use two-way-clustered standard errors at bond and country-by-currency-by-time levels.

By estimating the semi-elasticity α in regressions at the bond level with granular fixed effects, we rule out many potentially confounding factors. For instance, this specification ensures that the results are not driven by time-invariant heterogeneity across securities, issuers, or investors. Country–sector–by–time fixed effects ($u_{i,t}$) absorb shocks that differentially affect investors, identified at the country–sector level. These fixed effects subsume both country–by–time and sector–by–time fixed effects, as they also absorb differences across sectors within a given country–time pair (and vice versa). For example, the fixed effects absorb any impact of fund flows on the demand for USD bonds when funds keep their portfolio allocation constant. Country-sector-by-bond fixed effects ($v_{i,b}$) absorb variation from time-invariant investor preferences. Thus, the regression effectively examines variation in the portfolio share of different securities relative to investors' average investment preferences. Issuer industry-by-time fixed effects ($w_{\text{industry}(b),t}$) absorb shocks that differentially affect bond issuers depending on their industry (including governments). Thus, the estimate compares bonds issued within the same industry at the same

[13] According to the Handbook on Securities Statistics (`https://data.ecb.europa.eu/methodology/securities-holdings-statistics`), "Nominal valuation of debt securities reflects the sum of funds originally advanced, plus any subsequent advances, less any repayments, plus any accrued interest" (p. 109).

point in time but with different currency denominations. This alleviates the potential concern that demand for bonds in more internationally diversified industries differs from that in other industries.

4.2 Heterogeneity in Rollover Needs

Despite the detailed fixed effects, the main coefficient may still be biased by the presence of currency-specific omitted variables or simultaneous supply and demand shocks. For example, in the dynamic model presented in Internet Appendix F, the equilibrium CCB is an increasing function of USD asset demand. Therefore, a shock to USD demand would widen the CCB through reverse causality. To address this identification challenge, we first construct a measure for investors' exposure to changes in the CCB. Specifically, we focus on the share of investors' FX hedging contracts maturing within the current quarter. For each country-sector pair i, we identify hedgers in EMIR as investors maintaining an average net buy position over the preceding three months. Among these hedgers' FX hedging (i.e., buy EUR forward) positions outstanding at the end of the preceding quarter with original maturities exceeding 7 days, we calculate the share of notional amounts maturing in the current quarter, denoted by FX $\text{mat}_{i,t}$. A higher FX $\text{mat}_{i,t}$ indicates greater rollover needs for hedgers in country-sector i, and thus greater exposure to changes in the CCB.

Decomposing the variance of FX $\text{mat}_{i,t}$ reveals that maturity profiles (i.e., variation arising from investors choosing different original FX maturities) and rollover schedules (i.e., variation from investors trading on different days) each explain approximately half of the total variation, with rollover schedules being slightly more important (see Table IA.7). By including country-sector-by-bond fixed effects, we absorb any potential sorting of investors depending on their unconditional maturity profile, implying that the estimate is driven by differences in rollover schedules.

We then define the indicator variable High Rollover $\text{Need}_{i,t} = 1\{\text{FX mat}_{i,t} > 0.95\}$ to indicate the country-sector pairs most exposed to changes in the CCB, which approximately corresponds to the 75th percentile of the distribution of FX $\text{mat}_{i,t}$. We add a triple-interaction term to equation (7) that interacts $\text{USD}_b \times \Delta\text{CCB}_t$ with High Rollover $\text{Need}_{i,t}$. The coefficient on this interaction term captures the differential response of USD bond holdings to changes in the CCB between investors with high rollover needs and those with low rollover needs.

The identifying assumption is that differences in FX rollover needs are not correlated with other factors that give rise to heterogeneous portfolio rebalancing in response to the CCB. A potential concern is that investors match FX rollover dynamics to their portfolio characteristics. However, we find that observable portfolio characteristics do not systematically differ with rollover needs, suggesting as-good-as-random matching of rollover dynamics and portfolios (see Table IA.8).[14] Furthermore, by including country-sector-by-time and bond-by-time fixed effects, we ensure that our estimate is not contaminated by investor-specific or bond-specific shocks, thus ruling out any bias arising from sorting on investor or bond characteristics.

4.3 Instrumental Variable Approach

As a second step to address identification concerns, we isolate variation in the CCB that stems from idiosyncratic changes in FX positions, exploiting entity-level FX derivatives data at daily frequency to construct a granular instrumental variable.

Preliminaries We start with the set of all EA entities classified as banks, insurers, pension funds, investment funds, or nonfinancial companies and aggregate at the parent level using their LEIs. We consider the total net position $Q_{i,t}$ of investor i on day t in USD-EUR FX forward contracts in the 3-month maturity segment, namely with a residual maturity of between 2 and 4 months. To focus on investors who regularly use FX derivatives, we exclude those with non-missing positions for less than 4 weeks, those with an absolute net FX position of less than EUR 200,000 on average or at least one-third of the sample, and those with a standard deviation of their net position that exceeds two times their average gross position.

We detrend net positions $Q_{i,t}$ by their 3-month trailing average $\bar{Q}_{i,t} = \frac{1}{84}\sum_{\tau=1}^{84} Q_{i,t-\tau}$ and define the percentage deviation of positions as $\Delta Q_{i,t} = (Q_{i,t} - \bar{Q}_{i,t})/|\bar{Q}_{i,t}|$.[15] To ensure high data quality, we consider the sample of $\Delta Q_{i,t}$ starting in the second quarter of 2019, motivated by a significant improvement in reporting quality in December 2018. We also winsorize extreme observations of $\Delta Q_{i,t}$ at the 1st and 99th percentiles.

To isolate changes in FX demand, we focus on the set of investors who are *typical hedgers* of USD currency, defined as those who have maintained a long position in future EUR against USD on average in the past 3 months: $\mathcal{L}_t = \left\{i \geq 1 : \bar{Q}_{i,t} > 0\right\}$, in which $\mathcal{L}_t$ reflects the demand side of the market. The sample contains nearly 7,500 typical hedgers.[16] Hereafter, we use $\bar{Q}_{i,t}$ as a

[14] In particular, the results in Table IA.8 suggest that rollover needs are not systematically related to a larger share of maturing bonds. To rule out any potentially confounding impact of bond portfolio rollovers, we exclude bonds that mature in the current quarter from the sample.

[15] Throughout the paper, we compute the 3-month trailing average of a variable as its average value over the preceding 84 calendar days, while excluding missing values (on weekends and public holidays).

[16] Nearly half of all investors in the 3-month segment are hedgers, and their 3-month trailing net position corresponds to between 50% and 75% of that of all investors, emphasizing the significance of hedgers in the EA FX market (see Figure IA.3). In our sample, pension funds account for 36% of the total size of hedgers, followed

measure of investor size, and $\bar{Q}_{i,t}/\sum_i \bar{Q}_{i,t}$ as the (size) weight of investor i among all (typical) hedgers at time t.

Instrument Construction To extract idiosyncratic shocks to investors' FX positions, we build on the methodology proposed by Gabaix and Koijen (2024). We residualize $\Delta Q_{i,t}$ by sector-by-country-by-time fixed effects, investor fixed effects, maturity bucket-by-time fixed effects, and the average maturity of outstanding positions:

$$\Delta Q_{i,t} = u_{s,c,t} + v_i + w_{m,t} + \gamma \log(\text{mat}_{i,t}) + \check{q}_{i,t}, \tag{8}$$

where $\log(\text{mat}_{i,t})$ is the log average remaining time to maturity of investor i's FX positions within the 3-month maturity segment.[17] In this construction, including the sector-by-country-by-time fixed effects ($u_{s,c,t}$) is central as they absorb shocks that affect the investors in sector s domiciled in country c. For example, $u_{s,c,t}$ absorbs the sector-specific effects of changes in a country's regulatory environment, trade surplus, or financial market. Including these fixed effects is equivalent to absorbing all country-by-sector–level exposures to aggregate factors, such as exchange rate volatility. The residual variation stems from differences in the de-trended positions across investors within the same country, sector, and day. In addition, investor fixed effects (v_i) absorb time-invariant heterogeneity in hedging demand. Maturity bucket-by-time fixed effects ($w_{m,t}$) account for maturity-specific shocks, with three maturity buckets for up to 2.75 months, above 2.75 and up to 3 months, and above 3 months. After purging $\Delta Q_{i,t}$ from such systematic variation, the remaining residual $\check{q}_{i,t}$ represents idiosyncratic changes in FX positions, which, for simplicity, we refer to as "idiosyncratic shocks."

We aggregate these idiosyncratic shocks of typical hedgers by taking the difference between their size-weighted and equal-weighted averages:

$$\widetilde{\text{GFX}}_t = \frac{1}{\sum_{i \in \mathcal{L}_t} \bar{Q}_{i,t}} \sum_{i \in \mathcal{L}_t} \bar{Q}_{i,t} \check{q}_{i,t} - \frac{1}{|\mathcal{L}_t|} \sum_{i \in \mathcal{L}_t} \check{q}_{i,t}, \tag{9}$$

This construction follows Gabaix and Koijen's (2024) insight that such size weighting maximizes the relevance of the instrument. Finally, to address potential remaining identification concerns (discussed below), we orthogonalize $\widetilde{\text{GFX}}_t$ with respect to the first three principal components of residuals $\check{q}_{i,t}$, following Gabaix and Koijen (2023), as they capture the dominant common variation in $\check{q}_{i,t}$.[18] We refer to the resulting instrument as granular shocks to FX hedging

by banks (23%), investment funds (22%), nonfinancial companies (11%), and insurers (8%).

[17] We set $\log(\text{mat}_{i,t})$ to zero if $\text{mat}_{i,t}$ is missing, which is the case in the absence of outstanding positions. The intercept of the relationship with $\log(\text{mat}_{i,t})$ is absorbed by maturity-by-time fixed effects.

[18] Investors with different volatilities of $\check{q}_{i,t}$ are likely to have different exposures to the factors. Therefore, in

demand, GFX_t.

Relevance The granular instrumental variable is relevant when idiosyncratic shocks to hedgers' positions do not wash out in the aggregate (Gabaix, 2011). In particular, it depends positively on the skewness in the cross-sectional distribution of investor size to create meaningful dispersion between size-weighted and equal-weighted observations. In our sample, the distribution of hedger size is highly fat-tailed. The largest 1% (10%) of hedgers account for 44% (87%) of the total size of all hedgers. This substantial skewness in investor size is confirmed by fitting a Pareto I density to the cross-sectional size distribution, with a Pareto rate of 1 in the right tail of the cross-sectional distribution (among the 5% largest hedgers).

Exclusion Restriction The identifying assumption underlying our instrumental variable strategy is that investor-level innovations in FX hedging activity, $\check{q}_{i,t}$, are orthogonal to unobserved shocks that contemporaneously affect USD bond demand. Under this assumption, Gabaix and Koijen (2024) show that the size-minus-equal weighted aggregation $\widetilde{\text{GFX}}_t$ is a valid instrument. The residualization in equation (8) is therefore central. By absorbing sector-by-country-by-time fixed effects, it removes all shocks common to investors within a given country-sector cell at date t, leaving only within-cell reallocation in FX positions across investors. Hence, any remaining confounding component must operate through heterogeneous exposure to aggregate factors *within* a sector–country cell. Such heterogeneity contaminates $\widetilde{\text{GFX}}_t$ only insofar as it covaries with the instrument weights; otherwise, it cancels in the size-minus-equal aggregation. To further rule out confounding factors, we orthogonalize $\widetilde{\text{GFX}}_t$ with respect to the leading principal components of the residual panel.

Appendix E formalizes these identifying assumptions. In particular, Proposition IA.2 shows that if the residualization eliminates common shocks, the instrument is valid even when large and small investors load differently on aggregate factors, while Proposition IA.3 shows that residual common variation biases the estimator toward zero when larger investors are more exposed to the remaining factor.

Two pieces of evidence are consistent with the exclusion restriction. First, as a descriptive diagnostic, GFX_t co-moves negatively with the CCB, whereas instrumenting the CCB with GFX_t implies a positive co-movement between (instrumented) CCB and the (equal-weighted) average FX position. These patterns are consistent with the interpretation that higher GFX_t reflects tighter hedging conditions. Second, our IV estimates are stable when we additionally control for

each month, we sort investors into 100 groups based on the time-series standard deviation of their residuals $\check{q}_{i,t}$ and compute the group-by-day-level average residual. Principal components are then based on the panel of 100 groups.

a broad set of macro-financial variables—including bond yields and measures of financial market volatility—that could otherwise proxy for aggregate shocks affecting both FX hedging activity and USD bond demand. Together with the residualization and principal-component orthogonalization described above, these results mitigate the concern that GFX_t is capturing residual aggregate demand shifts rather than plausibly exogenous movements in hedging conditions.

4.4 Alternative Instruments Construction

To further assess the robustness of our approach, we consider several alternative constructions of the instrumental variable.

Additional factors First, to address the concern that residuals may still inherit systematic factor exposures within sector–country pairs, we augment equation (8) with additional controls. FX hedging activity may be sensitive to financial market uncertainty, exchange rate volatility, and currency strength. Accordingly, we include the logarithm of the US VIX (CBOE Volatility Index) and European VIX (EURO STOXX 50 Volatility Index), and dollar strength (proxied by the trade-weighted average USD exchange rate against major U.S. trading partners, following Avdjiev et al., 2019), all in deviations relative to their trailing 3-month average, and spot exchange rate volatility (defined as the 30-day trailing standard deviation of the daily growth rate of the USD–EUR spot rate). Importantly, we allow each investor to load flexibly on these factors by estimating investor-specific coefficients and denote the resulting instrument by $\text{GFX}_t^{-VIX,EX}$.[19]

Investor size Second, we account for the possibility that investor size is a source of heterogeneity in FX market behavior. For instance, smaller or less sophisticated investors may face higher FX markups (Hau et al., 2021). The investor fixed effect v_i in equation (8) absorbs time-invariant differences in such markups, while the sector-by-country-by-time fixed effect $u_{s,c,t}$ captures time-varying markup components common to investors within a sector–country pair. To eliminate any remaining size-related exposures, we further residualize FX positions by including the logarithm of gross FX positions with a time-varying coefficient, where gross positions are computed as 3-month trailing averages, analogously to net positions. This step absorbs any aggregate exposures that are correlated with investor portfolio size, such as differential responses to the global financial cycle or time-varying markup dispersion between large and small investors.

[19] Operationally, we first obtain residuals from equation (8) and then regress these residuals on the three factors using investor-specific regressions. The second-stage residuals are used to construct the instrumental variable.

Heteroskedasticity Third, we address the concern that investors may differ in the volatility of their idiosyncratic shocks, which could weaken identification. In the presence of heteroskedastic shocks, Gabaix and Koijen (2024) recommend weighting observations inversely by their idiosyncratic variance. We implement this adjustment in a robustness exercise, estimating investor-specific idiosyncratic volatility from the residuals $\check{q}_{i,t}$ and incorporating the corresponding weights into the construction of the instrumental variable.

Fund-share closure Finally, we focus on a specific and economically transparent source of idiosyncratic demand shocks originating from investment funds: share class closures. Share class closures can result from various factors, including consolidation efforts, changes in fee structures, shifts in investor clientele, or efficiency-driven cost reductions. When funds close a share class, investors holding that class typically must either transition to alternative share classes within the same fund or liquidate their positions entirely. This forced transition can induce substantial adjustments in a fund's derivative positions, especially when they offer shares with explicit hedging mandates. Consistent with this mechanism, we observe significantly larger idiosyncratic adjustments in FX positions following share class closures (Figure IA.7 b). Motivated by this empirical observation, we construct an alternative instrumental variable that captures variation exclusively from idiosyncratic changes in FX positions coinciding with share class closures of funds with hedging mandates:

$$\text{Fund closures}_t = \sum_{i \in \mathcal{H}M_t} 1\{\text{Closure}_{i,t}\} \left(\frac{\max(0, \bar{Q}^F_{i,t-1})}{\sum_j \max(0, \bar{Q}^F_{j,t-1})} - \frac{1}{N^{closure}_t} \right) \check{q}^F_{i,t}, \tag{10}$$

where $\bar{Q}^F_{i,t-1}$ denotes fund i's average net FX derivatives position in quarter $t-1$ and $\mathcal{H}M_t$ denotes the set of euro-area bond, mixed-asset, and equity funds that (i) hold USD assets, (ii) are subject to FX hedging mandates (defined as in Section 1), and (iii) are alive in both quarters $t-1$ and t. $N^{closure}_t$ denotes the number of funds in $\mathcal{H}M_t$ that experience share class closures in quarter t. In an average quarter, this group includes 8 funds (see Figure IA.7 a) and is highly concentrated, with the largest 25% funds accounting for more than two-thirds of total fund size (measured by $|\bar{Q}^F_{i,t-1}|$).

The variable $\check{q}^F_{i,t}$ is constructed by residualizing the daily (relative) deviation of fund i's net FX position from its 3-month trailing average with respect to fund and time fixed effects, and averaging the residuals at the fund-by-quarter level. To increase the number of funds in $\mathcal{H}M_t$ with nonzero FX positions, we expand the maturity coverage to compute Fund closures$_t$ and include all FX positions with residual maturities between three weeks and eight months.

Fund closures$_t$ can be interpreted as a granular instrumental variable (i.e., a size-weighted minus equal-weighted average) of idiosyncratic changes in FX positions among hedging-mandated funds that experience share-class closures. Accordingly, as in our baseline specification, identification relies on the assumption that $\check{q}^F_{i,t}$ captures truly idiosyncratic shocks. This assumption is particularly compelling in this setting, as we condition on FX position adjustments that occur in direct conjunction with share-class closures. A potential concern is that share-class closures themselves may be correlated with macroeconomic fundamentals. This concern is addressed in equation (10) by computing the difference between size- and equal-weighted averages conditional on experiencing closures, thereby differencing out common shocks that may drive closures.

5 CCB Elasticity of FX Derivatives Positions

This section reports the results from the first-stage regression of GFX_t and provides estimates of the elasticity of FX derivative positions. For daily regressions, we define ΔCCB_t as the daily deviation of the cross-currency basis from its 3-month trailing average, expressed in percentage points. This construction aligns with the definition of $\Delta Q_{i,t}$, ensuring consistency between the instrument and the dependent variable. Using deviations from a trailing average also reduces high-frequency noise in the CCB and helps maintain a strong first stage relative to simple first differences. In first-stage regressions, we regress ΔCCB_t on GFX_t:

$$\Delta\text{CCB}_t = \mu\text{GFX}_t + \Gamma' M_t + \varepsilon_t, \tag{11}$$

where M_t is a vector of control variables described in Table 3. We expect that $\mu < 0$—i.e., that demand shifts captured by GFX_t widen the CCB (i.e., render it more negative). To interpret μ in equation (11), it is useful to note that, by definition, the size-weighted average idiosyncratic shock is equal to the percentage deviation in the aggregate net position of typical hedgers from its trailing average. Thus, μ is the price impact of a 1% idiosyncratic shock to typical hedgers' aggregate net position. In second-stage regressions, we regress equal-weighted average net FX positions on ΔCCB_t, using GFX_t as an instrument.

Columns (1) and (2) of Table 3 report the first-stage estimates, assessing the instrument's relevance. Consistent with Proposition IA.5, we find a significantly negative coefficient, indicating that the CCB widens (becomes more negative) following idiosyncratic FX demand shocks. Quantitatively, the point estimate suggests that a 4% increase (EUR 7.4 billion) in hedgers' total net position corresponds to a 1 bp reduction in the CCB. The magnitude of this effect highlights the presence of supply constraints in FX hedging markets (Du et al., 2018). Even modest shifts in hedging demand can generate economically meaningful changes in the CCB, whose average level in our sample is −9.7 bps. A natural concern in the daily-frequency analysis is that innovations in the de-trended CCB mean-revert too quickly to affect portfolio decisions. Appendix Figure IA.6 addresses this concern by estimating the impulse response function of the de-trended CCB with respect to GFX_t: the response decays gradually and remains statistically significant at the 1% level for nearly 60 business days (approximately one quarter).

In column (2), we include a variety of macroeconomic control variables. These include FX positions' average residual maturity, risk-free rates, stock market returns and volatility, spot rate volatility, and dollar strength. Including these controls removes potential confounding influences from monetary policy, financial market conditions, and unobserved aggregate shocks. The resulting estimate remains robust, both in terms of magnitude and statistical significance. This robustness suggests that the variation in GFX_t is orthogonal to these macroeconomic factors, lending support to the validity of our empirical approach. Appendix Figure IA.4 further illustrates that the correlation between ΔCCB_t and GFX_t is evident across the entire distribution of our sample.

5.1 FX Demand Elasticity

Equipped with a relevant instrument, we can now test the second prediction of Proposition IA.5, that EA investors reduce their FX positions in response to a widening of the CCB. Columns (3) and (4) in Table 3 report the estimated demand (semi-)elasticity ϕ from the following second-stage regression at daily frequency:

$$\overline{\Delta Q}_t = \phi \Delta\text{CCB}_t + \Gamma' M_t + \varepsilon_t. \tag{12}$$

ϕ is the (semi-)elasticity of $\overline{\Delta Q}_t$ to an increase in the CCB. The outcome variable is the equal-weighted average of de-trended investor-level FX positions across EA banks, investment funds, insurers, and pension funds.

OLS Estimate We first report the OLS estimate in column (3). The estimated coefficient is close to zero. In Appendix E, we show that this is a natural outcome when the regressor is an equilibrium price and most aggregate variation in FX positions stems from common shocks. The central issue is simultaneity: because market clearing determines the CCB, aggregate shocks to hedging demand move the basis contemporaneously. With an aggregate (equal-weighted) position derived from many entities, idiosyncratic shocks tend to average out, so that aggregate dynamics reflect primarily common demand shocks. Under these conditions, market clearing predominantly translates common shocks into price adjustments, with minimal movement in aggregate quantities. Consequently, the OLS regression traces out the market-clearing condition rather than the demand curve, resulting in an estimated elasticity close to zero.

IV Estimates The GFX estimator removes this bias by exploiting the granularity of the market. While equal-weighted idiosyncratic shocks vanish in the aggregate due to the Law of Large Numbers, the GIV weights these shocks by investor size. These size-weighted shocks do not wash out; instead, they serve as valid supply shifters that are uncorrelated with common demand shocks, thus tracing out the demand curve. Column (4) reports our baseline estimate when instrumenting ΔCCB_t with GFX_t. The estimate implies that investors reduce their FX positions by 0.69% in response to a 1 bp decrease (i.e., widening) in the CCB, which is statistically significant at the 1% level. The magnitude is also economically significant. It implies that a 17 bp decrease in the cross-currency basis (corresponding to the 5th percentile of ΔCCB_t) reduces net FX positions by about 12% ($= 17 \times 0.69\%$).

Heterogeneity across Sectors We investigate differences across sectors in Figure 4 (a) by estimating equation (12) separately for different sectors. The sensitivity of FX positions to the CCB is the highest for pension funds (between 2 and 3), and lower for insurers and banks (between 1 and 2). In contrast, investment funds display a substantially lower elasticity (close to 0). A potential explanation for this heterogeneity is the diversity of regulatory frameworks across sectors.[20]

FX Rollover Needs We study the role of FX rollover needs in columns (5) to (8). For this purpose, we consider the panel of FX positions at the investor-by-day level and focus on hedgers—i.e., entities with a positive trailing average net FX position. We measure rollover needs at the investor-month level as the share of an investor's FX hedging contracts outstanding at the prior month's end that matures in the current month. Column (5) shows a larger elasticity for investors with high rollover needs, defined as those for whom more than 75% of outstanding positions mature in the current month. The estimated elasticity for high-rollover-need investors is approximately 50% larger than that for investors with low rollover needs. Although this underscores the economic importance of rollover needs, the coefficient on the interaction term with high rollover needs is not precisely estimated (p-value: 18%).

In column (6), we further include sector-by-time fixed effects, restricting identification to within-sector differences in FX positions across investors at the same point in time. The coefficient of

[20] Bank, insurer, and pension fund regulation is based on risk, trading off different types of (market) risk. Instead, investment fund risk-taking is not regulated. However, many funds follow mandates to hedge currency risk, which reduces their sensitivity to changes in hedging costs as we show below.

interest becomes slightly larger and statistically significant at the 10% level, indicating that the effect of rollover needs on demand elasticities is driven by cross-sectional rather than aggregate variation.

The empirical specification also includes fixed effects that absorb sector-specific differences in the average response to rollover needs, ensuring that the identification exploits within-sector variation across investors and over time. We also include investor-by-calendar-month fixed effects, which absorb investor-specific average rollover patterns. As a result, the coefficient on the interaction between CCB_t and high rollover need is identified from deviations in rollover needs from an investor's own average rollover schedule.

Hedging Mandates Finally, we examine the role of hedging mandates. Proposition 2 predicts that hedging mandates dampen FX demand elasticities by constraining investors' ability to reduce FX positions without adjusting underlying portfolio allocations. To test this prediction, we restrict the sample to European investment funds and distinguish between funds without and with hedging mandates, focusing on the differential response to rollover needs.

For funds without mandates, we find a large and statistically significant coefficient on the interaction between ΔCCB_t and high rollover need (column 7), implying a high elasticity of FX demand. In contrast, the corresponding coefficient for funds with hedging mandates is smaller and statistically indistinguishable from zero (column 8). These differences are consistent with the model's predictions and highlight the role of hedging mandates in shaping FX demand elasticities.

6 CCB Elasticity of Bond Holdings

This section estimates the elasticity of EA investors' USD bond holdings to fluctuations in the CCB.

6.1 Baseline Results

OLS Estimates Panel (A) of Table 4 reports estimates of the semi-elasticity of EA bond holdings with respect to the CCB, based on equation (7). Column (1) presents the OLS estimate from regressing bond holdings on the interaction between the CCB and an indicator for USD denomination. The estimated coefficient is significantly positive, implying that USD bond holdings decline by 0.2% relative to EUR bond holdings in response to a 1 bp decrease (i.e., widening) in the CCB.

Rollover Needs: OLS Estimates Column (2) examines heterogeneity across investors based on their FX derivatives rollover needs using the OLS approach. Because bond holdings are observed at the country-by-sector level, we aggregate rollover needs to this level, as described in Section 4.2, and exclude observations for which the measure is missing or fully absorbed by fixed effects. We find that the elasticity of bond holdings with respect to the CCB is marginally larger for investors with higher rollover needs. However, the coefficient on the interaction term is not statistically significant.

IV Estimates We strengthen the identification by instrumenting the CCB with the quarterly average of GFX_t in columns (3) and (4).[21] As a result, the estimated CCB elasticity of bond holdings increases to 0.32, implying that USD bond holdings decrease by 0.32% relative to EUR bond holdings in response to a 1 bp decrease in the CCB. The larger magnitude of the IV estimate suggests that the OLS specification remains partly biased by shocks that jointly affect bond demand and the CCB.

Rollover Needs: IV Estimates We find that the impact of rollover needs on the CCB elasticity becomes highly significant once the CCB is instrumented (column 4). To isolate the effect of differences in FX derivatives rollover needs across investors, we include bond-by-time fixed effects, which absorb bond-specific shocks (such as variation in USD $\times$ CCB). Thus, the coefficient of interest identifies differences in bond demand within a particular bond and period, eliminating potential effects from investors with different rollover needs sorting into different bonds.[22] This result highlights the currency-hedging channel and rules out several alternative channels. For example, an important potential confounder is exchange rate volatility, which might widen the CCB and negatively affect USD bond demand at the same time. However, FX derivatives rollover needs are unlikely to be correlated with differences in investors' responses to exchange rate volatility.

Alternative Instruments The baseline IV estimates in columns (3) and (4) are robust to two alternative instrument constructions. First, in columns (5) and (6), we use a granular instrument that further purges FX positions of investor-specific exposures to financial market

[21] In Internet Appendix B, we show that GFX_t also correlates significantly with the CCB at the quarterly frequency.

[22] These detailed fixed effects require that for each bond-by-quarter observation, at least one low-rollover-needs and one high-rollover-needs country-sector holds the bond, which reduces the overall sample size.

volatility, USD strength, and exchange rate volatility. Second, in columns (7) and (8), we employ an instrument that isolates idiosyncratic shocks to the FX positions of investment funds with hedging mandates experiencing share-class closures. In both cases, the estimated coefficients remain statistically significant and are quantitatively close to the baseline IV estimates.

6.2 Economic Magnitudes

Volume-weighted Elasticity The baseline estimate reports the elasticity for the average bond weighted by the number of observations. To assess the implications for aggregate flows, we also compute the estimate when weighting by the lagged nominal value of bond holdings. The (unreported) holdings-weighted estimate that corresponds to column (3) is 0.25, which implies that (for the average EUR invested) USD-denominated bond holdings decline by 0.25% *relative* to EUR-denominated bonds in response to a 1 bp widening (more negative) of the CCB. Adjusting by the average USD portfolio share, this estimate translates into a decline by approximately 0.21% in the EA's *total* USD bond holdings.[23] This aggregate elasticity is economically significant: It implies that the 5% largest declines in the CCB (about 17 bps) are associated with a nearly 4% decrease in total USD-denominated bond holdings (about $17 \times 0.21\% \approx 3.6\%$). Since the four sectors in our sample jointly hold EUR 2.3 trillion of USD-denominated bonds in 2024Q1, this corresponds to investors disposing of approximately EUR 82 billion of USD bonds.

Relation to Previous Literature The estimated CCB elasticity is of the same order of magnitude as existing estimates for the price elasticity in bond markets. For example, Jansen (2025) estimates a demand elasticity of 4.31 and Koijen et al. (2021) estimates one of 3.21 for EA investors' demand for EA government bonds (estimates for the U.S. corporate bond market are in a similar range (Chaudhary et al., 2023; Kubitza, forthcoming)). Using our average maturity of 9.7 years as a proxy for duration in the standard duration approximation, these estimates imply yield semi-elasticities of about 0.42% and 0.31% for a 1 bp change in bond

[23] Because the fixed effects hold portfolio size constant, equation (7) provides an estimate for the differential change in USD- relative to EUR-denominated bond portfolio weights w^D and w^E:

$$\alpha \, \Delta \text{CCB}_t = \frac{\Delta w^D}{w^D_{t-1}} - \frac{\Delta w^E}{w^E_{t-1}}.$$

Rearranging this equation and using that $w^D = 1 - w^E$ gives that the semi-elasticity of USD bond demand is equal to

$$\frac{\Delta w^D}{w^D_{t-1}} = \alpha \, (1 - w^D_{t-1}) \, \Delta \text{CCB}_t.$$

The average USD portfolio share w^D_{t-1} is 17%.

yields, respectively. The persistence of demand shocks in the literature is comparable to that of the CCB shocks in our analysis, with effects reverting after roughly one to two quarters in bond markets (Chaudhary et al., 2023; Kubitza, forthcoming) as well as for GIV shocks on the CCB (see Figure IA.6). Accordingly, our semi-elasticity should be interpreted as the response to a persistent shock in hedging costs that lasts around one quarter, rather than to transitory day-to-day fluctuations or to permanent yield shifts. Whereas the semi-elasticities in the previous literature measure the demand response to an exogenous change in the bond yield, investors can partially offset CCB-induced changes in the effective (hedged) bond yield, inclusive of hedging costs, by adjusting hedging intensity (as discussed below). As a result, we expect the semi-elasticity with respect to the CCB to be lower than the semi-elasticity with respect to yield changes. This prediction is consistent with our (volume-weighted and portfolio-share-adjusted) estimate of 0.21%.

Risk–Return Trade-off and Imperfect Hedging A more negative CCB maps one-for-one into a lower annualized expected return on a fully currency-hedged USD bond position: a 1 bp more negative basis corresponds to a 1 bp reduction in the annualized hedged yield. Because the basis is quoted in annualized yield units, a change of ΔCCB (in bps) lowers the expected return by ΔCCB bps per year; equivalently, over a τ-month holding period, it lowers the holding-period expected return by $(\tau/12)\ \Delta$CCB bps.

In our sample, the standard deviation of the instrument GFX_t is 0.13, which widens the 3-month CCB by about 3 bps (annualized) according to the first-stage estimate. Expressed in holding-period units, a 3 bps annualized CCB widening corresponds to about 0.75 bps over a three-month hedge roll.

Instead of bearing a higher cost of hedging, investors may choose to hedge less, which exposes them to spot FX risk. During our sample horizon, the daily standard deviation of log changes in the USD–EUR spot rate is about 45 bps, which corresponds to roughly 7.2% annualized, or about 3.6% over a 3-month horizon. A rolling 3-month hedge removes this first-order spot-FX component over each hedge interval.

As we clarify in Appendix D, the mismatch between the FX tenor and the bond maturity makes the hedge imperfect, but only to the extent that it creates FX rollover (i.e., basis) risk and not because it does not match the cash flows. Thus, the residual imperfection is rollover risk, not unhedged long-term spot-FX risk. To gauge its magnitude, the relevant object is the variation in the 3-month CCB at rollover dates, expressed in holding-period return units. The standard deviation of the 3-month CCB in our sample is about 13 bps in annualized units, which corresponds to $13 \times 0.25 \approx 3.25$ bps of risk in hedging costs over a 3-month roll. Hence, residual basis risk is small relative to the spot-FX risk avoided by hedging. These magnitudes therefore support the hedging channel underlying our results: when hedging becomes more expensive, investors adjust hedge ratios and USD holdings at the margin, rather than leaving large USD bond positions unhedged.

6.3 Heterogeneity and Hedge Ratios

Heterogeneity We uncover heterogeneity across bond characteristics, shedding light on differences in investors' currency hedging motives. One mechanism is that investors trade off currency risk against interest rate and credit risk. In this case, when currency hedging becomes more expensive, investors rebalance away from bonds with higher interest rate exposure or greater credit risk. An alternative mechanism is that investors hedge currency risk more intensively for safer bonds, for which currency risk constitutes a larger share of total investment risk.

Consistent with the first mechanism, Figure 4 (c) shows that the elasticity of bond demand with respect to the CCB is larger for corporate bonds than for government bonds and larger for long-term bonds (with at least five years remaining to maturity) than for short-term bonds. These patterns suggest that investors trade off currency risk against interest rate risk and credit risk when adjusting their portfolios. This finding is also consistent with evidence from credit ratings: High-yield bonds display a larger elasticity (close to 0.35) than other bonds (0.3).

Hedge Ratios The CCB elasticity of bond holdings is, on average, lower than the CCB elasticity of FX positions. Thus, investors, on average, reduce their hedge ratios in response to higher hedging costs. However, in contrast to FX positions, differences in the elasticity of bond holdings across investor types are muted, as we document in Figure 4 (b).[24] Thus, the cross-sector differences in FX demand observed in Figure 4 (a) translate into differences in the elasticity of the hedge ratio. Banks, insurers, and pension funds substantially reduce their hedge ratios in response to a more negative cross-currency basis. Instead, the hedge ratio of investment funds appears less responsive to changes in CCB. Section 6.6 below further investigates the role of investment funds' hedging mandate in driving this result.

[24] In contrast to the aggregate dynamics depicted in Figure 3 (a), we do not find a significant difference between the CCB elasticity of banks and nonbanks. A potential explanation is the different level of observation across analyses. Whereas different business models of banks confound aggregate dynamics (e.g., whether banks act as dealers in the FX market), the granular fixed effects in the empirical specification in equation (7) absorb heterogeneity in banks' business models. As a result, the estimate is likely driven by banks with demand for long-term USD assets.

6.4 Robustness

A possible remaining concern regarding the interpretation of our results is that variation in USD relative to EUR bond holdings may reflect other determinants of bond demand, such as fluctuations in the spot exchange rate. Several features of our analysis address this concern. First, FX positions do not mechanically respond to spot exchange rate fluctuations by construction (see Section 1). As a result, movements in the spot rate do not mechanically affect the instrumental variable GFX_t. Second, we revalue current USD-denominated bond holdings using the previous quarter's spot exchange rate, thereby purging the dependent variable of contemporaneous exchange rate movements. Third, Figure IA.13 shows that our baseline results are robust to including controls for the spot exchange rate and exchange rate volatility interacted with the USD indicator.

More broadly, the results are robust to a range of alternative specifications, reported in Figure IA.13. First, we include credit-rating-by-time and residual-maturity-by-time fixed effects, which absorb shocks affecting bonds with different credit risk and interest rate exposures. Second, we exclude 2020q1 and 2022q3 from the sample, thereby removing periods associated with the COVID-19 shock and the UK mini-budget episode.[25] Third, we further residualize idiosyncratic FX position shocks using portfolio size (i.e., gross notional) interacted with time dummies, eliminating size-related exposures. Finally, we adjust the instrument for heteroskedasticity following Gabaix and Koijen (2024). Across all specifications, the estimated CCB elasticity remains statistically significant and quantitatively close to the baseline estimate.

6.5 Portfolio-level Estimates

The baseline results primarily reflect portfolio adjustments at the intensive margin (e.g., adjusting the size of existing holdings), as the log specification requires positive bond holdings. However, bond holdings may also be zero or negative, and investors may adjust their portfolios along the extensive margin by initiating or fully liquidating positions.

To assess the relevance of extensive-margin adjustments and short positions, Panel (B) of Table 4 examines the portfolio share of USD bonds relative to total USD and EUR bond holdings. The regression sample is restricted to investors with a non-negligible preference for USD bonds.[26]

[25] These stress episodes also coincide with unusually tight dollar funding conditions and policy interventions, including central bank U.S. dollar liquidity swap lines, which can affect the CCB by easing intermediaries' dollar funding constraints. Excluding these quarters therefore mitigates concerns that crisis-specific dynamics drive the estimated elasticities.

[26] Specifically, for each country–sector pair, we compute the 25th percentile of total USD bond investments and exclude the bottom 25% from the sample.

The specification includes country-by-sector fixed effects, absorbing time-invariant heterogeneity.

Across all three instruments, we find a significantly positive coefficient on the CCB in the second-stage regression. For the GFX instruments, the magnitudes are comparable to the corresponding bond-level estimates (columns 3 and 5), whereas the fund closure instrument yields a smaller second-stage estimate (column 7), which may reflect that the identifying variation is narrower than that of the GFX instruments. The consistency of the results across bond-level and portfolio-level specifications suggests that country-sector pairs primarily adjust their USD bond holdings at the intensive rather than the extensive margin. This finding is not surprising, as extensive-margin adjustments at the level of aggregation in the data require all investors within a country-sector to jointly initiate or liquidate all positions in a given bond. Moreover, (net) short positions are uncommon (see Appendix Table IA.4). Finally, we also find evidence of differential responses by rollover needs, although these effects are not precisely estimated at the portfolio level.

6.6 Funds' Hedging Mandates

In the conceptual framework described in Section 3, USD bond holdings respond to fluctuations in the CCB because investors seek to hedge the currency risk of their asset investments with potential currency hedging mandates. In this section, we study the role of FX hedging mandates across EA investment funds, using the fund-level holdings data described in Section 1.

Whereas funds may wish to reduce their FX hedging activity when the CCB widens (i.e., becomes more negative), hedging mandates constrain their ability to do so. In particular, such mandates limit adjustments to hedge ratios. As a result, funds with hedging mandates can reduce total hedging costs only by lowering their exposure to foreign-currency assets. This implies a stronger response of USD bond holdings by funds with mandates, as formalized in Proposition 2.

To test this prediction, we estimate the CCB elasticity of bond holdings in equation (7) separately for funds with and without FX hedging mandates. Table 5 reports the corresponding estimates. As a baseline, columns (1) and (4) present OLS and IV estimates for the average fund, pooling funds with and without mandates, and imply a statistically significant elasticity of 0.12 and 0.14, respectively.[27] Because we include fund-by-quarter fixed effects, identification comes from within-fund reallocation between USD- and EUR-denominated bonds; we therefore restrict the sample to fund-quarters in which the fund holds both USD- and EUR-denominated bonds.

Consistent with our framework's predictions, the elasticity estimate is larger for funds with FX

[27] This elasticity is smaller than the corresponding country-sector-level estimate in Table 4, reflecting differences in sample coverage and the fact that fund-level regressions identify the elasticity of the average fund rather than that of the aggregate fund sector.

hedging mandates. The IV estimates indicate that funds with mandates are 75% more responsive to changes in the CCB than funds without mandates (columns (5) and (6)). Moreover, the coefficient is statistically more significant for funds with mandates–despite a smaller sample size, suggesting that the difference is unlikely to be driven by statistical power. Nonetheless, the difference between the coefficients is not statistically significant (p-value 0.24). Taken together, these results emphasize the importance of FX hedging in the mechanism through which the CCB affects portfolio allocation.

7 Additional Results

This section reports additional results on the role of derivatives tenors and the implications of changes in the CCB for bond prices.

7.1 The Role of Derivatives Tenors

Our baseline analysis focuses on the 3-month FX derivatives tenor. This choice reflects market practice—the 3-month tenor is the most commonly used for currency hedging—as well as the data, as the average residual maturity of FX positions in our sample is close to three months (see Figure IA.11).

In this section, we examine whether our results extend to other commonly traded tenors. Specifically, we consider 1-week, 1-month, and 6-month FX derivatives. For each tenor, we construct a granular instrumental variable following exactly the same methodology as in the baseline analysis. Table IA.9 reports the correlations across the resulting tenor-specific instruments. These correlations are generally low, with the largest (in absolute value) being around -14% between the 1-month and 3-month tenors. This pattern is consistent with the instrument capturing idiosyncratic, tenor-specific demand shocks rather than aggregate shocks common to the FX derivatives market.

We assess the relevance of the instrument across tenors by estimating tenor-specific first- and second-stage regressions. Table 6 shows that the instrument significantly predicts the corresponding CCB for all tenors, and that the instrumented CCB, in turn, significantly affects FX positions (columns (1) to (8)). While elasticities are broadly comparable across maturities, we find a substantially higher elasticity at the 1-week tenor, consistent with stronger short-term responses documented in the literature (e.g., Du et al., 2018). Columns (9) and (10) report the corresponding estimates from a pooled panel that includes the instruments, CCBs, and FX positions at all tenors.

Finally, we re-estimate the baseline results on bond holdings using tenor-specific CCBs instrumented by the corresponding granular instruments. The results are reported in Table 7. The 3-month tenor stands out: it is the only tenor to which bond holdings respond with high statistical significance. In contrast, the estimates for the other tenors are imprecise and, except for the 6-month tenor, statistically indistinguishable from zero. Overall, these results reinforce our focus on the 3-month maturity as the relevant hedging horizon for bond holdings.

7.2 CCB Elasticity of Bond Yields

In the following, we examine the price impact of CCB-risk–implied investor rebalancing. Due to the segmentation of bond markets—e.g., by issuers and maturities— investor base characteristics tend to be mirrored in bond prices (Coppola, 2025; Kubitza, forthcoming). With strong enough segmentation, bonds whose investors are exposed to EUR-USD CCB risk are likely to display stronger price sensitivity to fluctuations in the EUR-USD CCB. Since investors reduce USD bond holdings in response to a widening of the CCB, we expect this rebalancing to increase the yields of exposed USD bonds relative to other bonds. To measure exposure, we aggregate investors' rollover needs to the bond level.

U.S. Corporate Bonds We first examine corporate bonds, which account for more than 60% of EA USD bond holdings. Because only corporate bonds with significant EA ownership should be affected by fluctuations in the CCB, we start by restricting our sample to USD bonds issued by U.S. entities with at least 10% EA ownership share on average over our sample. We regress the bonds' yield spread on the CCB at daily frequency, both de-trended by their respective 3-month trailing averages.

To isolate the pass-through of the CCB through hedging behavior, we focus on the differential response of bonds whose investors experience high FX rollover needs in the current month relative to other bonds. To explore this role of rollover needs, analogously to the previous section, we compute for each country-sector i the share of hedging positions of hedgers (i.e., investors with a positive trailing average position) outstanding at the previous month-end that matures in the current month m, denoted by FX $\text{mat}_{i,m}$.[28] Then, we aggregate FX $\text{mat}_{i,m}$ to the bond level by computing the holdings-weighted average across past bond investors:

$$\overline{\text{FX mat}}_{b,m} = \sum_i \frac{h_{i,b,q-1}}{\sum_j h_{j,b,q-1}} \times \text{FX mat}_{i,m}, \tag{13}$$

[28]The high frequency of price data allows us to use monthly instead of quarterly variation in rollover need.

where $h_{i,b,q-1}$ is the total nominal value of bond b held by country-sector i in the preceding quarter $q-1$. Finally, we split bonds into those exposed to high and low rollover needs through their investor base based on the median value of $\overline{\text{FX mat}}_{b,m}$.

Column (1) in Table 8 reports the estimated coefficient from regressing de-trended yield spreads (relative to their 3-month trailing average) on instrumented CCB changes interacted with an indicator for high rollover needs. The specification includes time fixed effects, which absorb aggregate shocks to all U.S. corporate bonds, bond fixed effects, which absorb time-invariant heterogeneity in bond characteristics, and rollover need fixed effects, which absorb time-invariant differences across bonds associated with the rollover needs of their investor base. The coefficient on the interaction term is significantly negative, implying that the yield spreads of bonds with high rollover needs increase by 0.55 bps in response to a 1 bp decline (i.e., widening) in the CCB, relative to bonds with low rollover needs. This result is robust in both statistical and economic significance when we additionally include residual-maturity-by-time and credit-rating-by-time fixed effects (column 2), which ensure that the coefficient compares similar bonds that differ only in whether investors face different rollover needs. A significantly negative coefficient also persists when we additionally include issuer-by-quarter fixed effects (column 3), which absorb shocks to bond issuer fundamentals at quarterly frequency.

We expect the rollover needs of EA investors to be more relevant for bonds with higher EA ownership. To test this hypothesis, in column (4), we additionally include bonds with low EA ownership in the sample. We then expand the specification by including a triple interaction between CCB changes, high rollover need, and an indicator variable that is equal to one for bonds with at least 10% EA ownership share on average. The estimated coefficient on this interaction is significantly negative, implying that the differential effect of the CCB on bond yields is stronger for bonds with higher EA ownership, consistent with the hypothesis. This result emphasizes the hedging behavior of EA investors as the primary mechanism driving the findings.

Government Bonds Furthermore, we examine the price effects for U.S. Treasuries and EA government bond yields at constant maturities. We compute the rollover need of the investor base for each issuer–maturity pair analogously to above.[29] We regress government bond yields (de-trended by their 3-month trailing average) on the interaction of ΔCCB_t and an indicator for high rollover needs, absorbing aggregate shocks by including time fixed effects.

[29] Holdings of bonds with residual maturities of up to 6 months are assigned to the 3-month yield; those with residual maturities between 6 months and 2 years to the 1-year yield; between 3 and 7 years to the 5-year yield; between 8 and 12 years to the 10-year yield; between 13 and 17 years to the 15-year yield; and between 18 and 22 years to the 20-year yield.

For U.S. Treasuries, the estimated coefficient is not statistically significant. The imprecise estimate is consistent with the low euro-area ownership share of U.S. Treasuries (approximately 3% of the amount outstanding) and the limited cross-sectional variation across Treasury bonds.

We then turn to EA government bonds and hypothesize that CCB-induced rebalancing from USD into EUR bonds by EA investors exerts downward pressure on EA government bond yields. Consistent with this hypothesis, we find a statistically significant effect for bonds with high rollover needs relative to those with low rollover needs (column 6). The estimated coefficient implies that yields on exposed EA government bonds decline by 0.45 bps in response to a 1 bp decrease in the CCB, relative to less exposed bonds. This result is robust to including granular maturity-by-time and credit-rating-by-time fixed effects (column 7), implying a decline of 0.19 bps per 1 bp decrease in the CCB. Taken together, these results suggest that investors substitute domestic currency (EUR) bonds for foreign currency (USD) bonds when hedging currency risk becomes more expensive.

8 Conclusion

This paper provides evidence that deviations from the covered interest rate parity (CIP), as observed since 2008, have significant consequences for international capital markets. Because wider deviations raise the cost of hedging currency risk, international investors reduce both their FX positions and their investments in USD assets, resulting in significant international capital flows and bond price effects. This rebalancing is driven primarily by a currency-hedging channel: investors with greater rollover needs in their FX derivatives portfolios respond more strongly to wider CIP deviations. Overall, these results speak to the broader consequences of frictions in international financial markets for capital allocation, financial stability, and monetary policy transmission.

References

Ahmed, Ahmed, Boris Hofmann, and Martin Schmitz, 2021, Foreign institutional investors, monetary policy, and reaching for yield, *Available at SSRN 4002545*.

Aldunate, Felipe E., Zhi Da, Borja Larrain, and Clemens Sialm, 2025, Pension fund flows, exchange rates, and covered interest rate parity, *Journal of Financial Economics* 170, 104075.

Alfaro, Laura, Mauricio Calani, and Liliana Varela, 2021, Granular corporate hedging under dominant currency, NBER Working Paper 28910, National Bureau of Economic Research.

Andersen, Leif, Darrell Duffie, and Yang Song, 2019, Funding value adjustments, *Journal of Finance* 74, 145–192.

Augustin, Patrick, Mikhail Chernov, Lukas Schmid, and Dongho Song, 2024, The term structure of covered interest rate parity violations, *Journal of Finance* 79, 2077–2114.

Avdjiev, Stefan, Wenxin Du, Catherine Koch, and Hyun Song Shin, 2019, The dollar, bank leverage, and deviations from covered interest parity, *American Economic Review: Insights* 1, 193–208.

Ben Zeev, Nadav, and Daniel Nathan, 2024, The widening of cross-currency basis: When increased FX swap demand meets limits of arbitrage, *Journal of International Economics* 152, 103984.

Bräuer, Leonie, and Harald Hau, 2023, Can time-varying currency risk hedging explain exchange rates?, *Available at SSRN 4245778*.

Bruno, Valentina, and Hyun Song Shin, 2015, Cross-border banking and global liquidity, *Review of Economic Studies* 82, 535–564.

Bräuer, Leonie, and Harald Hau, 2025, Do funds engage in optimal FX hedging?, Research Paper 24-103, Swiss Finance Institute, Posted 27 Nov 2024; Last revised 25 Aug 2025.

Camanho, Nelson, Harald Hau, and Hélene Rey, 2022, Global portfolio rebalancing and exchange rates, *Review of Financial Studies* 35, 5228–5274.

Campbell, John Y, Karine Serfaty-De Medeiros, and Luis M. Viceira, 2010, Global currency hedging, *Journal of Finance* 65, 87–121.

Campbell, John Y, and Luis M. Viceira, 2002, Strategic asset allocation: Portfolio choice for long-term investors, in *Clarendon Lectures in Economics* (Oxford University Press).

Cenedese, Gino, Pasquale Della Corte, and Tianyu Wang, 2021, Currency mispricing and dealer balance sheets, *Journal of Finance* 76, 2763–2803.

Cesa-Bianchi, Ambrogio, Robert Czech, and Fernando Eguren-Martin, 2025, Dash for Dollars, *Working Paper*.

Chaudhary, Manav, Zhiyu Fu, and Jian Li, 2023, Corporate bond multipliers: Substitutes matter, *Available at SSRN 4292266*.

Coeurdacier, Nicolas, and Pierre-Olivier Gourinchas, 2016, When bonds matter: Home bias in goods and assets, *Journal of Monetary Economics* 82, 119–137.

Coeurdacier, Nicolas, and Helene Rey, 2013, Home bias in open economy financial macroeconomics, *Journal of Economic Literature* 51, 63–115.

Coppola, Antonio, 2025, In safe hands: The financial and real impact of investor composition over the credit cycle, *Review of Financial Studies* 38, 2275–2325.

Coppola, Antonio, Arvind Krishnamurthy, and Chenzi Xu, 2024, Liquidity, debt denomination, and currency dominance, NBER Working Paper 30984, National Bureau of Economic Research.

Correa, Ricardo, Wenxin Du, and Gordon Y. Liao, 2020, U.S. banks and global liquidity, NBER Working Paper 27491, National Bureau of Economic Research.

d'Avernas, Adrien, Damon Petersen, and Quentin Vandeweyer, 2024, The central bank balance sheet and treasury market disruptions, *Available at SSRN 4826919*.

Dávila, Eduardo, Daniel Graves, and Cecilia Parlatore, 2024, The value of arbitrage, *Journal of Political Economy* 132, 1947–1993.

Dick-Nielsen, Jens, 2014, How to clean enhanced trace data, *Available at SSRN 2337908*.

Du, Wenxin, Benjamin Hébert, and Amy Wang Huber, 2023, Are intermediary constraints priced?, *Review of Financial Studies* 36, 1464–1507.

Du, Wenxin, and Amy Huber, 2024, Dollar asset holding and hedging around the globe, NBER Working Paper 32453, National Bureau of Economic Research.

Du, Wenxin, Alexander Tepper, and Adrien Verdelhan, 2018, Deviations from covered interest rate parity, *Journal of Finance* 73, 915–957.

Faia, Ester, Juliana Salomao, and Alexia Ventula Veghazy, 2025, Market segmentation and international bond prices: The role of ECB asset purchases, *American Economic Journal: Macroeconomics* 17, 391–421.

Florez-Orrego, Sergio, Matteo Maggiori, Jesse Schreger, Ziwen Sun, and Serdil Tinda, 2024, Global capital allocation, *Annual Review of Economics* 16, 623–653.

French, Kenneth R., and James M. Poterba, 1991, Investor diversification and international equity markets, *American Economic Review: Papers & Proceedings* 81, 222–226.

Gabaix, Xavier, 2011, The granular origins of aggregate fluctuations, *Econometrica* 79, 733–772.

Gabaix, Xavier, and Ralph SJ Koijen, 2023, In search of the origins of financial fluctuations: The inelastic markets hypothesis, *Available at SSRN 3686935*.

Gabaix, Xavier, and Ralph SJ Koijen, 2024, Granular instrumental variables, *Journal of Political Economy* 132, 2274–2303.

Gürkaynak, Refet S., Brian Sack, and Jonathan H. Wright, 2007, The U.S. Treasury yield curve: 1961 to the present, *Journal of Monetary Economics* 54, 2291–2304.

Hacioglu Hoke, Sinem, Daniel A. Ostry, Hélène Rey, Adrien Rousset Planat, Vania Stavrakeva, and Jenny Tang, 2026, Topography of the FX derivatives market: A view from London, Working Paper 34588, National Bureau of Economic Research.

Hau, Harald, Peter Hoffmann, Sam Langfield, and Yannick Timmer, 2021, Discriminatory pricing of over-the-counter derivatives, *Management Science* 67, 6660–6677.

Hau, Harald, and Hélene Rey, 2004, Can portfolio rebalancing explain the dynamics of equity returns, equity flows, and exchange rates?, *American Economic Review* 94, 126–133.

Hau, Harald, and Hélene Rey, 2006, Exchange rates, equity prices, and capital flows, *Review of Financial Studies* 19, 273–317.

Hommel, Nicolas, and Thibaut Piquard, 2025, Firms' foreign exchange hedging, Working Paper.

ICMA, 2023, 44th European Repo Market Survey, *Available at www.icmagroup.org*.

Ivashina, Victoria, David S. Scharfstein, and Jeremy C. Stein, 2015, Dollar funding and the lending behavior of global banks, *Quarterly Journal of Economics* 130, 1241–1281.

Jansen, Kristy A.E., 2025, Long-term investors, demand shifts, and yields, *Review of Financial Studies* 38, 114–157.

Keller, Lorena, 2024, Arbitraging covered interest rate parity deviations and bank lending, *American Economic Review* 114, 2633–2667.

Khetan, Umang, 2024, Synthetic dollar funding, *Available at SSRN 4863575*.

Kloks, Peteris, Edouard Mattille, and Angelo Ranaldo, 2024, Hunting for dollars.

Koijen, Ralph SJ, François Koulischer, Benoît Nguyen, and Motohiro Yogo, 2021, Inspecting the mechanism of quantitative easing in the euro area, *Journal of Financial Economics* 140, 1–20.

Koijen, Ralph SJ, and Motohiro Yogo, 2024, Exchange rates and asset prices in a global demand system, NBER Working Paper 27342, National Bureau of Economic Research.

Kubitza, Christian, forthcoming, Investor-driven corporate finance: Evidence from insurance markets, *Review of Financial Studies*.

Lenoci, Francesca D., and Elisa Letizia, 2021, Classifying counterparty sector in EMIR data, in *Data Science for Economics and Finance: Methodologies and Applications*, 117–143 (Springer International Publishing).

Liao, Gordon Y., 2020, Credit migration and covered interest rate parity, *Journal of Financial Economics* 138, 504–525.

Maggiori, Matteo, Brent Neiman, and Jesse Schreger, 2020, International currencies and capital allocation, *Journal of Political Economy* 128, 2019–2066.

Moskowitz, Tobias J., Chase P. Ross, Sharon Y. Ross, and Kaushik Vasudevan, forthcoming, Risk, specialization, and covered-interest parity, *Journal of Finance*.

Opie, Wei, and Steven Riddiough, 2024, On the use of currency forwards: Evidence from international equity mutual funds, *Available at SSRN 4432796*.

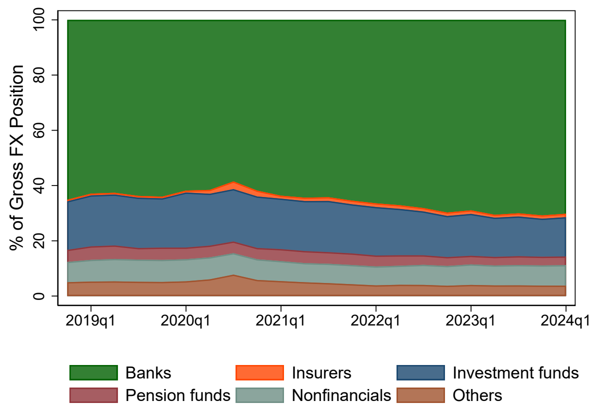
Rime, Dagfinn, Andreas Schrimpf, and Olav Syrstad, 2022, Covered interest parity arbitrage, *Review of Financial Studies* 35, 5185–5227.

Sialm, Clemens, and Qifei Zhu, 2024, Currency management by international fixed income mutual funds, *Journal of Finance* 79, 4037–4081.

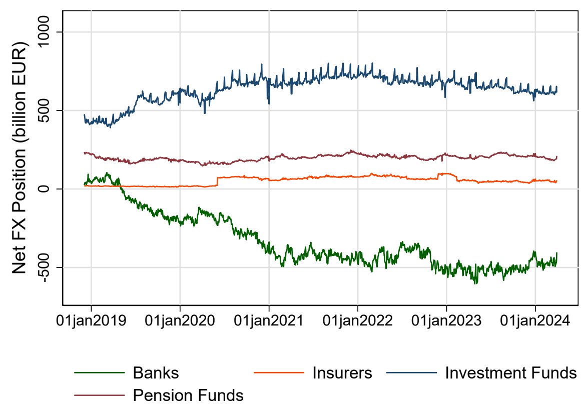
Figures and Tables

Figure 1. FX Forward Positions.

Figure (a) plots the sectoral shares (in percent) of total USD-EUR gross forward positions for EA financial sectors. "Others" include governments, other financial institutions, and entities with missing sector classification. Figure (b) plots the total net position (in terms of notional in EUR) for EA financial sectors. Net positions are defined as the difference between buy and sell positions. A buy position is one in which the investor has the obligation to deliver USD in the future against EUR. Such positions can be achieved, for example, by entering a swap in which the investor obtains USD at the spot date and delivers USD at the forward date.



(a) Gross FX Positions



(b) Net FX Positions

Figure 2. USD-EUR Cross-currency Basis.

The figure plots the USD-EUR CCB for a 3-month maturity. It is computed from transaction-volume-weighted median spot and forward rates from money market statistical reporting (MMSR) to the ECB and the EURIBOR and USD LIBOR rates. The more negative the CCB, the more expensive it is for euro-area investors to hedge USD positions. For confidentiality purposes, the original value of 11 observations is omitted (i.e., not shown). This omission applies only to this figure but not to our analysis.

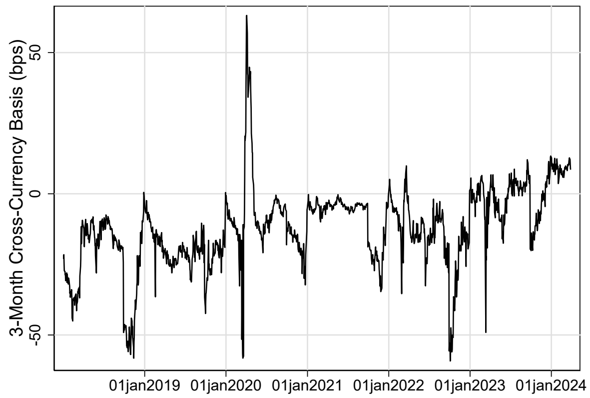
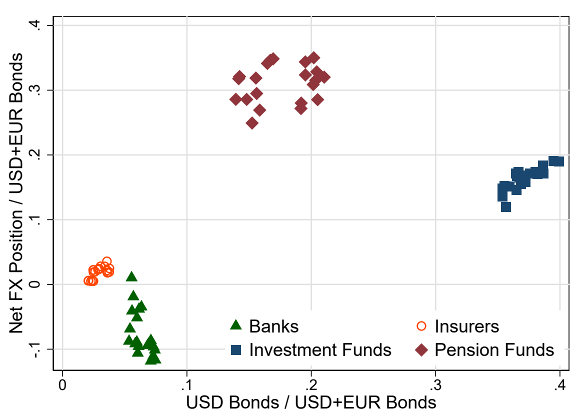
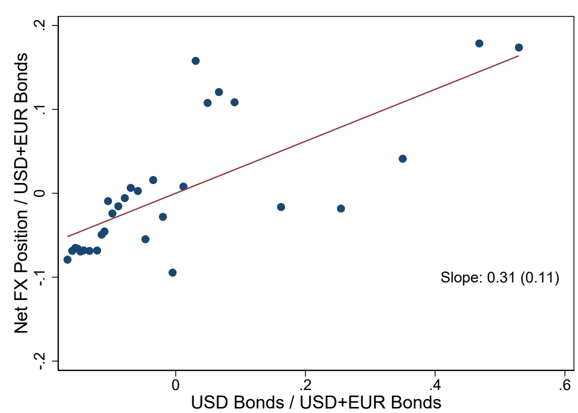


Figure 3. FX Forward Positions and Portfolio Allocation.

Figure (a) plots an investor sector's total net FX forward position (y-axis) and total USD bond holdings (x-axis), both scaled by total USD and EUR bond holdings. Figure (b) is a binned scatter plot of total net FX forward positions (y-axis) and total USD bond holdings (x-axis) of insurers, pension funds, and investment funds at the country-sector-by-quarter level, both scaled by total USD and EUR bond holdings, after absorbing time fixed effects. The figure also reports the estimated coefficient and its standard error of a regression of (scaled) net FX forward positions on USD bond holdings. In both figures, bond holdings are measured in USD, and FX position size is given by the cash flow exchanged in USD at the derivative contract's maturity.

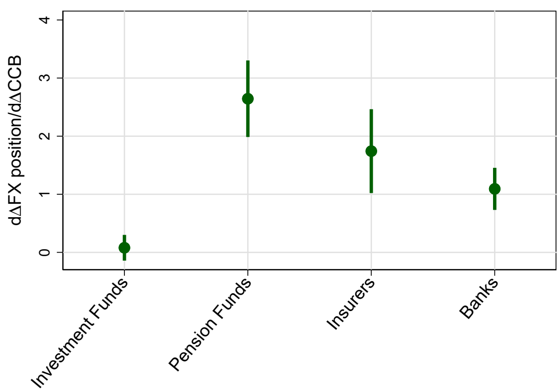


(a) Time Series (sector level)

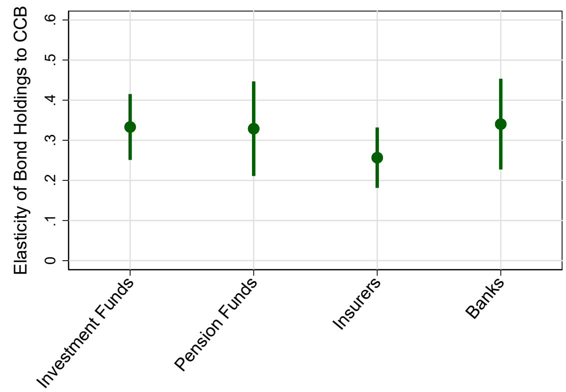


(b) Cross-section of Nonbanks (country-sector level)

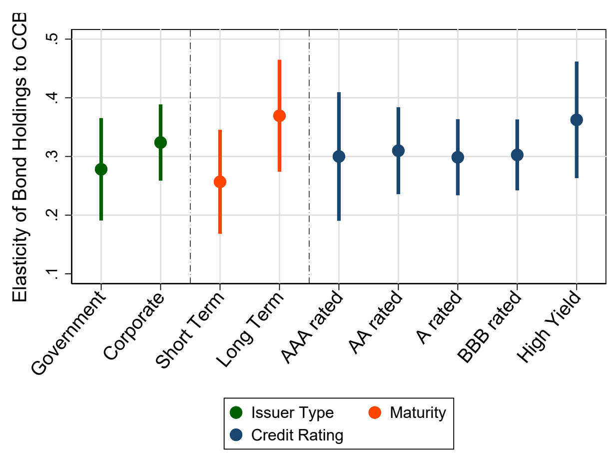
Figure 4. Cross-currency Basis, FX Forward Positions, and Bond Holdings: Heterogeneity.
This figure depicts the estimated coefficients on the instrumented change in the 3-month cross-currency basis individually for different sectors and types of bonds based on regressions analogous to (a) column (4) in Table 3 and (b,c) column (3) in Table 4, respectively, and the corresponding 90% confidence intervals. Long-term (short-term) bonds are bonds with at least (less than) 5 years remaining time to maturity. High-yield bonds are those with a credit rating worse than BBB.



(a) FX Positions: by Investor Sector



(b) Bond Holdings: by Investor Sector



(c) Bond Holdings: by Issuer Type, Maturity, and Credit Rating

Table 1. Summary Statistics.

The table depicts summary statistics for (1) USD-EUR net and gross FX forward positions as well as their gross volume-weighted average residual time to maturity at sector-day level, (2) the share of USD bond holdings (relative to USD and EUR bonds), the volume-weighted average residual time to maturity of USD bond holdings (excluding bonds with more than 50 years to maturity), the hedge ratio relative to bond holdings, and the hedge ratio relative to combined bond and equity holdings at sector-quarter level, (3) the quarterly change in log bond holdings at bond-country-sector-quarter level, (4) the USD-EUR 3-month cross-currency basis (CCB), the deviation of the daily CCB from its 3-month trailing average (ΔCCB_t), and the size- minus equal-weighted average of idiosyncratic shocks to typical hedgers' FX positions (GFX), orthogonalized by their first three principal components, at daily frequency, (5) the share of FX hedging contracts maturing in the current quarter at country-sector-quarter level, and (6) the deviation of the yield spread from its 3-month trailing average and the residual maturity of USD-denominated U.S. corporate bonds at bond-day level. FX positions are winsorized at the 1st and 99th percentiles at investor level before aggregation. The hedge ratio is computed using a sector's average net FX position at the last 3 days of each quarter. To preserve confidentiality, we only report one digit for the CCB and replace one percentile of rollover needs by *. Appendix Table IA.1 details variable definitions and sources.

	N	Mean	SD	p5	p50	p95
FX Derivatives Positions (Sector-by-Day Level, Dec 2018 - Mar 2024)						
Net FX Position (bil EUR)	5,560	138.41	361.70	-487.73	126.29	704.01
Gross FX Position (bil EUR)	5,560	2,051.36	2,500.04	52.64	801.19	7,357.94
FX: Residual Maturity (months)	5,560	2.23	0.82	1.06	2.19	3.44
Bond Holdings (Sector-by-Quarter Level, 2019q1 - 2024q1)						
Share of USD Bonds	84	0.17	0.14	0.03	0.11	0.40
USD Bonds: Residual Maturity (ex > 50 yrs)	84	9.69	1.66	7.03	10.11	12.36
Hedge Ratio (Banks)	21	-1.20	0.52	-1.67	-1.36	-0.33
Hedge Ratio (Banks; incl Equity Inv)	21	-1.02	0.42	-1.41	-1.16	-0.30
Hedge Ratio (Non-Banks)	63	0.95	0.64	0.27	0.66	2.07
Hedge Ratio (Non-Banks; incl Equity Inv)	63	0.40	0.28	0.12	0.29	0.88
Bond Holdings (Bond-by-Country-Sector-by-Quarter Level, 2019q2 - 2024q1)						
Δlog Bond Holdings	9,029,001	-0.01	0.36	-0.45	0.00	0.39
Time-Series Variables (Daily Frequency, 2019q2 - 2024q1)						
CCB (bps)	1,256	-9.7	13.4	-28.4	-8.7	8.9
ΔCCB (bps)	1,256	0.41	10.69	-16.64	0.76	16.27
GFX	1,256	-0.00	0.13	-0.22	-0.00	0.21
ΔFX position	1,256	0.04	0.09	-0.10	0.04	0.19
Investor Characteristics (Country-Sector-by-Quarter Level, 2019q2 - 2024q1)						
Rollover Need (quarterly)	1,045	0.75	0.23	0.31	0.82	
U.S. Bonds (Bond-by-Day Level, Apr 2019 - Sep 2023)						
ΔYield Spread (ppt)	6,665,472	0.00	0.53	-0.59	-0.03	0.58
Residual Maturity (years)	6,665,472	9.63	9.91	1.00	6.00	28.00

Table 2. Summary Statistics by Sector: FX Forward Positions and Bond Holdings.
The table depicts the sector-specific time-series averages of the corresponding variables from Table 1.

	Investment Funds	Pension Funds	Insurers	Banks
Net FX Position (bil EUR)	637.45	197.70	52.95	-334.47
Gross FX Position (bil EUR)	1,577.96	359.25	114.93	6,153.32
FX: Residual Maturity (months)	1.21	1.93	2.53	3.25
Share of USD Bonds	0.39	0.18	0.03	0.07
Hedge Ratio	0.44	1.79	0.62	-1.20
Hedge Ratio (incl Equity Inv)	0.17	0.76	0.27	-1.02

Table 3. Cross-currency Basis and FX Forward Positions.
Columns (1) and (2) present ordinary least squares (OLS) estimates from first-stage specifications analogously to equation (11) at daily frequency, where the dependent variable, ΔCCB_t, is the deviation of the 3-month USD-EUR cross-currency basis from its 3-month trailing average (in ppt). The main explanatory variable, GFX_t, is the difference between the size- and equal-weighted average of idiosyncratic shocks to typical hedgers' FX positions, orthogonalized by their first three principal components. Columns (3) to (8) present estimated coefficients from second-stage specifications analogously to equation (12) at daily frequency, where the dependent variable is the % deviation of 3-month net FX positions from their 3-month trailing average and the explanatory variable is ΔCCB_t. In columns (4) to (8), ΔCCB_t is instrumented with GFX_t. Columns (1) to (4) are based on the time-series of the respective variables, and (5) to (8) on an investor-by-day panel of FX positions with 2 and 4 months maturity, comprised of investment funds, pension funds, insurers, and banks. Columns (7) and (8) only include investment funds, distinguishing between funds (7) without and (8) with a mandate to hedge currency risk. *High Rollover Need* indicates that more than 75% of an investor's FX hedging positions outstanding at the prior month's end are maturing in the current month. Res. Mat. is the volume-weighted average residual maturity of typical hedgers' outstanding FX positions. Macro controls are the deviation in the US-EA risk-free rate differential and in the log of the S&P 500, Euro STOXX 50, dollar strength, and U.S. and European VIX from their respective 3-month trailing averages as well as the 30-day trailing standard deviation of USD-EUR spot rates. Cal. Month FEs are based on dummies for each calendar month. In columns (7) and (8), Sector-High Rollover Need FEs and Sector-Time FEs collapse to High Rollover Need FEs and Time FEs, respectively. In columns (1) to (4), heteroskedasticity-robust standard errors and, in columns (5) to (8), standard errors two-way clustered by investor and day are shown in parentheses. We also report the first-stage Cragg-Donald Wald F statistic. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	ΔCCB		ΔFX Position					
	OLS			IV				
Sample:	Time Series				Investor-level Panel		Panel: Investment Funds	
							No Mandate	Mandate
GFX	-0.25***	-0.20***						
	(0.02)	(0.02)						
ΔCCB			0.01	0.69***	3.35**			
			(0.02)	(0.11)	(1.62)			
ΔCCB × High Rollover Need					1.58	2.00*	17.58***	5.91
					(1.18)	(1.16)	(6.18)	(7.13)
Res. Mat.		Y	Y	Y	Y			
Macro Controls		Y	Y	Y	Y			
Sector-High Rollover Need FEs					Y	Y	Y	Y
Investor-Cal. Month FEs					Y	Y	Y	Y
Sector-Time FEs						Y	Y	Y
F Statistic (1st)				83.4				
No. of obs.	1,256	1,256	1,256	1,256	895,039	895,039	57,050	15,521
No. of investors					1,363	1,363	131	23

Table 4. Cross-currency Basis and Bond Holdings.

Panel (A) presents estimated coefficients from specifications of the form

$$\Delta \log \text{Bond Holdings}_{i,b,t} = \beta \Delta \text{CCB}_t \times \text{USD}_b + \Gamma' C_{i,b,t} + \varepsilon_{i,b,t},$$

estimated at the country-sector-bond-quarter level. $\Delta \log \text{Bond Holdings}_{i,b,t}$ is the quarterly change in country-sector i's log holdings of bond b at nominal value. ΔCCB_t is the quarterly change in the quarterly average 3-month USD-EUR cross-currency basis (in ppt). $C_{i,b,t}$ is a vector of fixed effect indicators. Panel (B) presents estimated coefficients from specifications of the form

$$\Delta \log \text{USD share}_{i,t} = \beta \Delta \text{CCB}_t + \Gamma' C_{i,t} + \varepsilon_{i,t},$$

estimated at country-sector-quarter level, where $\Delta \log \text{USD share}_{i,t}$ is the quarterly change in the log portfolio share of USD bonds relative to EUR and USD bonds held by country-sector i. The sample excludes country-sectors with the 25% lowest (time-series 25th percentile of the) amount of USD holdings. In both panels, in columns (3) and (4), ΔCCB_t is instrumented with GFX_t, defined as the difference between the size- and equal-weighted average of idiosyncratic shocks to typical hedgers' FX positions, orthogonalized by their first three principal components. In columns (5) and (6), the instrument is additionally purged of investor-specific exposure to financial market volatility, USD strength, and spot rate volatility. In columns (7) and (8), the instrument is based on idiosyncratic shocks to FX positions of hedging-mandated funds with share-class closures. *High Rollover Need* indicates that at least 95% of a country-sector's FX hedging positions outstanding at the prior quarter's end are maturing in the current quarter. Standard errors are shown in parentheses, two-way clustered in panel (A) at bond and country-by-currency-by-time levels and in panel (B) at country-sector and country-by-time levels. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Panel A: Bond level	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	$\Delta \log$ Bond Holdings							
	OLS		IV					
Instrument:			GFX_t		$\text{GFX}_t^{-VIX,EX}$		Fund Closures_t	
USD × ΔCCB	0.20***		0.32***		0.33***		0.39***	
	(0.02)		(0.04)		(0.04)		(0.09)	
USD × ΔCCB × High Rollover Need		0.04		0.13***		0.11**		0.16**
		(0.03)		(0.04)		(0.05)		(0.08)
Country-Sector-Time FEs	Y	Y	Y	Y	Y	Y	Y	Y
Country-Sector-Bond FEs	Y	Y	Y	Y	Y	Y	Y	Y
Issuer Industry-Time FEs	Y		Y		Y		Y	
Bond-Time FEs		Y		Y		Y		Y
No. of obs.	9,029,001	6,962,469	9,029,001	6,962,469	9,029,001	6,962,469	9,029,001	6,962,469
No. of bonds	346,965	95,935	346,965	95,935	346,965	95,935	346,965	95,935

Panel B: Portfolio level	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	$\Delta \log$ USD Share							
	OLS		IV					
Instrument:			GFX_t		$\text{GFX}_t^{-VIX,EX}$		Fund Closures_t	
ΔCCB	0.05		0.32***		0.30***		0.15**	
	(0.04)		(0.07)		(0.07)		(0.07)	
ΔCCB × High Rollover Need		0.16*		0.02		0.04		0.08
		(0.09)		(0.18)		(0.18)		(0.22)
Country-Sector FEs	Y	Y	Y	Y	Y	Y	Y	Y
High Rollover Need FEs		Y		Y		Y		Y
Time FEs		Y		Y		Y		Y
No. of obs.	1,038	971	1,038	971	1,038	971	1,038	971
No. of country-sectors	52	50	52	50	52	50	52	50

Table 5. Hedging Mandates and Bond Holdings.

This table presents estimated coefficients from specifications of the form

$$\Delta \log \text{Holdings}_{i,b,t} = \beta \text{USD}_b \times \Delta\text{CCB}_t + \Gamma' C_{i,b,t} + \varepsilon_{i,b,t},$$

estimated at the fund-bond-quarter level. $\Delta \log \text{Bond Holdings}_{i,b,t}$ is the quarterly change in fund i's log holdings of bond b at market value. ΔCCB_t is the quarterly change in the quarterly average 3-month USD-EUR cross-currency basis (in ppt). $C_{i,b,t}$ is a vector of fixed effect indicators. In columns (4) to (6), ΔCCB_t is instrumented with GFX_t, defined as the difference between the size- and equal-weighted average of idiosyncratic shocks to typical hedgers' FX positions, orthogonalized by their first three principal components. Mandate funds are defined as funds with an FX portfolio hedging mandate for at least 10% of outstanding shares on average. We also report the p-value on the coefficient of the interaction term $\text{Mandate}_i \times \text{USD}_b \times \Delta\text{CCB}_t$ in a pooled specification that also includes $\text{USD}_b \times \Delta\text{CCB}_t$ as a control. Standard errors are in parentheses, two-way clustered at bond and fund country-by-currency-by-time levels. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	$\Delta \log$ Bond Holdings					
	OLS			IV		
Investors:	All	Non-Mandate	Mandate	All	Non-Mandate	Mandate
USD × ΔCCB	0.12***	0.11***	0.13***	0.14**	0.12*	0.21***
	(0.03)	(0.03)	(0.02)	(0.06)	(0.07)	(0.04)
Investor-Time FEs	Y	Y	Y	Y	Y	Y
Investor-Bond FEs	Y	Y	Y	Y	Y	Y
No. of obs.	3,774,085	3,339,621	434,464	3,774,085	3,339,621	434,464
No. of bonds	42,688	39,753	22,712	42,688	39,753	22,712
p-value for H0: Mandate = Non-Mandate			0.52			0.24

Table 6. Cross-currency Basis and FX Forward Positions: Role of FX Tenors.

This table reports estimated coefficients from specifications analogous to columns (2) and (4) of Table 3. The specifications differ only in the tenor of the cross-currency basis (CCB), which matches the tenor of FX positions and those used to construct the instrumental variable GFX_t in each column. The results are based on the 1-week tenor in columns (1) and (2), the 1-month tenor in columns (3) and (4), the 3-month tenor in columns (5) and (6), and the 6-month tenor in columns (7) and (8). Columns (9) and (10) pool all four tenors in a single panel. Heteroskedasticity-robust standard errors are reported in parentheses in columns (1) to (8), while standard errors clustered by day are reported in parentheses in columns (9) and (10). ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable:	ΔCCB	ΔPos	ΔCCB	ΔPos	ΔCCB	ΔPos	ΔCCB	ΔPos	ΔCCB	ΔPos
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Tenor:	1 week		1 month		3 months		6 months		All	
GFX	-0.02**		-0.09**		-0.20***		-0.06***		-0.04***	
	(0.01)		(0.04)		(0.02)		(0.01)		(0.01)	
ΔCCB		11.00**		2.22*		0.69***		3.48***		5.97***
		(4.72)		(1.14)		(0.11)		(0.92)		(1.36)
Res. Mat.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Macro Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Tenor FEs									Y	Y
F Statistic (1st)		7.3		4.5		83.4		10.3		36.7
No. of obs.	1,012	1,012	1,256	1,256	1,256	1,256	1,256	1,256	4,780	4,780

Table 7. Cross-currency Basis and Bond Holdings: Role of FX Tenors.

This table reports IV estimates from specifications analogous to columns (3) and (4) in Table 4. The specifications differ only in the tenor of the cross-currency basis (CCB), which matches the tenor of FX positions used to construct the instrumental variable GFX_t in each column. The results are based on the 1-week tenor in columns (1) and (2), the 1-month tenor in columns (3) and (4), the 3-month tenor in columns (5) and (6), and the 6-month tenor in columns (7) and (8). Standard errors are in parentheses, two-way clustered at bond and country-by-currency-by-time levels. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	Δ log Bond Holdings							
CCB Tenor:	1 week		1 month		3 months		6 months	
USD × ΔCCB	7.07		-4.27		0.32***		0.15*	
	(11.68)		(9.35)		(0.04)		(0.08)	
USD × ΔCCB × High Rollover Need		-1.00		-0.30		0.13***		0.06
		(1.27)		(0.31)		(0.04)		(0.10)
Country-Sector-Time FEs	Y	Y	Y	Y	Y	Y	Y	Y
Country-Sector-Bond FEs	Y	Y	Y	Y	Y	Y	Y	Y
Issuer Industry-Time FEs	Y		Y		Y		Y	
Bond-Time FEs		Y		Y		Y		Y
No. of obs.	9,029,001	6,962,469	9,029,001	6,962,469	9,029,001	6,962,469	9,029,001	6,962,469
No. of bonds	346,965	95,935	346,965	95,935	346,965	95,935	346,965	95,935

Table 8. Cross-currency Basis and Bond Yields.
This table reports IV estimates from specifications of the form

$$Y_{b,t} = \beta\Delta\mathrm{CCB}_t + \Gamma' C_{b,t} + \varepsilon_{b,t},$$

estimated at the bond-by-day level. $\Delta\mathrm{CCB}_t$ is the deviation of the 3-month USD-EUR cross-currency basis from its 3-month trailing average (in ppt) and is instrumented with GFX_t, defined as the size- minus equal-weighted average of idiosyncratic shocks to typical hedgers' FX positions, orthogonalized by their first three principal components. $C_{b,t}$ is a vector of fixed effect indicators. We interact $\Delta\mathrm{CCB}_t$ with an indicator that equals one when investors holding bond b in the previous quarter exhibit above-median, holdings-weighted FX hedging rollover needs in the current month. In columns (1) to (4), the dependent variable is the deviation of the yield spread of USD U.S. corporate bonds from its 3-month trailing average. The yield spread is defined as the difference between bond b's yield and the U.S. nominal yield curve at the corresponding maturity (in ppt). The sample in columns (1) to (3) is restricted to USD-denominated U.S. corporate bonds with an average EA ownership share of at least 10%. In column (4), *EA* is an indicator for high euro area bond ownership, which equals one if a bond's average euro area ownership share is at least 10%. In column (5), the dependent variable is the deviation of U.S. government bond yields from their 3-month trailing average, and in columns (6) and (7) the deviation of EA government bond yields, computed analogously. Government bond yields are observed at the maturity-by-issuer-country level for constant maturities. Rating FEs are based on the prior end-of-month credit rating (AAA–AA, A, BBB, BB, B, CCC, below CCC, or unrated). Maturity FEs in columns (2) to (4) are defined using thresholds at 2, 5, 10, and 15 years, and those in column (7) using thresholds at 3 months and 1, 5, 10, 15, and 20 years. Issuer-quarter FEs are based on the combination of 6-digit CUSIP dummies with year-quarter dummies. Standard errors are reported in parentheses, two-way clustered at the bond and day levels in columns (1) to (4), at the bond-by-month and day levels in column (5), and at the maturity-by-issuer-country and day levels in columns (6) and (7). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bond Type:	U.S. Corporate				U.S. Gov	EA Gov	
Dependent variable:	ΔYield Spread				ΔYield		
Sample:	High EA Ownership				All		
ΔCCB × High Rollover Need	-0.55***	-0.36***	-0.30**	0.04	0.41	0.45***	0.19**
	(0.17)	(0.13)	(0.12)	(0.04)	(0.67)	(0.12)	(0.08)
ΔCCB × High Rollover Need × EA				-0.45***			
				(0.13)			
Bond FEs	Y	Y	Y	Y	Y	Y	Y
Rollover Need FEs	Y	Y	Y		Y	Y	Y
Time FEs	Y				Y	Y	
Maturity-Time FEs		Y	Y	Y			Y
Rating-Time FEs		Y	Y	Y			Y
Issuer-Quarter FEs			Y				
EA-Rollover Need FEs				Y			
EA-Time FEs				Y			
No. of obs.	1,247,103	1,247,018	1,246,940	6,665,472	6,062	95,527	95,527
No. of bonds	2,566	2,566	2,566	13,238			
No. of issuer-maturity pairs					5	81	81

Internet Appendix for

The Implications of CIP Deviations for International Capital Flows

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A Details on Sample Construction

Table IA.1: Variable Definitions and Data Sources.

This table reports the definitions of the variables used in the analysis and the data sources from which they are constructed. *EMIR* refers to the European Market Infrastructure Regulation, *MMSR* to the Money Market Statistical Reporting, *CSDB* to the Centralised Securities Database, and *SHS-S* to the Securities Holdings Statistics at Sector level, all of which are datasets maintained by the European Central Bank.

Variable	**Definition**
Net FX Position	USD-EUR net FX forward position such that a positive position indicates buying EUR and selling USD in the future (*Source: EMIR*)
Gross FX Position	USD-EUR gross FX forward position (*Source: EMIR*)
FX: Residual Maturity	Gross volume-weighted average remaining time to maturity of outstanding FX positions (*Source: EMIR*)
Hedge Ratio	Total net FX forward position, measured as the net USD cash flow at maturity, divided by total USD-denominated bond holdings measured in USD (*Sources: EMIR, CSDB, SHS-S*)
Hedge Ratio (incl. Equity)	Total net FX forward position, measured as the net USD cash flow at maturity, divided by total USD-denominated bond and equity holdings measured in USD (*Sources: EMIR, CSDB, SHS-S*)
USD	Indicator variable that equals one if a bond is denominated in USD and zero otherwise (*Source: CSDB*)
CCB	USD-EUR cross-currency basis with a tenor of 3 months unless otherwise noted (*Sources: MMSR, Bloomberg*)
ΔCCB	At daily frequency: the deviation of the CCB from its 3-month trailing average; at quarterly frequency: the quarterly change in the quarterly average of the CCB
ΔFX position	Deviation of the net FX position from its 3-month trailing average scaled by the absolute value of the 3-month trailing average (*Source: EMIR*)
Δlog Bond Holdings	Quarterly change in a country-sector pair's or fund's logarithm of bond holdings (*Sources: SHS-S, Lipper*)
$\Delta \log$ USD Share	Quarterly change in the logarithm of the portfolio share of USD bonds relative to all USD and EUR bond holdings (*Sources: CSDB, SHS-S*)
Bonds: Residual Maturity	Remaining time to maturity of outstanding bond holdings (*Sources: CSDB, Mergent FISD*)
ΔYield Spread	Deviation of a USD-denominated U.S. corporate bond's yield spread on day t from its 3-month trailing average (in percentage points), where the yield spread is the difference between the bond's market yield and the nominal Treasury yield with the same residual maturity, based on the Fed's estimated yield curve model (*Sources: TRACE, Mergent FISD, https://www.federalreserve.gov/data/nominal-yield-curve.htm*)
ΔYield	Deviation of the yield of U.S. Treasuries or euro-area government bonds with constant maturity on day t from its 3-month trailing average (in percentage points) (*Sources: FRED, Refinitiv*)
GFX	Granular instrumental variable based on idiosyncratic shocks to euro-area typical hedgers' 3-month FX positions, orthogonalized by their first three principal components (*Source: EMIR*)

Continued on next page

Table IA.1 – *Continued from previous page*

Variable	**Definition**
Rollover Need	Share of hedgers' hedging (i.e., buy) positions outstanding at the prior period's end that are maturing in the current period (*Source: EMIR*)
US-EA risk-free rate differential	3-month U.S. LIBOR minus 3-month EURIBOR (*Source: Bloomberg*)
S&P 500	U.S. stock market index (*Source: Datastream*)
Euro STOXX 50	European stock market index (*Source: Datastream*)
Dollar strength	Trade-weighted average USD exchange rate against major U.S. trading partners (*Source: Datastream*)
U.S. VIX	U.S. stock market volatility index (*Source: FRED St. Louis*)
European VIX	European stock market volatility index (*Source: Datastream*)
$\Delta \log S^{\text{USD/EUR}}$	Log growth in the USD-EUR spot rate (*Source: Datastream*)
Exchange rate volatility	30-day trailing standard deviation of the daily growth rate of the USD-EUR spot rate (*Source: Datastream*)

A.1 FX Positions (EMIR)

Under the European Market Infrastructure Regulation (EMIR), derivatives transactions must be reported to the European Central Bank whenever at least one of the two counterparties of a transaction is domiciled in the euro area, where counterparties are identified as the entities bearing the derivatives exposure. EMIR "state reports" record each euro-area entity's outstanding derivative positions at a daily frequency.

From these reports, we extract all positions classified as USD-EUR FX forwards or FX swaps, defined as contracts with asset class "currency derivatives," contract type "forward" or "swap," and notional currencies EUR and USD. We exclude intragroup transactions. Because each euro-area entity is required to report its positions, the raw dataset contains trades that are reported twice when both counterparties are domiciled in the euro area, as well as trades reported only once when one counterparty is domiciled outside the euro area.

Trades are intended to be uniquely identified by a transaction identifier ("tec ruti"). For each trade, the notional amount is reported in euros, potentially converted using the spot exchange rate on the reporting date. We restructure the raw data so that each trade appears twice—once for each counterparty—such that each observation corresponds to a unique combination of reporting date, counterparty, and trade.

We apply several filters to ensure the reliability of the data:

1. We drop observations with implausible notional (below EUR 10,000 or above EUR 200 billion) or missing counterparty side information (i.e., whether a counterparty receives or pays USD).
2. Among the trades that are reported by more than one counterparty, we drop those with inconsistent information on counterparty IDs or maturity dates across reporting counterparties.
3. For each transaction, we use the information from the most reliable report. Specifically, we prefer to use the information reported by banks that are also subject to MMSR reporting because these are typically more accurate. Additionally, we prefer reports with non-missing forward rate, non-missing spot rate, and a reasonable maturity date (before April 2034).
4. We then *de*duplicate the dataset by keeping only one observation for each unique outstanding trade (identified by its tec ruti) on a given reporting date. However, tec rutis are not always correctly reported and, thus, two reports of the same trade may exhibit two different tec rutis. To address such misreporting, we also detect and drop excessive (more than 10) duplicates of trades identified by sharing the same notional amounts, counterparties, maturity dates, and exchange rates.
5. We then "*re*duplicate" the dataset by assigning each unique outstanding trade to each of its two counterparties.
6. If a *Classification of Financial Instrument* (CFI) is reported, we drop observations for which the CFI does not start with either JF (FX forward) or SF (FX swaps).
7. We drop trades for which the currency of exchange rates is neither EUR nor USD , the forward rate is missing, the spot rate on swap contracts is missing , or the spot or forward is equal to zero.
8. We improve the reliability of reported rates as follows:
   (a) We swap the sign of spot or forward rates if they are negative.
   (b) For forwards: If the contract is reported without a forward rate but with a spot rate, we assume that the reported spot rate is the actual forward rate.
   (c) For swaps: We identify and correct spot rates that have been reported with a wrong

base currency (rates are supposed to be reported in USD per EUR). When the Bloomberg spot rate is available for the trade date, we construct an interval centered around the Bloomberg rate, allowing for a 0.05 USD per EUR deviation. When the Bloomberg rates are not available for the trade date, we construct an interval with lower and upper bounds equal to the minimum and maximum Bloomberg rates during the sample period, respectively. We consider the reported rate to be in EUR per USD if it is outside the interval of USD per EUR spot rates and within the interval of EUR per USD spot rates. When this is the case, we convert both the spot and the forward rates into USD per EUR.

(d) For swaps: We drop observations with an implausible spot rate (more than a ± 0.2 USD per EUR deviation from the Bloomberg spot rate).

(e) For swaps: We adjust the forward rate by winsorizing the forward point at the 1st and 99th percentiles (within each month). Forward points, i.e., the forward-spot differential, are, on average, strictly positive for rates expressed in USD per EUR throughout our sample.

(f) For forwards: We remove observations for which the forward rate deviates by more than ± 5 USD per EUR from the Bloomberg spot rate.

9. We drop swaps for which the settlement date variable is a string that, instead of containing two distinct settlement dates, contains two identical dates.

10. We separate each swap into its two constituent forwards. In an FX swap, the contractual notional is fixed in one currency (the base currency) and identical across legs. The counter-currency amount typically differs between the near and far legs because it is determined using the spot and forward exchange rates, respectively. For example, if the base currency is EUR and the contractual notional is Notional_{EUR}, then, in the first (near) leg, EUR Notional_{EUR} is exchanged against USD $\text{Notional}_{EUR} \times S^{USD/EUR}$. In the second (far) leg, the exchange is reversed at the forward rate: the party that received USD in the near leg pays USD $\text{Notional}_{EUR} \times F^{USD/EUR}$ and receives EUR Notional_{EUR}, where $S^{USD/EUR}$ and $F^{USD/EUR}$ denote the contract's spot and forward rates (USD per EUR), respectively. Because the reported variables in the EMIR data do not reliably indicate the base currency of FX swaps, we infer the base currency using an algorithm based on the economic structure

of the contract and market quoting conventions. For each trade, we construct the candidate notionals in EUR and in USD.

We then exploit the market convention that contractual notionals are typically quoted as round numbers in the base currency (e.g., multiples of 10, 100, 1,000, 10,000, up to millions or billions). For each of the two candidate notionals (expressed in EUR and USD), we assess how "round" the number is. The key idea is that contractual notionals in FX markets are typically quoted in clean, round amounts in the base currency (e.g., 1 million, 10 million, 100 million), whereas the converted counter-currency amount is usually less round because it reflects multiplication by the exchange rate.

To operationalize this intuition, we measure how close each candidate notional is to rounded numbers at different levels of granularity. The rounding grid is allowed to depend on the size of the contract: for smaller trades we consider rounding to tens or hundreds, while for larger trades we consider rounding to thousands, millions, or higher powers of ten. We also apply additional checks at coarser rounding levels to capture common market quoting conventions.

We then classify the base currency as the currency in which the implied notional appears more "round." In particular, if the EUR-denominated amount is systematically closer to a round benchmark than the USD-denominated amount, we assign EUR as the base currency, and vice versa. When one currency amount is almost perfectly round and the other is clearly not, this criterion delivers a sharp classification.

For observations classified as swaps, we subsequently define the contractual notional as the notional in this base currency, and use it to split the contract into its two constituent forward positions.

11. We re-define notional amounts as either the contractual EUR or contractual USD amount deliverable at maturity, such that positions are comparable across contracts and are not mechanically affected by spot-rate revaluation. When, in the data, the contractual notional is reported in USD, we divide the variable by the contract's forward rate $F^{USD/EUR}$ to obtain the deliverable EUR amount:

$$\text{Notional}_{EUR} = \widehat{\text{Notional}} \times \frac{1}{F^{USD/EUR}},$$

where $\widehat{\text{Notional}}$ is the reported notional amount.

Analogously, if the contractual notional is reported in EUR, the USD amount deliverable at maturity is given by

$$\text{Notional}_{USD} = \widehat{\text{Notional}} \times F^{USD/EUR}.$$

Throughout the paper, except when specifically noted otherwise (namely to compute hedge ratios), we use the Notional_{EUR} to measure FX notional because it is constant over a contract's lifetime and, thus, not subject to fluctuations in exchange rates.

12. We drop contracts with missing Notional_{EUR}.
13. We drop contracts with a spot or maturity date before 2000, with a maturity date before the reporting date, or with an original or residual time to maturity of more than 10 years.

Additionally, except for aggregate statistics on the EA FX derivatives market, we apply the following filters:

1. We obtain information on an entity's domicile and sector following Lenoci and Letizia (2021), who combine various data sources (e.g., public registers of financial institutions) to map LEIs to sectors and countries.
2. We restrict the analysis to EA entities (EA19 composition). Non-EA institutions are excluded because EMIR only records the subset of their derivatives positions that involve EA counterparties and, thus, does not provide a complete view of their FX derivatives portfolios.
3. For computing the instrumental variable and de-trended FX positions, we
   (a) consolidate entities to the level of their ultimate parents, using the ECB's Agora (for banks) and RIAD (for non-banks) databases,
   (b) remove observations for ultimate parents outside the euro area,
   (c) only keep positions of banks, investment funds, pension funds, insurance companies, and non-financial companies,
   (d) identify the birthday (death date) of investors as the first (last) date that precedes (is preceded by) one week during which the investor had an absolute gross position

of more than EUR 200,000, and remove observations outside the investor's lifetime,

(e) keep positions with (approximately) 3 months residual maturity, namely between 2 and 4 months, (other maturity buckets are defined as follows: 1 week = (3 days, 8 days), 1 month = (3 weeks, 2 months), 6 months = (4 months, 8 months))

(f) exclude investors with nonzero positions for less than 1 month, those with an absolute net FX position of less than EUR 200,000 either on average or for more than one-third of the sample, and those with a standard deviation of their net position that exceeds two times their average gross position.

4. For estimating FX demand elasticity, the dependent variable is based on the positions of banks, insurers, pension funds, and investment funds.

We report the impact of these cleaning steps on the number of observations and total gross notional in the sample in Figure IA.1 (for each month) and Table IA.2 (for the average month). In the time series, there are several structural breaks that suggest shifts in reporting that improve data quality. The fact that these structural breaks do not coincide with structural breaks in the aggregate FX derivatives volume in Figure IA.8 highlights the robustness of our cleaning methodology.

Table IA.2. Sample Construction: FX Derivatives.
This table reports, for an average month, the number of observations and the total gross notional amount in the raw EMIR USD–EUR FX derivatives dataset after each cleaning step, along with the sample size relative to the initial size of the raw sample. The number of observations is reported in millions, and total gross notional is reported in trillion EUR.

	No. of observations	Total gross notional
Raw data	21.0 (100%)	EUR 234.6 (100%)
post: remove observations with implausible notional	19.3 (91.9%)	EUR 234.3 (99.9%)
post: remove observations with missing counterparty side	19.3 (91.9%)	EUR 234.3 (99.9%)
post: remove observations with either inconsistent notional, counterparties, or maturity dates across reporting agents for the same trade	18.6 (88.5%)	EUR 212.8 (90.6%)
post: reduplicate trades and remove observations with wrongly classified products	24.2 (115.5%)	EUR 313.0 (133.2%)
post: remove observations with missing rates or base currencies other than EUR or USD	23.6 (112.6%)	EUR 299.7 (127.6%)
post: remove observations with implausible rates	23.6 (112.3%)	EUR 298.7 (127.1%)
post: split swaps into two forwards and require non-missing (spot and) maturity date, notional in EUR, and counterparty sides	24.7 (117.6%)	EUR 323.9 (138.0%)
post: remove observations with implausible spot or maturity date	23.3 (111.3%)	EUR 291.1 (123.9%)

Figure IA.1. Impact of Data Cleaning on the Sample of FX Derivatives.

These figures report, for each month, (a) the number of observations and (b) the total gross notional amount in the raw EMIR USD–EUR FX derivatives dataset after each cleaning step, expressed relative to the initial size of the raw sample. *Ex Impl Notional* removes observations with implausible notional. *Ex Miss Cnpty* excludes observations with missing counterparty side information. *Ex Inconsist Duplicates* drops trades for which reporting agents provide inconsistent information on notionals, counterparties, or maturity dates for the same trade. *Redupl & Ex Wrongly Classified* corresponds to attributing trades to both counterparties and removing observations with wrongly classified products. *Ex Miss/Impl Rates & Wrong Curr* removes observations with missing or implausible rates and those denominated in base currencies other than EUR or USD. *Split Swaps & Non-Miss Charact* splits swap contracts into two forward legs and requires non-missing (spot and) maturity date, notional in EUR, and counterparty sides. *Ex Impl Maturity* removes observations with implausible spot or maturity date.

(a) Number of Observations

(b) Total Notional Amount

A.2 Bond Holdings (SHS-S)

Bond holdings are reported to the ECB for each investor group and each euro-area country at the security level and at quarterly frequency (see `https://data.ecb.europa.eu/data/datasets/SHSS/data-information`). We start with the raw sample of holdings of bonds (identified by an instrument class starting with "F_3") by euro-area investors (EA19) between 2019q1 and 2024q1. The data include a third party flag (TPH) that indicates holdings by non-financial residents that are held in custody by the respective reporting entity and supposed to be excluded (e.g., because they would be double-counted otherwise). We follow the TPH flag assessment and exclude such holdings in the raw data. Bond holdings are measured in two ways, namely at nominal value and market value (i.e., current market prices). According to the Handbook on Securities Statistics (`https://data.ecb.europa.eu/methodology/securities-holdings-statistics`), "Nominal valuation of debt securities reflects the sum of funds originally advanced, plus any subsequent advances, less any repayments, plus any accrued interest" (p. 109). Investors are encouraged to also report short positions. However, net short positions at the country-sector level are uncommon (see Table IA.4).

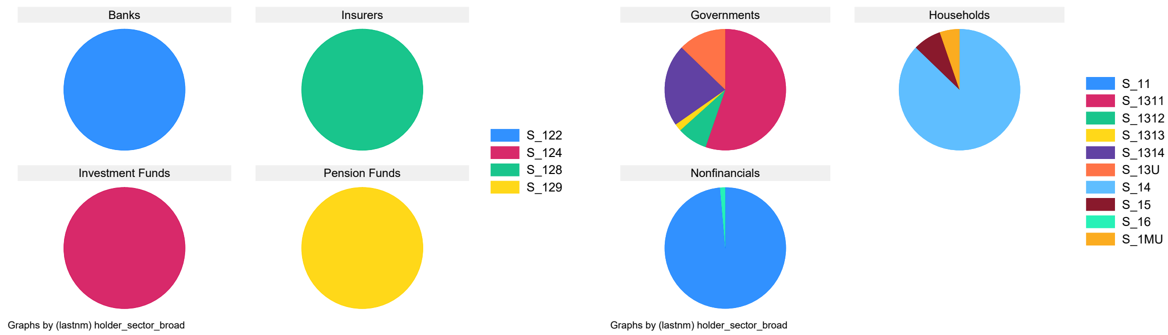
We apply several filters to ensure the reliability of the data:

1. We only keep bonds identified by an International Securities Identification Number (ISIN).
2. We remove duplicates at the reporting date, investor group, country, bond, TPH flag level.
3. We remove bonds for which multiple currencies are reported.
4. We remove bonds that are neither denominated in EUR nor USD.
5. We consolidate the investor sector by aggregating across granular sector categories (illustrated in Figure IA.2).
6. We drop holdings of bonds that are reported for the same or a later quarter in which the bonds mature, and those reported before bond issuance.
7. We truncate the residual time to maturity at 50 years.

When combining FX positions and bond holdings, we drop Austrian, Finnish, French, and Luxembourg pension funds and Estonian and Portuguese investment funds from the analysis.

Figure IA.2. Sector Consolidation.

The figure depicts the breakdown of total quarterly nominal holdings by consolidated investor sectors into the most granular categories available in the raw SHS-S data for an average quarter. Definitions follow the ESA classification (`https://ec.europa.eu/eurostat/esa2010/chapter/view/23/`) and, additionally, the following conventions: S_16 are non-financial investors excluding households (to be reported in the case of third-party holdings); S_13U are other general government investors (sub-sector not identified); S_1MU are other households and non-profit institutions serving households (sub-sector not identified).



(a) Top Sectors

(b) Other Sectors

For these country-sector pairs, the data imply a hedge ratio of more than 10 (in absolute terms), which suggests significant measurement error—e.g., stemming from low accuracy in merging EMIR with SHS-S and a small total amount of USD bond holdings. These six country-sector pairs account for less than 1% of total USD bond holdings (by all insurers, investment funds, pension funds, and banks) and for approximately 1% of total FX gross positions in our sample.

Table IA.3. Sample Construction: Bond Holdings.

This table reports the number of observations and total nominal value in the SHS-S data after each cleaning step, along with the sample size relative to the initial size of the raw sample. The number of observations is in millions and total nominal value is in trillion EUR.

	No. of observations	Total nominal value
Raw data	50.5 (100%)	EUR 338.4 (100%)
post: remove bonds without ISIN	47.0 (93.1%)	EUR 331.4 (97.9%)
post: remove duplicates	46.7 (92.5%)	EUR 331.3 (97.9%)
post: remove observations with multiple currencies	46.7 (92.4%)	EUR 331.1 (97.9%)
post: keep only EUR and USD bonds	44.2 (87.5%)	EUR 304.0 (89.8%)
post: collapse across TPH flag	42.8 (84.7%)	EUR 304.0 (89.8%)
post: consolidate investor sector	41.9 (82.9%)	EUR 304.0 (89.8%)
post: remove holdings outside a bond's lifetime	34.8 (68.8%)	EUR 300.4 (88.8%)

Table IA.4. Short Positions.

The table depicts the ratio of the absolute nominal value of short positions to the sum of the absolute nominal value of short and long positions for each investor sector in an average quarter. Short and long positions are identified at country-by-sector-by-bond level and, then, separately aggregated to sector level.

	|Short| / (|Short| + |Long|)
Banks	2.7%
Investment funds	0.1%
Pension funds	0.0%
Insurers	0.0%

A.3 Spot and Forward Rates (MMSR)

The main euro-area banks are required to report FX swap transactions under the Money Market Statistical Reporting (MMSR) framework (see `https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/money_market/html/index.en.html`). This includes information on the spot rate and forward rate as well as the spot and maturity date of contracts. We use MMSR to compute the USD-EUR spot and forward rates in the euro area.

We exclude contracts with a spot date that occurs more than 4 days after the trade date and define 3-month contracts as those with a time to maturity of between 81 and 99 days. On each trading day, we compute the transaction-volume-weighted median spot rate and forward point (the difference between the forward and spot rate) among 3-month contracts. On days when the market covered by MMSR reporting is relatively illiquid (indicated by a transaction volume below EUR 1 million), we use the forward and spot rates from Bloomberg instead (this only applies to 9 days in our sample).

A.4 Bank Funding Characteristics

We retrieve information on the currency composition of bank funding from supervisory data available to the ECB, namely the supervisory financial information (FINREP), submitted by credit institutions, and the common reporting framework (COREP), submitted by institutions under the Capital Requirements Regulation (CRR). In both cases, we examine data at the consolidated level, i.e., considering all subsidiaries of a given LEI. To improve the data quality, we only consider this data from 2022 onward.

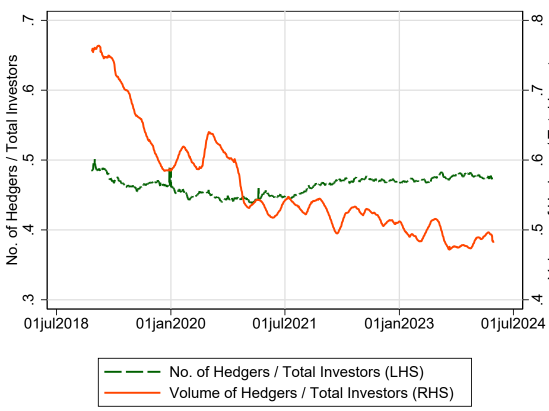
Deposit Geography From FINREP's Template F20.06 ("Geographical breakdown of liabilities by residence of the counterparty") for each bank's euro-area parent, we retrieve the carrying amount of deposits from U.S. and EA counterparties, respectively, where deposits are defined as the deposits of financial and non-financial institutions, central banks, governments, and households, including repos. We then compute the ratio of U.S. to U.S. and EA deposits and take the bank-level average. After merging with EMIR, this ratio ranges from 0% to 4% at the 10th and 90th percentiles in the cross section of LEIs, with an average of 1.4%.

Currency Composition of Funding From COREP's Template C68.00.w ("Concentration of funding by product type - Significant currencies breakdown") for each bank's euro-area parent, we retrieve the total carrying amount for total retail funding, unsecured wholesale funding and secured wholesale funding in EUR and USD. To address misreporting at the consolidated level, we also consider the total EUR and USD funding computed by aggregating solo-level reports across subsidiaries. We use these "self-consolidated" values for a bank when the associated ratio of USD to USD and EUR funding deviates by more than 5 ppt on average from the ratio based on consolidated reporting. Finally, we take the bank-level average of the ratio of USD funding to USD and EUR funding as the main variable. After merging with EMIR, this ratio ranges from 0% to 58% at the 10th and 90th percentiles in the cross section of LEIs, with an average of 20.8%.

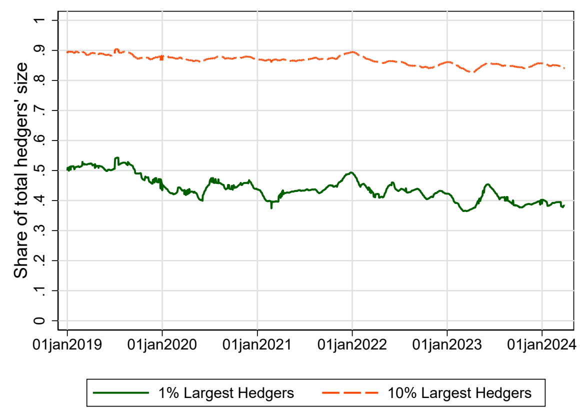
B Details on Empirical Methodology

Figure IA.3. FX Market Structure and Granularity in Size.

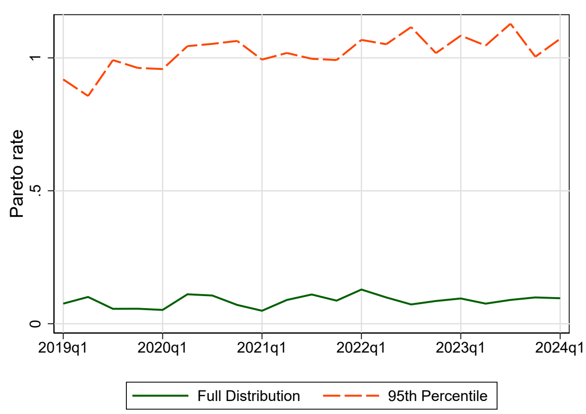
(Typical) Hedgers are defined as investors who exhibit a positive 3-month trailing average net FX forward position. Figure (a) plots (i) the number of hedgers relative to the total number of investors and (ii) the total 3-month trailing average net position of hedgers relative to the total absolute value of the 3-month trailing average net position of all investors. Figure (b) plots the total size of the 1% and 10% largest hedgers relative to the total size of all hedgers, where size is defined as the 3-month trailing average net FX position. Figure (c) plots the Pareto rate of the cross-sectional distribution of hedger size for each quarter end for (i) all hedgers and (ii) the 5% largest hedgers. The Pareto rate is defined as ξ when sizes are drawn from a power law distribution $\mathbb{P}(S > x) = ax^{-\xi}$. $\xi < 2$ implies that the distribution is fat tailed.



(a) Importance of Hedgers



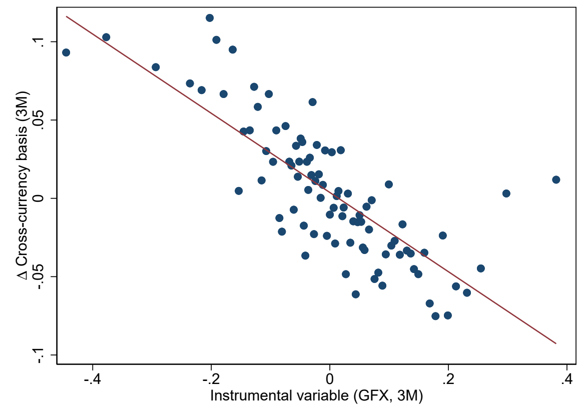
(b) Concentration of Hedgers



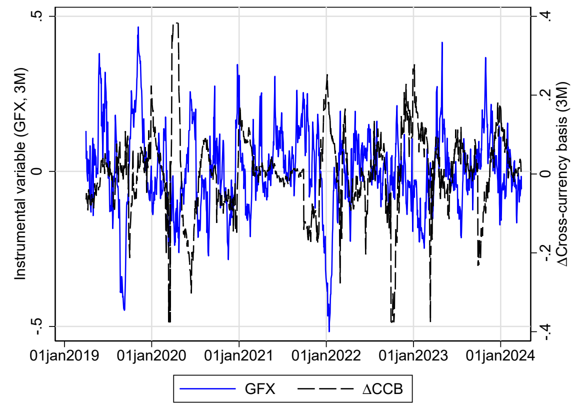
(c) Pareto Rate of Hedger Size

Figure IA.4. Cross-currency Basis and GFX_t at Daily Frequency.

These figures plot the deviation of the 3-month USD-EUR cross-currency basis from its 3-month trailing average, $\Delta\mathrm{CCB}_t$, and the size-weighted minus equal-weighted average of idiosyncratic shocks to typical hedgers' FX positions, orthogonalized by their first three principal components, GFX_t, (a) as a binned scatter plot, and (b) as a time series at daily frequency.



(a) Binscatter Plot



(b) Time Series

Figure IA.5. Cross-currency Basis and GFX_t at Quarterly Frequency.

This figure plots the quarterly change in the quarterly average 3-month USD-EUR cross-currency basis, $\Delta\mathrm{CCB}_t$, and the size-weighted average of idiosyncratic shocks to typical hedgers' FX positions, orthogonalized by their first three principal components, GFX_t, as a binned scatter plot at quarterly frequency. We also display the estimated coefficient of the corresponding linear regression and its standard error (in parentheses).

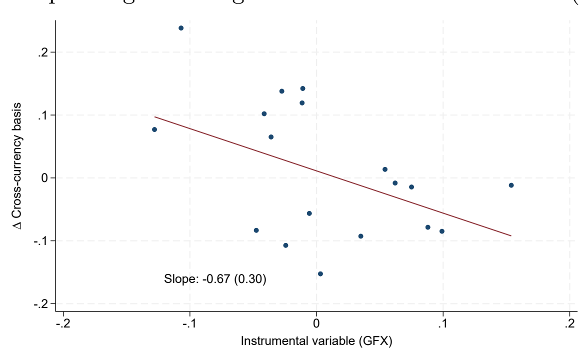


Figure IA.6. GFX Shock Persistence.

This figure plots the OLS estimates for the coefficient β_h and its 99% confidence interval for specifications of the following form: $\Delta\text{CCB}_{t+h} = \beta_h \text{GFX}_t + \Gamma' C_t + \varepsilon_{t+h}$, where ΔCCB_{t+h} is defined as the deviation of the USD-EUR 3-month cross-currency basis on day $t+h$ from its 3-month trailing average as of day t (i.e., based on the 84 calendar days before t). Lags h are measured in business days. C_t is a vector of the same macro control variables as in column (2) of Table 3.

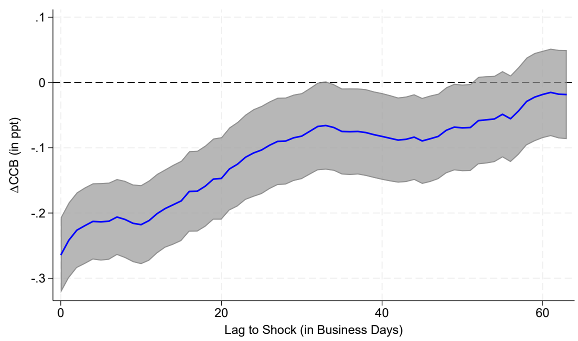
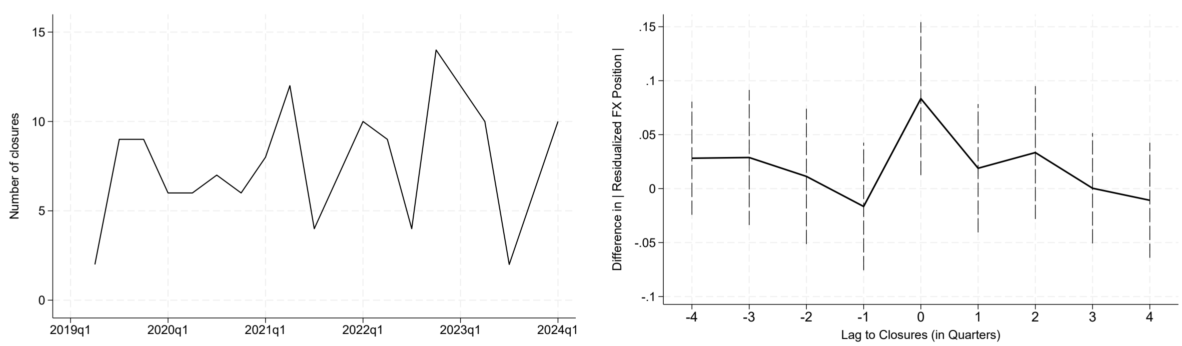


Figure IA.7. Fund Closures.

Figure (a) plots the total number of funds that experience share class closures and face currency hedging mandates per quarter. Figure (b) plots the OLS estimates for the coefficients β_{-4} to β_4 and their 90% confidence intervals from the following specifications: $|\check{q}^F_{i,t}| = \sum_{\tau=-4}^{4} \beta_\tau 1\{\text{Closure}_{i,t-\tau}\} + u_i + v_t + \varepsilon_{i,t}$, which is estimated at quarterly frequency based on the sample of funds i with hedging mandates that experience at least one share class closure since 2019Q1. $|\check{q}^F_{i,t}|$ is defined as the absolute value of the residualized de-trended net FX position of fund i in quarter t, as described in Section 4, and winsorized at the 5th and 95th percentiles. β_τ reflects the dynamics of idiosyncratic FX adjustment intensity around share-class closures. Standard errors are clustered at the fund level.



(a) Number of Closures

(b) Closures and FX Positions

C Additional Figures and Tables

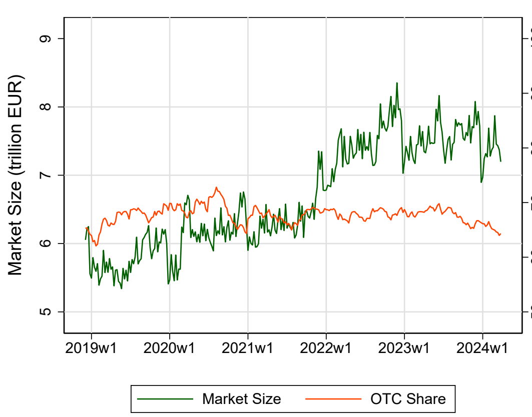
Table IA.5. Additional Summary Statistics.

This table reports summary statistics for de-trended yields and the maturities of U.S. and euro-area government bonds with constant maturity at issuer-country-by-maturity level at daily frequency. The sample of U.S. Treasuries includes bonds with 3 months and 1, 5, 10, and 20 years to maturity, and that of euro-area government bonds with 3 months and 1, 5, 10, 15, and 20 years to maturity.

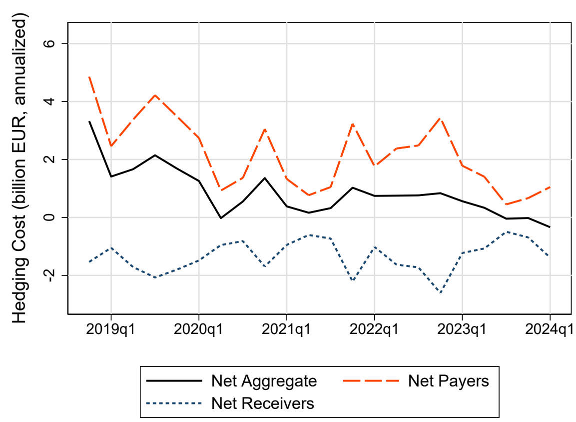
	N	Mean	SD	p5	p50	p95
U.S. Treasuries (Maturity-by-Day Level, Apr 2019 - Mar 2024)						
ΔYield (ppt)	6,062	0.05	0.31	-0.41	0.02	0.62
Residual Maturity (years)	6,062	7.49	7.27	0.25	5.00	20.00
EA Gov Bonds (Maturity-by-Issuer-by-Day Level, Apr 2019 - Mar 2024)						
ΔYield (ppt)	95,527	0.06	0.34	-0.34	0.02	0.58
Residual Maturity (years)	95,527	8.69	6.82	0.25	10.00	20.00

Figure IA.8. Market Size and Aggregate Hedging Cost in the European USD-EUR FX Market.

Figure (a) depicts on the left vertical axis the gross amount (in trillion EUR) of all USD-EUR FX contracts outstanding in a given week (averaged across days) reported in EMIR (i.e., with at least one euro-area counterparty) and on the right vertical axis the share of these contracts that are traded over the counter. Figure (b) depicts the annualized net hedging cost paid by (1) the euro area, (2) net payers of hedging costs, (3) net receivers of hedging costs. Both figures include all euro-area entities reporting in EMIR. To calculate the hedging cost, we first compute each trade h's hedging cost as $\mathcal{C}_h = N_h\big(\exp(-\tau_h\ \mathrm{CCB}_{t,\overline{\tau}}) - 1\big)$, where N_h denotes notional, t the trade date, τ the (original) time to maturity, and $\overline{\tau}$ the corresponding maturity bucket. The (forward EUR) buyer pays $\mathcal{C}_h$, whereas the (forward EUR) seller receives $\mathcal{C}_h$. For each investor, we aggregate hedging costs $\mathcal{C}_h$ across all trades executed in a given quarter to compute the net hedging cost, and annualize by multiplying by 4. Based on this net cost, investors are sorted into net receivers or payers.



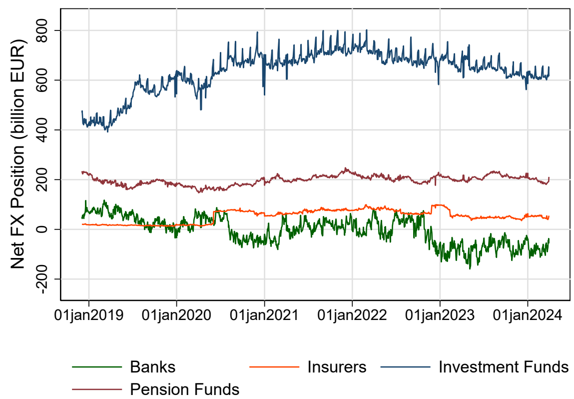
(a) Market Size



(b) Hedging Cost

Figure IA.9. FX Forward Positions by Parent Domicile.

The figures depict the net FX forward positions analogously to Figure 1 (b), splitting the sample into euro-area investors whose parent is headquartered in the euro area (Figure (a)) and euro-area investors whose parent is not headquartered in the euro area (Figure (b)). Because non-banks with international parents have negligible positions, these are excluded to preserve confidentiality in Figure (b).

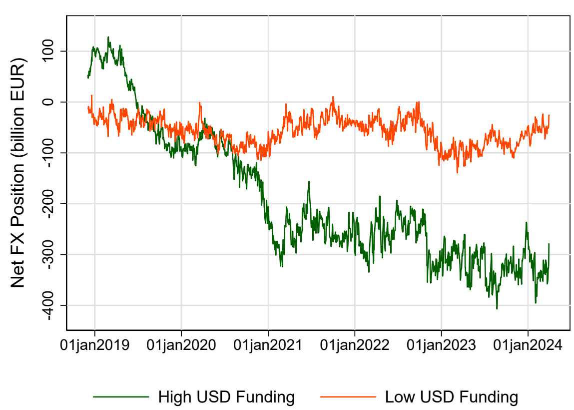


(a) Euro-Area Parent.

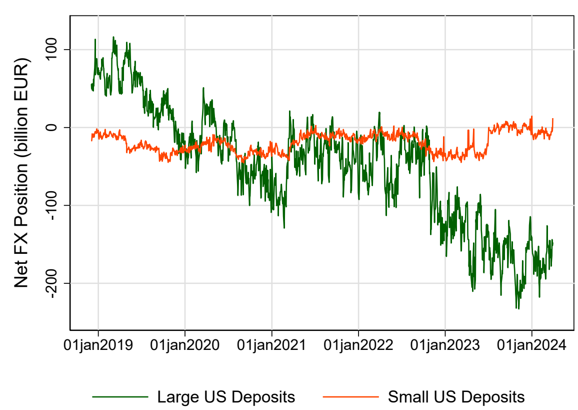
(b) International Parent (Banks).

Figure IA.10. FX Forward Positions and Bank Funding Composition.

These figures depict the net FX forward positions of euro-area banks analogously to Figure 1 (b), splitting the sample depending on proxies for the currency composition of bank funding. In Figure (a), we classify banks as high-USD-funding banks if USD-denominated retail and wholesale funding accounts for at least 5% of combined EUR- and USD-denominated funding, and as low-USD-funding banks otherwise. In Figure (b), we classify banks as large-US-deposits banks if U.S. counterparties account for at least 1% of combined (retail and wholesale) deposits with euro-area and U.S. counterparties, and as small-US-deposits banks otherwise.



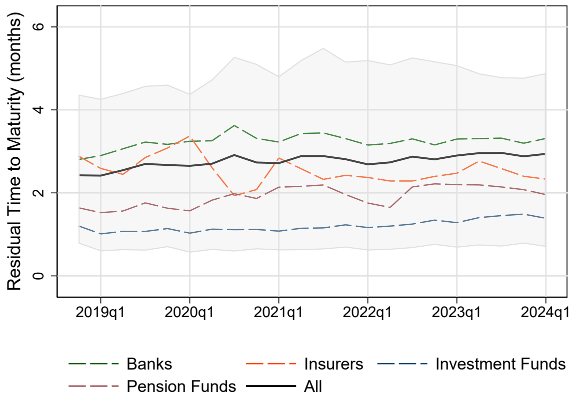
(a) Funding Currency Denomination.



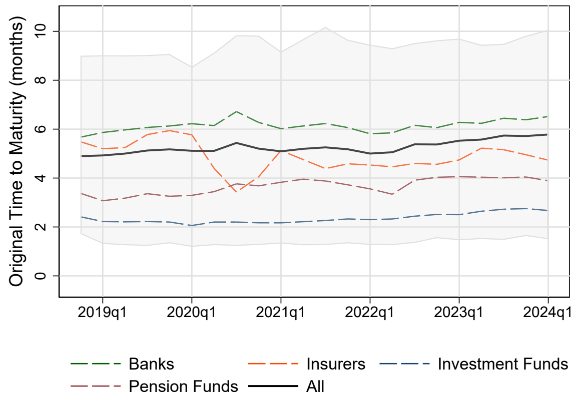
(b) Deposit Counterparty Location.

Figure IA.11. Residual and Original Maturities of FX Positions.

These figures depict the average (a) residual and (b) original time to maturity of FX contracts weighted by outstanding gross notional by sector and in the pooled sample, as well as the respective 10th and 90th percentiles in the pooled sample. Residual maturity is defined as the time from the reporting date to the maturity date of the derivative contract. Original maturity is defined as the time from the spot date to the maturity date of the derivative contract.



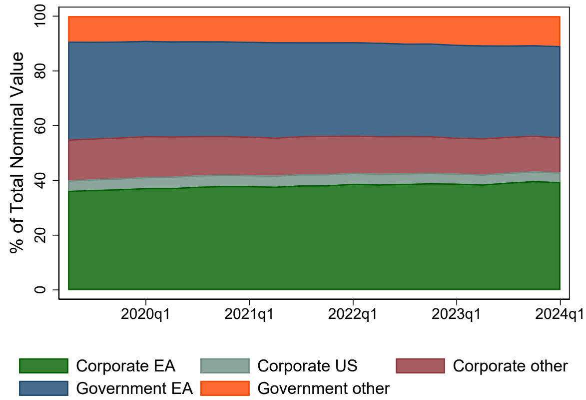
(a) Residual Maturities.



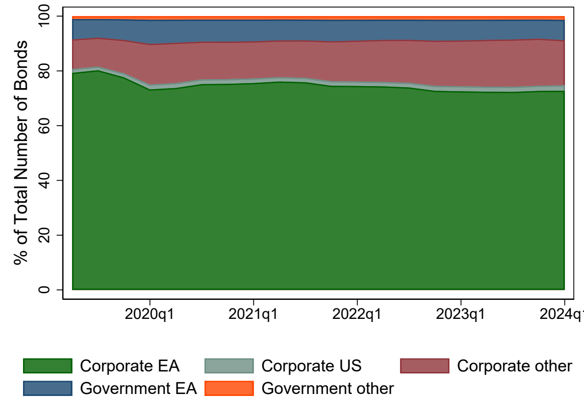
(b) Original Maturities.

Figure IA.12. Bond Portfolio Composition.

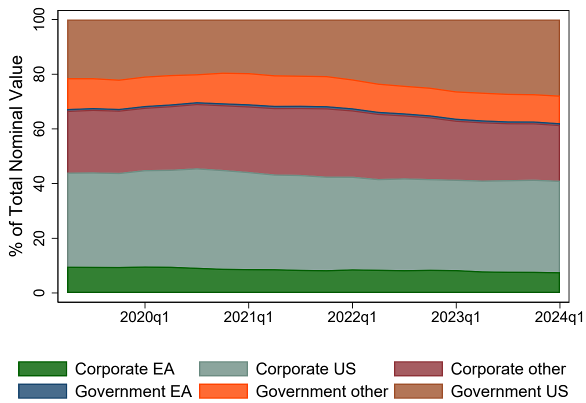
These figures depict the composition of the (a,b) EUR and (c,d) USD bond portfolios of euro-area investors in our main regression sample. We report the composition in terms of (a,c) nominal value held and (b,d) number of bonds.



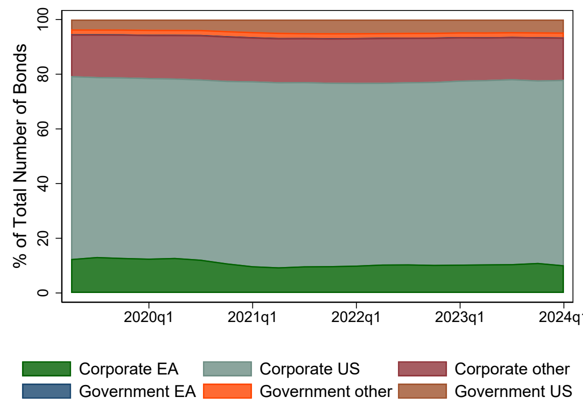
(a) EUR Bonds: Nominal Value.



(b) EUR Bonds: No. of Bonds.



(c) USD Bonds: Nominal Value.



(d) USD Bonds: No. of Bonds.

Figure IA.13. Cross-currency Basis and Bond Holdings: Robustness.

The figure depicts the IV estimate for α in equation (7). The baseline specification (GFX) corresponds to column (3) in Table 4. The "Fund IV" specification corresponds to column (5) in Table 4. The "Rat-Time & Mat-Time FEs" specification includes credit-rating-by-time and residual-maturity-by-time fixed effects. The "Ex Covid-19 & UK Minibudget" specification excludes 2020q1 and 2022q3. The "Incl Spot" specification includes the quarterly change in the log USD-EUR spot exchange rate interacted with the USD indicator as a control variable. The "Incl Spot Vola" specification includes the lagged quarterly average of the 30-day-trailing standard deviation of the daily change in the log USD-EUR spot rate interacted with the USD indicator as a control variable. The "Size Resid" specification uses an alternative instrument that additionally residualizes FX positions by adding size-dependent loadings on aggregate factors, $\log(\text{Gross FX}_{i,t}) \times \eta_t$, as a control variable in equation (8), where Gross $\text{FX}_{i,t}$ is the 3-month trailing average gross FX position of investor i. The "Heterosk" specification uses an alternative heteroskedasticity-adjusted instrument defined as $\text{GFX}_t^{\text{het}} = \frac{1}{\sum_{i \in \mathcal{L}_t} \bar{Q}_{i,t}} \sum_{i \in \mathcal{L}_t} \bar{Q}_{i,t} \check{q}_{i,t} - \frac{1}{\sum_{i \in \mathcal{L}_t} 1/\sigma_i^2} \sum_{i \in \mathcal{L}_t} \frac{1}{\sigma_i^2} \check{q}_{i,t}$. The "Fund IV ex Covid-19" specification re-estimates the specification in column (5) in Table 4 excluding 2020q1.

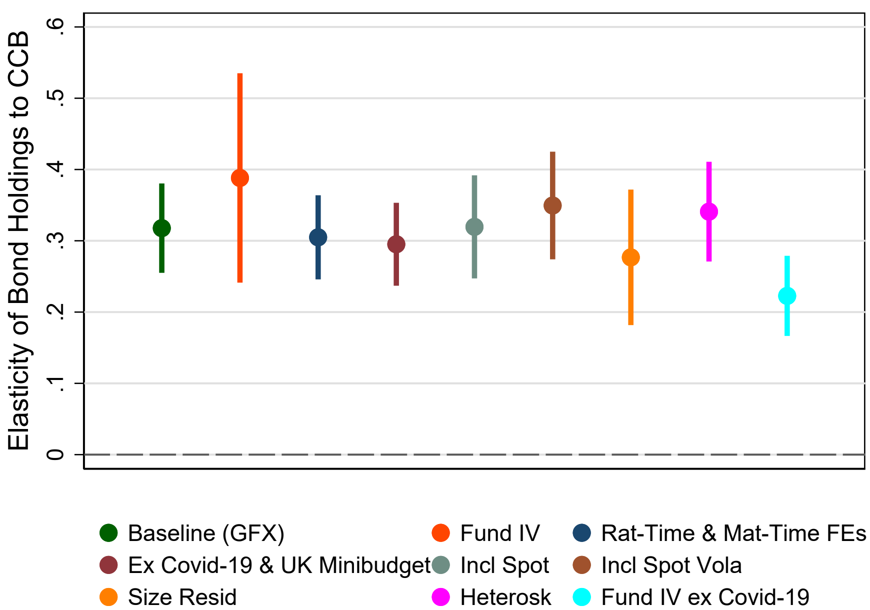
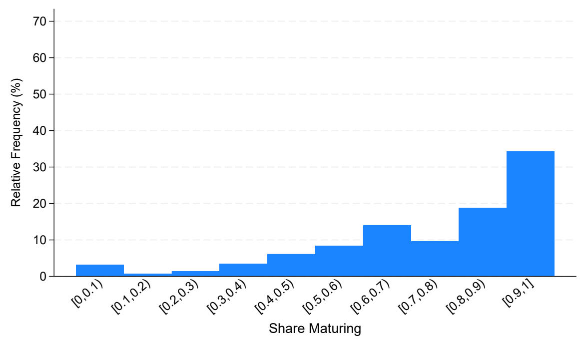
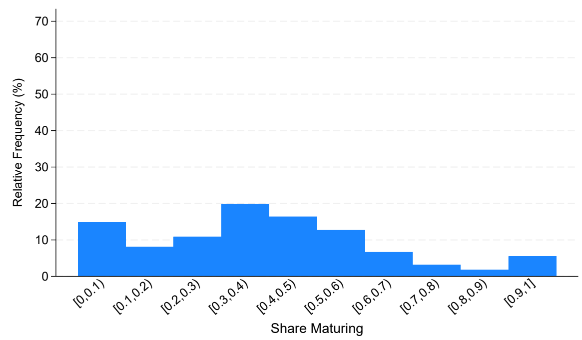


Figure IA.14. Distribution of Rollover Needs.

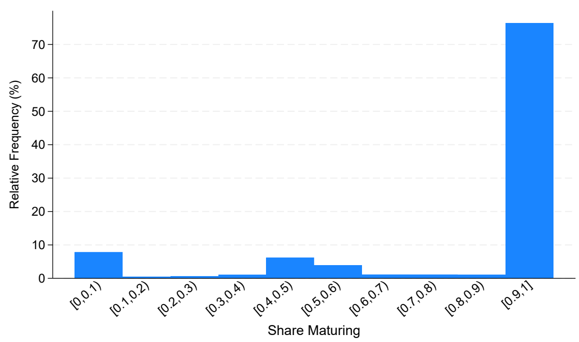
These figures depict histograms of the share of FX positions maturing in the next period at different frequencies and aggregation levels. The sample in figures (b) and (d) is restricted to quarter-end months.



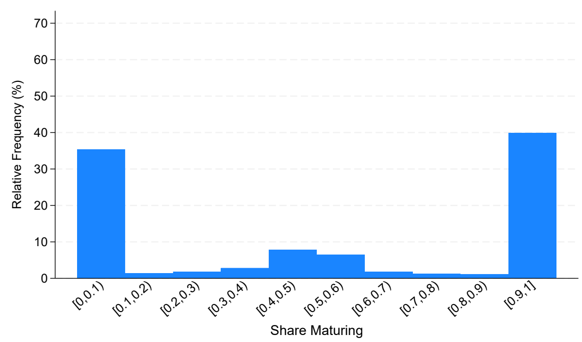
(a) Next quarter, country-sector level



(b) Next month, country-sector level



(c) Next quarter, entity level



(d) Next month, entity level

Table IA.6. Decomposing Variation in FX Maturities.

This table reports the OLS estimate for β as well as the R^2 and adjusted R^2 from regressions of the average residual maturity of FX positions on the average residual maturity of USD bond holdings at the country-sector level at quarterly frequency:

$$\text{FX Maturity}_{i,t} = \beta \text{USD Bond Maturity}_{i,t} + u_i + v_t + \varepsilon_{i,t},$$

for country-sector pair i and quarter t. In column (2), we additionally include indicators for pension funds, insurers, and banks, with investment funds being the omitted category. Standard errors are shown in parentheses, clustered at country-sector level. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	(1)	(2)	(3)	(4)
Dependent variable:	FX Maturity			
Sample:	All Sectors			Nonbanks
USD Bond Maturity	-0.03	0.05	0.01	0.07
	(0.05)	(0.05)	(0.06)	(0.06)
Pension Funds		0.02		
		(0.43)		
Insurers		0.97**		
		(0.38)		
Banks		1.30***		
		(0.36)		
Time FEs	Y	Y	Y	Y
Country-Sector FEs			Y	Y
R^2	0.01	0.13	0.65	0.60
Adj. R^2	-0.00	0.11	0.63	0.56

Table IA.7. Decomposing Variation in Rollover Need.

This table reports the R^2 and adjusted R^2 from regressions of rollover needs at either monthly frequency and individual investor level ("M") or quarterly frequency and country-sector level ("Q") on either time fixed effects (columns 1 and 2), unconditional FX maturity fixed effects (columns 3 and 4), unconditional FX maturity-by-time fixed effects (columns 5 and 6), conditional FX maturity fixed effects (columns 7 and 8), and conditional FX maturity-by-time fixed effects (columns 9 and 10). Unconditional FX maturity is defined as the investor-specific average original time to maturity of outstanding FX positions (aggregated at the investor level by weighting by gross notional amount). Fixed effects are based on the cross-sectional deciles of this variable. Conditional FX maturity is defined as the average original time to maturity of FX positions outstanding at the end of the preceding quarter (aggregated at the investor level by weighting by gross notional amount). Fixed effects are based on the deciles of this variable.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Fixed Effects:	Time		Uncond Maturity		Uncond Maturity-Time		Cond Maturity		Cond Maturity-Time	
Frequency:	M	Q	M	Q	M	Q	M	Q	M	Q
R^2	0.01	0.01	0.23	0.33	0.26	0.44	0.26	0.40	0.29	0.52
Adj. R^2	0.01	-0.00	0.23	0.33	0.26	0.31	0.26	0.40	0.29	0.41

Table IA.8. Bond Holdings and Rollover Needs.

This table tests for differences in portfolio allocation between investors with high and low rollover needs. We regress the portfolio share of (1) USD-denominated, (2) short-term (up to 3 years remaining to maturity), (3) medium-term (between 3 and 13 years), (4) long-term (more than 13 years), (5) investment-grade, (6) high-yield, and (7) unrated bonds on the indicator for investors with high rollover needs at country-sector level at quarterly frequency. Standard errors are shown in parentheses, clustered at country-sector level. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	Portfolio share of						
	USD	short-term	medium-term	long-term	IG	HY	unrated
High Rollover Need	0.04	0.00	-0.01	0.01	-0.02	0.02	-0.00
	(0.03)	(0.03)	(0.02)	(0.04)	(0.04)	(0.03)	(0.01)
Time FEs	Y	Y	Y	Y	Y	Y	Y
No. of obs.	1,045	1,045	1,045	1,045	1,045	1,045	1,045

Table IA.9. Correlation of GFX_t across Tenors.

This table reports the pairwise correlation between the instrumental variable $\text{GFX}_{T,t}$ for different tenors T, which are either 1 week (1W), 1 month (1M), 3 months (3M), or 6 months (6M).

	$\text{GFX}_{1W,t}$	$\text{GFX}_{1M,t}$	$\text{GFX}_{3M,t}$	$\text{GFX}_{6M,t}$
$\text{GFX}_{1W,t}$	1	.032	.026	-.046
$\text{GFX}_{1M,t}$	.032	1	-.143	.058
$\text{GFX}_{3M,t}$	.026	-.143	1	.001
$\text{GFX}_{6M,t}$	-.046	.058	.001	1

D Mechanics of Hedging via Short-Term Rolls

This appendix illustrates why a short-maturity FX instrument (e.g., a 3-month forward or swap) effectively hedges the currency exposure of a long-maturity asset (e.g., a 10-year bond). It demonstrates that the maturity mismatch does not re-introduce spot exchange rate risk; rather, it exposes the investor specifically to *rollover risk* (fluctuations in the cross-currency basis).

D.1 Intuition

Consider a euro-based investor holding a USD bond. The investor hedges the currency risk by selling USD forward. When the short-term forward expires, they settle the spot difference and immediately enter a new forward contract.

Elimination of Spot Risk: The rolling mechanism mechanically cancels out fluctuations in the future spot rate. The cash flow gained or lost on the expiring forward exactly offsets the loss or gain on the principal value of the bond at that moment.

Rollover Risk (Basis Risk): Because the spot risk is eliminated, the only remaining uncertainty is the *pricing* of the future forward contracts. If the cross-currency basis (i.e., the cost of the hedge) is constant or deterministic, the total cost is fixed ex-ante. Risk arises only if the basis fluctuates unexpectedly over the life of the bond.

D.2 Formal Proof

Setup Let S_t be the spot exchange rate (EUR per USD) at time t. Let $i_{\text{USD},k}$ and $i_{\text{EUR},k}$ be the one-period interest rates for the period $[t_k, t_{k+1}]$.

We allow for deviations from Covered Interest Rate Parity (CIP). We define the cross-currency basis, b_k, as the additional cost of USD synthetic funding in the FX swap market relative to the cash market:

$$\frac{F_{t_k,t_{k+1}}}{S_{t_k}} = \frac{1 + i_{\text{EUR},k}}{1 + i_{\text{USD},k} + b_k}. \tag{IA.1}$$

If $b_k = 0$, CIP holds exactly. If $b_k > 0$, hedging is more expensive than implied by interest rate differentials.

Rolling Hedge Consider a USD cash flow CF_N (principal plus coupon) to be received at a future date t_N. The investor hedges this exposure by continuously rolling one-period forward contracts.

The effective EUR-per-USD conversion rate achieved at t_N by rolling forwards from t_0 is the product of the initial forward rate and the subsequent periodic returns from settling and re-opening the position:

$$X_{\text{roll}}(t_N) = F_{0,1} \times \left(\frac{F_{1,2}}{S_1}\right) \times \cdots \times \left(\frac{F_{N-1,N}}{S_{N-1}}\right).$$

Substituting the pricing relationship from equation (IA.1) into the expression above:

$$X_{\text{roll}}(t_N) = S_0 \prod_{k=0}^{N-1} \frac{1 + i_{\text{EUR},k}}{1 + i_{\text{USD},k} + b_k}.$$

Valuation of the Hedged Position The Present Value (PV) in EUR of a stream of USD cash flows $\{CF_i\}$ hedged via this rolling strategy is calculated by discounting the converted cash flows at the EUR risk-free rate:

$$\begin{aligned} \text{PV}_{\text{EUR}}^{\text{hedged}} &= \sum_i \frac{CF_i \cdot X_{\text{roll}}(t_i)}{\prod_{k=0}^{i-1}(1 + i_{\text{EUR},k})} \\ &= \sum_i \frac{CF_i \cdot \left(S_0 \prod_{k=0}^{i-1} \frac{1+i_{\text{EUR},k}}{1+i_{\text{USD},k}+b_k}\right)}{\prod_{k=0}^{i-1}(1 + i_{\text{EUR},k})}. \end{aligned}$$

The EUR interest rate terms in the numerator (from the hedge roll) and the denominator (from the discounting) cancel out:

$$\text{PV}_{\text{EUR}}^{\text{hedged}} = S_0 \sum_i \frac{CF_i}{\prod_{k=0}^{i-1}(1 + i_{\text{USD},k} + b_k)}.$$

Hence, the final valuation equation yields two key results regarding the hedge ratio and maturity mismatch:

1. **Spot Risk is Eliminated:** The future spot rates S_t $(t > 0)$ do not appear in the final value. A hedge ratio of 100% (matching the forward notional to the bond value) fully eliminates currency spot risk, regardless of the mismatch between the hedge tenor (short) and the bond tenor (long).
2. **Basis Stability vs. Volatility:** If the basis b_k is constant (or deterministic) over the life of the bond, the term $\prod_{k=0}^{i-1}(1 + i_{\text{USD},k} + b_k)$ is known at t_0. The hedge is perfect. On the other hand, if b_k is stochastic, the investor faces risk. However, this is not currency risk; it is rollover or basis risk.

E Bias in the OLS Estimate and Identifying Assumptions

In this appendix, we draw on Gabaix and Koijen (2024) and formally derive the following results: (i) the probability limit of the OLS estimate in an equilibrium demand system and conditions under which it collapses toward zero even when the structural elasticity is nonzero, and (ii) the identifying assumptions under which the granular instrumental variable (GIV) is consistent. We also characterize the direction of bias in IV estimates when the identifying assumptions are violated. The purpose of this appendix is not to derive novel results relative to those in the literature, and especially in Gabaix and Koijen (2024), but to provide a self-contained set of derivations that make the assumptions transparent that are required for the validity of our empirical approach.

E.1 Model Setup

We adopt the framework of Gabaix and Koijen (2024). Consider a market for an asset in fixed supply, normalized to one. The market consists of N entities indexed by i, with size weights $S_i > 0$ satisfying $\sum_i S_i = 1$.

Demand Entity i's demand at time t is

$$D_{i,t} = S_i(1 + q_{i,t}), \tag{IA.2}$$

where $q_{i,t}$ is the demand shifter

$$q_{i,t} = \phi p_t + \lambda_i \eta_t + u_{i,t}. \tag{IA.3}$$

Here $p_t = (P_t - \bar{P})/\bar{P}$ is the price deviation, $\phi < 0$ is the structural elasticity, η_t is a common aggregate shock with variance σ_η^2, and $u_{i,t}$ is an idiosyncratic demand shock with variance σ_u^2. We assume $\eta_t \perp u_{i,t}$ and that $u_{i,t}$ are independent across i.

Market Clearing and Price Determination Market clearing requires $\sum_i D_{i,t} = 1$, i.e.,

$$\sum_i S_i q_{i,t} = 0.$$

Define $\lambda_S = \sum_i S_i \lambda_i$ and $u_{S,t} = \sum_i S_i u_{i,t}$. Then, market clearing implies that

$$\phi p_t + \lambda_S \eta_t + u_{S,t} = 0 \quad \Longrightarrow \quad p_t = -\frac{1}{\phi}\big(\lambda_S \eta_t + u_{S,t}\big). \tag{IA.4}$$

Thus, the regressor p_t is endogenous: it loads mechanically on both common and idiosyncratic demand shocks.

E.2 Bias in the OLS Estimator

Let $q_{E,t} = \frac{1}{N}\sum_i q_{i,t}$ denote the equal-weighted average demand shift and, analogously, $\lambda_E = \frac{1}{N}\sum_i \lambda_i$ and $u_{E,t} = \frac{1}{N}\sum_i u_{i,t}$. Then

$$q_{E,t} = \phi p_t + \lambda_E \eta_t + u_{E,t}.$$

The OLS estimate from regressing $q_{E,t}$ on p_t is

$$\beta_{OLS} = \frac{cov(q_{E,t}, p_t)}{var(p_t)}.$$

Let $H = \sum_i S_i^2$ denote the Herfindahl index. Under the assumptions above,

$$\text{plim } \hat{\beta}_{OLS} = \phi \left(1 - \frac{\lambda_E \lambda_S \sigma_\eta^2 + \sigma_u^2/N}{\lambda_S^2 \sigma_\eta^2 + \sigma_u^2 H}\right). \tag{IA.5}$$

Proof. Under standard regularity conditions ensuring $\widehat{cov} \to cov$ and $\widehat{var} \to var$, one has

$$\text{plim } \hat{\beta}_{OLS} = \frac{cov(q_{E,t}, p_t)}{var(p_t)}.$$

Using $p_t = -(1/\phi)(\lambda_S \eta_t + u_{S,t})$ from equation (IA.4) and $\eta_t \perp u_{i,t}$,

$$var(p_t) = \frac{1}{\phi^2}\Big(\lambda_S^2 \sigma_\eta^2 + var(u_{S,t})\Big) \quad \text{with} \quad var(u_{S,t}) = var\Big(\sum_i S_i u_{i,t}\Big) = \sigma_u^2 \sum_i S_i^2 = \sigma_u^2 H.$$

Moreover, since $q_{E,t} = \phi p_t + \lambda_E \eta_t + u_{E,t}$,

$$cov(q_{E,t}, p_t) = \phi var(p_t) + \lambda_E cov(\eta_t, p_t) + cov(u_{E,t}, p_t).$$

Now $cov(\eta_t, p_t) = -(1/\phi)\lambda_S \sigma_\eta^2$, and $cov(u_{E,t}, p_t) = -(1/\phi) cov(u_{E,t}, u_{S,t})$. Finally,

$$cov(u_{E,t}, u_{S,t}) = cov\Big(\frac{1}{N}\sum_i u_{i,t}, \sum_j S_j u_{j,t}\Big) = \frac{1}{N}\sum_i S_i var(u_{i,t}) = \frac{\sigma_u^2}{N},$$

using cross-sectional independence and $\sum_i S_i = 1$. Substituting these identities and dividing by $var(p_t) = (1/\phi^2)(\lambda_S^2 \sigma_\eta^2 + \sigma_u^2 H)$ yields equation (IA.5). □

Proposition IA.1 (OLS estimate collapses toward zero)**.** *Assume* $N \to \infty$ *so that* $\sigma_u^2/N \to 0$, *and assume that common shocks dominate the price variation in equilibrium in the sense that* $\frac{\lambda_S^2 \sigma_\eta^2}{\sigma_u^2 H} \to \infty$.

Then plim $\hat{\beta}_{OLS} = \phi(1 - \lambda_E/\lambda_S)$*. In particular, if* $\lambda_E/\lambda_S \to 1$ *(similar exposure under equal and size weights), then* plim $\hat{\beta}_{OLS} = 0$.

Proof. From equation (IA.5),

$$\text{plim } \hat{\beta}_{OLS} = \phi \left(1 - \frac{\lambda_E \lambda_S \sigma_\eta^2 + \sigma_u^2/N}{\lambda_S^2 \sigma_\eta^2 + \sigma_u^2 H}\right).$$

As $N \to \infty$, $\sigma_u^2/N \to 0$. The dominance condition implies $\sigma_u^2 H/(\lambda_S^2 \sigma_\eta^2) \to 0$, hence $\lambda_S^2 \sigma_\eta^2 + \sigma_u^2 H \sim \lambda_S^2 \sigma_\eta^2$ and therefore

$$\frac{\lambda_E \lambda_S \sigma_\eta^2 + \sigma_u^2/N}{\lambda_S^2 \sigma_\eta^2 + \sigma_u^2 H} \to \frac{\lambda_E \lambda_S \sigma_\eta^2}{\lambda_S^2 \sigma_\eta^2} = \frac{\lambda_E}{\lambda_S}.$$

Substitution gives plim $\hat{\beta}_{OLS} = \phi(1 - \lambda_E/\lambda_S)$, and if $\lambda_E/\lambda_S \to 1$, then the limit is 0. □

Intuition The regression attempts to recover the slope of the demand curve, ϕ. The difficulty is that p_t is an equilibrium price: by market clearing, it moves in response to the same aggregate shocks that shift demand. In the regression $q_{Et} = \beta p_t + \varepsilon_t$, the error term contains the common component $\lambda_E \eta_t$, while p_t is itself a function of η_t through the market-clearing condition, implying $\text{Cov}(p_t, \varepsilon_t) \neq 0$ and hence a simultaneity bias. When the market is large, the equal-weighted idiosyncratic term u_{Et} averages out, so the observable aggregate quantity is driven mainly by common shocks. If common shocks also dominate price variation and average factor loadings are similar ($\lambda_E \approx \lambda_S$), the endogeneity term approximately offsets the structural slope, pushing the OLS estimate toward zero. Economically, in this case, equilibrium fluctuations are largely common demand shifts that are absorbed by price adjustments required for market clearing, leaving little independent aggregate-quantity variation with which to identify the demand elasticity. Hence, this result shows that under simultaneous equations, the OLS slope can be near zero even if the underlying coefficient is significantly positive when the market is large and common shocks dominate.

E.3 Identifying Assumptions for GIV and Bias under Imperfect De-factoring

Let E denote equal weights, $E_i := 1/N$, and $\Gamma := S - E$, so that $\sum_i \Gamma_i = 0$. The granular instrument is $z_t = \Gamma' \check{q}_t$, where $\check{q}_{i,t}$ are residuals after removing common components.

Proposition IA.2 (GIV consistency under perfect de-factoring)**.** *If common shocks are removed perfectly such that $\check{q}_{i,t} = u_{i,t}$, then the IV estimate*

$$\hat{\beta}_{IV} = \frac{cov(q_{E,t}, z_t)}{cov(p_t, z_t)}$$

is consistent for ϕ, provided $H > 1/N$ (entities do not have identical sizes).

Proof. If $\check{q}_{i,t} = u_{i,t}$, then $z_t = \Gamma' u_t$. Write $q_{E,t} = \phi p_t + \varepsilon_t$ with $\varepsilon_t = \lambda_E \eta_t + u_{E,t}$ and $u_{E,t} = E' u_t$. Exclusion holds because $cov(\eta_t, z_t) = 0$ (by $\eta_t \perp u_t$) and

$$cov(u_{E,t}, z_t) = cov(E'u_t, \Gamma' u_t) = E' var(u_t) \Gamma = \sigma_u^2 E' \Gamma = 0,$$

since $E'\Gamma = (1/N)\sum_i \Gamma_i = 0$. For relevance, using $p_t = -(1/\phi)(\lambda_S \eta_t + S'u_t)$,

$$cov(p_t, z_t) = -\frac{1}{\phi} cov(S'u_t, \Gamma' u_t) = -\frac{1}{\phi} S' var(u_t)\Gamma = -\frac{1}{\phi}\sigma_u^2 S'\Gamma = -\frac{1}{\phi}\sigma_u^2\Big(H - \frac{1}{N}\Big),$$

which is nonzero if $H > 1/N$. Therefore $cov(q_{E,t}, z_t) = \phi cov(p_t, z_t)$ and plim $\hat{\beta}_{IV} = \phi$. □

Proposition IA.3 (Direction of IV bias under imperfect de-factoring)**.** *Suppose instead that* $\check{q}_{i,t}$ *still contains a common component,* $\check{q}_{i,t} = \lambda_i \eta_t + u_{i,t}$*, such that*

$$z_t = (\lambda_S - \lambda_E)\eta_t + \Gamma' u_t.$$

Then, the IV estimate is given by

$$\text{plim } \hat{\beta}_{IV} = \phi\left(1 - \frac{\lambda_E(\lambda_S - \lambda_E)\sigma_\eta^2}{\lambda_S(\lambda_S - \lambda_E)\sigma_\eta^2 + \sigma_u^2\big(H - \frac{1}{N}\big)}\right). \tag{IA.6}$$

If $\lambda_S > \lambda_E > 0$*, then the IV bias is attenuated toward zero:* $|\text{plim } \hat{\beta}_{IV}| < |\phi|$.

Proof. With $\check{q}_{i,t} = \lambda_i \eta_t + u_{i,t}$, one has $z_t = (\lambda_S - \lambda_E)\eta_t + \Gamma' u_t$. Using $p_t = -(1/\phi)(\lambda_S \eta_t + S'u_t)$ and $\eta_t \perp u_t$,

$$cov(p_t, z_t) = -\frac{1}{\phi}\left(\lambda_S(\lambda_S - \lambda_E)\sigma_\eta^2 + \sigma_u^2\Big(H - \frac{1}{N}\Big)\right).$$

Moreover, since $q_{E,t} = \phi p_t + \lambda_E \eta_t + E'u_t$ and $E'\Gamma = 0$,

$$cov(q_{E,t}, z_t) = \phi cov(p_t, z_t) + \lambda_E cov(\eta_t, z_t) = \phi cov(p_t, z_t) + \lambda_E(\lambda_S - \lambda_E)\sigma_\eta^2.$$

Dividing gives (IA.6). If $\lambda_S > \lambda_E > 0$, then letting $A = \lambda_E(\lambda_S - \lambda_E)\sigma_\eta^2$ and $D = \lambda_S(\lambda_S - \lambda_E)\sigma_\eta^2 + \sigma_u^2(H - 1/N)$ yields $0 < A < D$, hence $0 < 1 - A/D < 1$ and therefore $|\text{plim } \hat{\beta}_{IV}| = |\phi|\,(1 - A/D) < |\phi|$. □

Intuition Imperfect de-factoring makes the instrument z_t load on the common shock η_t, which also appears in the regression error of $q_{E,t}$ and, therefore, violates the identifying assumption in Proposition IA.2. When $\lambda_S > \lambda_E > 0$, this induces a positive correlation between z_t and the regression error; since $\phi < 0$ and $cov(p_t, z_t) > 0$, the IV estimate becomes less negative (closer to zero).

Identifying Assumptions If common shocks are fully removed from $\tilde{q}_{i,t}$, then z_t contains no η_t component and the GIV satisfies the exclusion restriction regardless of the relative magnitudes of λ_S and λ_E (see Proposition IA.2). In addition, even under imperfect de-factoring, the exclusion restriction is recovered when $\lambda_S - \lambda_E = 0$, since the size-minus-equal weighting nets out the common-shock component (see equation (IA.6)). Bias arises only when (1) residual common-shock exposure remains *and* (2) $(\lambda_S - \lambda_E)\eta_t$ is non-negligible relative to the valid granular component, whose strength scales with $\sigma_u^2\big(H - \frac{1}{N}\big)$. Consequently, even when $\lambda_S \neq \lambda_E$, the IV estimate remains close to the true elasticity whenever the granular component is sufficiently large compared to any residual common-shock contamination.

F Dynamic Model

This section presents a stylized continuous-time asset-pricing model to study the joint determination of the EUR–USD cross-currency basis (CCB) and EUR investors' currency-hedged allocations to USD assets. In the model, EUR investors invest in USD-denominated assets while hedging part of the associated FX risk by rolling short-maturity FX forward contracts. We study the implications of this maturity mismatch between derivatives contracts and asset holdings in an environment in which (i) the supply curve for FX forwards has finite elasticity because CIP arbitrageurs face convex balance-sheet costs and (ii) EUR investors themselves face a convex cost of carrying forward positions. Trading in risky USD assets is subject to multiplicative transaction costs, generating an inaction region in portfolio rebalancing.

F.1 Environment

Let $(\Omega, \mathcal{F}, \mathbb{P})$ be a probability space satisfying the usual conditions and assume all stochastic processes are adapted. The economy evolves in continuous time $t \in [0, \infty)$. Uncertainty is driven by two independent Brownian motions (Z_t^x, Z_t^a) and by a two-state continuous-time Markov chain $d_t \in \{d, d'\}$ capturing residual demand in the FX forward market.

Three infinitely-lived agents with time-separable log utility and subjective discount rate ρ populate the economy: (i) a representative EUR investor (hedger) with a convex forward holding cost and a USD borrowing constraint; (ii) a CIP arbitrageur with convex balance-sheet costs and a mandate to take no net FX risk; and (iii) an outside investor that absorbs risky USD assets elastically at a reservation expected return (a tractable closure device).

Exchange Rate Process. Let S_t denote the EUR price of 1 USD (EUR per USD) and define $x_t \equiv \log S_t$. We postulate the (level) dynamics

$$\frac{dS_t}{S_t} = \mu^x \, dt + \sigma^x \, dZ_t^x, \tag{IA.7}$$

so that, equivalently,

$$dx_t = \left(\mu^x - \tfrac{1}{2}(\sigma^x)^2\right) dt + \sigma^x \, dZ_t^x. \tag{IA.8}$$

Capital Markets. Let r^d and r^e denote the USD and EUR risk-free rates. A risky USD asset has USD-price process P_t^a satisfying

$$\frac{dP_t^a}{P_t^a} = \left(r^d + \varsigma_t\right) dt + \sigma^a \, dZ_t^a, \qquad dZ_t^a \perp dZ_t^x, \tag{IA.9}$$

where ς_t is the USD risk premium required by investors. From the perspective of the EUR investor (i.e., in EUR terms), the instantaneous *simple* returns on the USD risk-free asset and the risky USD asset are

$$dR_t^d = (r^d + \mu^x) \, dt + \sigma^x \, dZ_t^x, \tag{IA.10}$$

$$dR_t^a = (r^d + \mu^x + \varsigma_t) \, dt + \sigma^a \, dZ_t^a + \sigma^x \, dZ_t^x. \tag{IA.11}$$

Derivatives Market. Investors trade FX forward contracts. At time t, consider a forward maturing at $t + dt$ with (log) forward rate $f_{t,t+dt}$. We define the instantaneous forward premium θ_t by the scaling

$$f_{t,t+dt} = x_t + \theta_t \, dt \qquad \iff \qquad F_{t,t+dt} \equiv e^{f_{t,t+dt}} = S_t(1 + \theta_t \, dt) + o(dt), \tag{IA.12}$$

where $F_{t,t+dt}$ is the forward EUR price of 1 USD at maturity.

A long position in the contract (receive $F_{t,t+dt}$ EUR, deliver 1 USD at $t + dt$) has EUR payoff $F_{t,t+dt} - S_{t+dt}$. Normalizing by S_t and using the spot dynamics yields the per-unit instantaneous forward return

$$dR_t^f \equiv \frac{F_{t,t+dt} - S_{t+dt}}{S_t} = (\theta_t - \mu^x) \, dt - \sigma^x \, dZ_t^x. \tag{IA.13}$$

A forward position of size α_t incurs a convex holding and margin cost $\frac{\kappa}{2}\alpha_t^2$ per unit time. In our sign convention, $\alpha_t > 0$ corresponds to a long position in the above contract (economically: selling USD forward / buying EUR forward), which reduces the investor's exposure to the FX shock dZ_t^x.

Residual FX Demand Shock. Residual net demand in the forward market is modeled in reduced form by a two-state Markov chain $d_t \in \{d, d'\}$ with $d' > d$:

$$d \xrightarrow{\lambda} d', \qquad d' \xrightarrow{\lambda'} d. \tag{IA.14}$$

The shock d_t is measured in the same units/sign convention as α_t.

Market Clearing. Market clearing requires:

$$\text{(i) Forward market:} \quad \alpha_t + \alpha_t^s + d_t = 0, \tag{IA.15}$$

$$\text{(ii) Risky USD asset market:} \quad w_t^a + \widetilde{b}_t = b, \tag{IA.16}$$

where w_t^a is the EUR investor's position in the risky USD asset (expressed in normalized units), b is exogenous net supply, and $\widetilde{b}_t$ is the outside investor's residual demand.

Financial Frictions. We impose frictions that generate finite elasticities in forward supply and demand and an inaction region in risky-asset rebalancing:

1. **No USD borrowing for the EUR investor:** $w_t^d \geq 0$.
2. **Arbitrageur balance-sheet cost:** quadratic cost with parameter $\chi > 0$.
3. **Forward holding cost for hedgers:** $\frac{\kappa}{2}\alpha_t^2$ per unit time.
4. **Transaction cost in risky USD trading:** a multiplicative (exponential) cost with parameter $\nu \geq 0$ (defined precisely below), generating inaction.

F.2 Equilibrium Derivations

F.2.1 Optimization Problems.

European Investor. The representative EUR investor maximizes lifetime log utility,

$$V_t = \sup\ \mathbb{E}_t\left[\int_t^{\infty} e^{-\rho(\tau-t)} \log(c_\tau)\, d\tau\right], \tag{IA.17}$$

by choosing consumption c_t, the USD risk-free position $w_t^d \geq 0$, the risky USD position w_t^a, and the forward position α_t.

Wealth dynamics (between regime switches). Let n_t denote net worth in EUR. Between jumps of d_t, net worth evolves as

$$\begin{aligned}\frac{dn_t}{n_t} =& \Big(r^e + w_t^d(r^d + \mu^x - r^e) + w_t^a(r^d + \mu^x + \varsigma(d_t) - r^e) + \alpha_t(\theta(d_t) - \mu^x) - \tfrac{\kappa}{2}\alpha_t^2 - \tfrac{c_t}{n_t}\Big)\, dt \\ &+ \big(w_t^d + w_t^a - \alpha_t\big)\sigma^x\, dZ_t^x + w_t^a \sigma^a\, dZ_t^a. \end{aligned} \tag{IA.18}$$

Transaction costs (at regime switches). For tractability, we assume risky-asset rebalancing occurs only at jump times of d_t. If at a jump time T the investor changes the risky USD position from w_{T-}^a to w_T^a, net worth jumps multiplicatively:

$$n_T = n_{T-} \exp\big(-\nu\, |w_T^a - w_{T-}^a|\big). \tag{IA.19}$$

This exponential form preserves homotheticity and yields a standard inaction region.

CIP Arbitrageur. The arbitrageur takes positions in the USD risk-free asset and FX forwards to exploit deviations from CIP, but is mandated to take no net FX risk. Let n_t^s denote its EUR net worth and let α_t^s denote its forward position (same sign convention as α_t). The FX-neutrality mandate implies that its USD cash position equals its forward position:

$$w_t^{d,s} = \alpha_t^s, \qquad \text{so net FX exposure is } (w_t^{d,s} - \alpha_t^s) = 0. \tag{IA.20}$$

Its wealth evolves as

$$\frac{dn_t^s}{n_t^s} = \Big(r^e + \alpha_t^s(r^d + \theta(d_t) - r^e) - \tfrac{\chi}{2}(\alpha_t^s)^2 - \tfrac{c_t^s}{n_t^s}\Big)\, dt, \tag{IA.21}$$

and it maximizes $\mathbb{E}\left[\int_t^{\infty} e^{-\rho(\tau-t)} \log(c^s_\tau)\, d\tau\right]$.

Global Outside Investor. To close the model, we assume outside demand for the risky USD asset is perfectly elastic at a reservation expected EUR excess return $\overline{r}^a_t$. In normalized units:

$$\widetilde{b}_t = \begin{cases} 0, & r^d + \mu^x + \varsigma_t - r^e < \overline{r}^a_t, \\ [0, +\infty), & r^d + \mu^x + \varsigma_t - r^e = \overline{r}^a_t. \end{cases} \tag{IA.22}$$

F.2.2 HJB, First-Order Conditions, and the Shadow Value of Risky Holdings.

Because preferences are logarithmic and the budget set is homogeneous, optimal *continuous* controls (c_t, w^d_t, α_t) are scale invariant. Let $\Lambda^d(d_t) \geq 0$ denote the multiplier on the constraint $w^d_t \geq 0$.

European Investor: continuous controls. The optimal consumption rule is

$$\frac{c(d_t)}{n_t} = \rho. \tag{IA.23}$$

The first-order conditions for w^d and α are

$$0 = r^d + \mu^x - r^e - \big(w^d(d_t) + w^a(d_t) - \alpha(d_t)\big)(\sigma^x)^2 + \rho\,\Lambda^d(d_t), \tag{IA.24}$$

$$0 = \theta(d_t) - \mu^x - \kappa\,\alpha(d_t) + \big(w^d(d_t) + w^a(d_t) - \alpha(d_t)\big)(\sigma^x)^2. \tag{IA.25}$$

Complementary slackness holds: $w^d(d_t) \geq 0$, $\Lambda^d(d_t) \geq 0$, and $\Lambda^d(d_t)\, w^d(d_t) = 0$.

CIP Arbitrageur. Similarly, log utility implies $c^s_t/n^s_t = \rho$, and the arbitrageur's first-order condition is

$$r^d + \theta(d_t) - r^e = \chi\, \alpha^s(d_t). \tag{IA.26}$$

Shadow value of the risky USD position and inaction. The risky USD position w^a can be reset at regime switches, at the cost (IA.19). Let $\phi(d_t)$ denote the (state-dependent) *shadow value* of marginally increasing w^a (formally, the marginal value of the risky position in the value function, evaluated at the equilibrium positions). Standard impulse-control arguments with multiplicative proportional costs imply the no-trade band

$$-\nu \le \phi(d) \le \nu, \qquad -\nu \le \phi(d') \le \nu, \tag{IA.27}$$

and in the *sale* region (where the investor reduces risky USD holdings when d jumps to d'),

$$\phi(d) = \nu, \qquad \phi(d') = -\nu. \tag{IA.28}$$

Between regime switches, the shadow values satisfy the envelope relation

$$(\rho + \lambda(d_t))\,\phi(d_t) = \lambda(d_t)\,\phi(d_t^+) + \left(r^d + \mu^x - r^e\right) + \varsigma(d_t) - \left(w^d(d_t) + w^a(d_t) - \alpha(d_t)\right)(\sigma^x)^2 - w^a(d_t)(\sigma^a)^2, \tag{IA.29}$$

where $\lambda(d) = \lambda$, $\lambda(d') = \lambda'$, and d_t^+ denotes the other regime.

F.3 Analysis

Equilibrium Restrictions. To focus on the empirically relevant region and keep the model tractable, we restrict attention to equilibria in which:

(i) **UIP holds:** $r^d + \mu^x - r^e = 0$.

(ii) **CIP deviates negatively (negative basis):** $r^d + \theta(d_t) - r^e < 0$ in both regimes.

(iii) **Outside investor enters only in the shock state:** $\widetilde{b}(d) = 0$ and, in state d', the reservation return pins $\varsigma(d') = \varsigma(d) \equiv \varsigma$.[1]

Under (i) and (ii), the USD borrowing constraint binds for the EUR investor in both regimes,

[1]This can be implemented by choosing $\overline{r}^a$ so that the outside investor is just indifferent in d' and strictly inactive in d.

so $w^d(d) = w^d(d') = 0$.

CCB and forward positions as a function of risky holdings. Let $\sigma_x^2 \equiv (\sigma^x)^2$ and define

$$H \equiv \chi + \sigma_x^2 + \kappa. \tag{IA.30}$$

Imposing $w^d = 0$ and using (IA.25), (IA.26), and forward market clearing (IA.15) yields, in either regime $d_t \in \{d, d'\}$,

$$\alpha(d_t) = \frac{\sigma_x^2\, w^a(d_t) - \chi\, d_t}{H}, \tag{IA.31}$$

$$r^d + \theta(d_t) - r^e = \chi\, \alpha^s(d_t) = -\frac{\chi\big(\sigma_x^2\, w^a(d_t) + (\sigma_x^2 + \kappa)d_t\big)}{H}. \tag{IA.32}$$

Under UIP, $\theta(d_t) - \mu^x = r^d + \theta(d_t) - r^e$.

Steady state ($d_t = d$). Restriction (iii) implies $\widetilde{b}(d) = 0$, so risky-asset market clearing (IA.16) implies

$$w^a(d) = b. \tag{IA.33}$$

Substituting (IA.33) into (IA.31)–(IA.32) yields

$$\alpha(d) = \frac{\sigma_x^2 b - \chi d}{H}, \tag{IA.34}$$

$$r^d + \theta(d) - r^e = -\frac{\chi\big(\sigma_x^2 b + (\sigma_x^2 + \kappa)d\big)}{H}. \tag{IA.35}$$

Finally, using UIP and the envelope equation (IA.29) in regime d, the steady-state risky-asset risk premium satisfies

$$\varsigma = (\rho + \lambda)\phi(d) - \lambda\phi(d') + \big(b - \alpha(d)\big)\sigma_x^2 + b(\sigma^a)^2. \tag{IA.36}$$

Shock state ($d_t = d'$) and the inaction region. In the shock state, restriction (iii) implies $\varsigma(d') = \varsigma(d) = \varsigma$. Define

$$D \equiv 1 + \frac{(\sigma^a)^2}{\sigma_x^2}\left(1 + \frac{\sigma_x^2}{\chi}\right) + \left(1 + \frac{(\sigma^a)^2}{\sigma_x^2}\right)\frac{\kappa}{\chi}. \tag{IA.37}$$

Combining the envelope equation (IA.29) in the two regimes with (IA.31) yields, in the trading (sale) region,

$$w^a(d') = b + \frac{-(d'-d) + \frac{H}{\chi\sigma_x^2}(\rho+\lambda+\lambda')\big(\phi(d) - \phi(d')\big)}{D}. \tag{IA.38}$$

Using (IA.28), this becomes

$$w^a(d') = b + \frac{-(d'-d) + 2(\rho+\lambda+\lambda')\nu\left(\frac{1}{\chi} + \frac{1}{\sigma_x^2} + \frac{\kappa}{\chi\sigma_x^2}\right)}{D}. \tag{IA.39}$$

Given $w^a(d')$, the forward position and basis in d' follow from (IA.31)–(IA.32).

Fire-sale threshold. A fire sale corresponds to $w^a(d') < w^a(d) = b$. From (IA.39), this occurs if and only if

$$d' - d > 2(\rho+\lambda+\lambda')\nu\left(\frac{1}{\chi} + \frac{1}{\sigma_x^2} + \frac{\kappa}{\chi\sigma_x^2}\right). \tag{C}$$

If (C) fails, the investor remains in the inaction region and keeps $w^a(d') = b$.

F.4 Model Predictions

The equilibrium in each regime is characterized by three objects:

$$\{\theta(d_t), \alpha(d_t), w^a(d_t)\},$$

with the risky-asset risk premium ς pinned by (IA.36) and restriction (iii).

Proposition IA.4 (No Balance-Sheet Cost Benchmark)**.** *As $\chi \to 0$, CIP holds in both regimes:*

$r^d + \theta(d) - r^e = r^d + \theta(d') - r^e = 0$, and the forward-demand shock does not affect allocations: $w^a(d') = w^a(d) = b$ and $\alpha(d') = \alpha(d)$.

Proof. From the arbitrageur's first-order condition (IA.26), $r^d + \theta(d_t) - r^e = \chi\alpha^s(d_t)$, so as $\chi \to 0$ we have $r^d + \theta(d) - r^e \to 0$ and $r^d + \theta(d') - r^e \to 0$, i.e., CIP holds.

Next, a fire sale occurs if and only if Condition (C) holds. For any fixed shock size $d' - d < \infty$, the right-hand side of (C) diverges as $\chi \to 0$ because it contains $1/\chi$. Hence, for sufficiently small χ, (C) fails and the investor remains in the inaction region, so $w^a(d') = w^a(d) = b$.

Finally, substituting $w^a(d') = w^a(d) = b$ yields $\alpha(d') - \alpha(d) = -(\chi/H)(d' - d) \to 0$ as $\chi \to 0$. □

Proposition IA.5 (Equilibrium Adjustment to Forward-Demand Shocks)**.** *Assume restrictions (i)–(iii) and suppose $d' > d$. Then, following a transition $d \to d'$:*

- *(a) The CCB widens (becomes more negative): $r^d + \theta(d') - r^e < r^d + \theta(d) - r^e < 0$.*
- *(b) The EUR investor hedges less: $\alpha(d') < \alpha(d)$.*
- *(c) If Condition (C) holds, the EUR investor sells risky USD assets: $w^a(d') < w^a(d) = b$.*

Proof. Under (i)–(ii), $w^d(d) = w^d(d') = 0$. From (IA.31),

$$\alpha(d') - \alpha(d) = \frac{\sigma_x^2\big(w^a(d') - b\big) - \chi(d' - d)}{H} < 0,$$

since $d' > d$ and $w^a(d') \le b$ (with strict inequality in the sale region).

For the basis, (IA.32) implies

$$\big(r^d + \theta(d') - r^e\big) - \big(r^d + \theta(d) - r^e\big) = -\frac{\chi}{H}\Big[\sigma_x^2\big(w^a(d') - b\big) + (\sigma_x^2 + \kappa)(d' - d)\Big] < 0,$$

where the bracket is strictly positive both in the inaction region ($w^a(d') = b$) and in the sale region (using $D > 1$ and $\phi(d) - \phi(d') \ge 0$ in (IA.38)). Finally, (c) is equivalent to Condition (C) by construction. □

Proposition IA.6 (Sensitivity to Expected Shock Duration)**.** *Assume the economy is in the sale region (Condition* (C) *holds), so that* (IA.39) *applies. For a fixed shock size* $(d' - d)$*:*

(a) The amount sold increases with expected shock duration $1/\lambda'$*:* $\partial\big(w^a(d) - w^a(d')\big)/\partial\lambda' < 0$*.*

(b) The CCB sensitivity decreases with expected shock duration: $\partial\big(\theta(d) - \theta(d')\big)/\partial\lambda' > 0$*.*

Proof. From (IA.39),

$$w^a(d) - w^a(d') = \frac{(d' - d) - 2(\rho + \lambda + \lambda')\nu\frac{H}{\chi\sigma_x^2}}{D}.$$

Differentiating yields

$$\frac{\partial\big(w^a(d) - w^a(d')\big)}{\partial\lambda'} = -2\nu\frac{\frac{H}{\chi\sigma_x^2}}{D} = -2\nu\frac{\frac{1}{\chi} + \frac{1}{\sigma_x^2} + \frac{\kappa}{\chi\sigma_x^2}}{D} < 0.$$

Under UIP, $\theta(d) - \theta(d')$ equals the basis difference. Using (IA.32) and the fact that only $w^a(d')$ depends on λ',

$$\frac{\partial\big(\theta(d) - \theta(d')\big)}{\partial\lambda'} = -\frac{\partial\big(r^d + \theta(d') - r^e\big)}{\partial\lambda'} = \frac{2\nu}{D} > 0.$$

□

F.5 Extension: Hedging Mandates (Partial Equilibrium)

To isolate the role of hedging constraints, consider a partial-equilibrium basis shock $\theta \to \theta'$ with a two-state Markov structure (intensities λ, λ') and take asset prices (including ς) as exogenous. Let the investor choose (w^a, α) and pay the same forward holding cost and risky-asset transaction cost as above.

Proposition IA.7 (Trading Region Expands with a 1-to-1 Hedging Mandate)**.** *Consider an exogenous deterioration* $\theta \to \theta'$ *and suppose the investor sells risky USD assets (so* $w^a(\theta') < w^a(\theta)$*). The sale (trading) region is characterized by:*

(a) ***No hedging mandate:***

$$\theta - \theta' > 2(\rho + \lambda + \lambda')\nu \left(1 + \frac{\kappa}{(\sigma^x)^2}\right).$$

(b) ***1-to-1 hedging mandate ($\alpha = w^a$):***

$$\theta - \theta' > 2(\rho + \lambda + \lambda')\nu.$$

Proof. With $w^d = 0$, the investor's instantaneous mean–variance (log-wealth) payoff, net of costs, is

$$u(w^a, \alpha; \theta) = \alpha(\theta - \mu^x) - \tfrac{1}{2}(w^a - \alpha)^2(\sigma^x)^2 - \tfrac{1}{2}(w^a)^2(\sigma^a)^2 - \tfrac{\kappa}{2}\alpha^2,$$

up to constants independent of (w^a, α). The FOC for α is

$$0 = (\theta - \mu^x) + (w^a - \alpha)(\sigma^x)^2 - \kappa\alpha \quad \Rightarrow \quad \alpha^*(w^a; \theta) = \frac{w^a(\sigma^x)^2 + (\theta - \mu^x)}{(\sigma^x)^2 + \kappa}.$$

Substituting α^* makes the marginal value of w^a with respect to θ equal to $\frac{(\sigma^x)^2}{(\sigma^x)^2+\kappa}$. With multiplicative proportional trading costs, the standard band logic implies a sale is triggered when the deterioration in the state variable exceeds $2(\rho + \lambda + \lambda')\nu$ scaled by the inverse of this sensitivity, yielding (a). Under the mandate $\alpha = w^a$, the sensitivity becomes one, yielding (b). □

References

Ahmed, Ahmed, Boris Hofmann, and Martin Schmitz, 2021, Foreign institutional investors, monetary policy, and reaching for yield, *Available at SSRN 4002545*.

Aldunate, Felipe E., Zhi Da, Borja Larrain, and Clemens Sialm, 2025, Pension fund flows, exchange rates, and covered interest rate parity, *Journal of Financial Economics* 170, 104075.

Alfaro, Laura, Mauricio Calani, and Liliana Varela, 2021, Granular corporate hedging under dominant currency, NBER Working Paper 28910, National Bureau of Economic Research.

Andersen, Leif, Darrell Duffie, and Yang Song, 2019, Funding value adjustments, *Journal of Finance* 74, 145–192.

Augustin, Patrick, Mikhail Chernov, Lukas Schmid, and Dongho Song, 2024, The term structure of covered interest rate parity violations, *Journal of Finance* 79, 2077–2114.

Avdjiev, Stefan, Wenxin Du, Catherine Koch, and Hyun Song Shin, 2019, The dollar, bank leverage, and deviations from covered interest parity, *American Economic Review: Insights* 1, 193–208.

Ben Zeev, Nadav, and Daniel Nathan, 2024, The widening of cross-currency basis: When increased FX swap demand meets limits of arbitrage, *Journal of International Economics* 152, 103984.

Bräuer, Leonie, and Harald Hau, 2023, Can time-varying currency risk hedging explain exchange rates?, *Available at SSRN 4245778*.

Bruno, Valentina, and Hyun Song Shin, 2015, Cross-border banking and global liquidity, *Review of Economic Studies* 82, 535–564.

Bräuer, Leonie, and Harald Hau, 2025, Do funds engage in optimal FX hedging?, Research Paper 24-103, Swiss Finance Institute, Posted 27 Nov 2024; Last revised 25 Aug 2025.

Camanho, Nelson, Harald Hau, and Hélene Rey, 2022, Global portfolio rebalancing and exchange rates, *Review of Financial Studies* 35, 5228–5274.

Campbell, John Y, Karine Serfaty-De Medeiros, and Luis M. Viceira, 2010, Global currency hedging, *Journal of Finance* 65, 87–121.

Campbell, John Y, and Luis M. Viceira, 2002, Strategic asset allocation: Portfolio choice for long-term investors, in *Clarendon Lectures in Economics* (Oxford University Press).

Cenedese, Gino, Pasquale Della Corte, and Tianyu Wang, 2021, Currency mispricing and dealer balance sheets, *Journal of Finance* 76, 2763–2803.

Cesa-Bianchi, Ambrogio, Robert Czech, and Fernando Eguren-Martin, 2025, Dash for Dollars, *Working Paper*.

Chaudhary, Manav, Zhiyu Fu, and Jian Li, 2023, Corporate bond multipliers: Substitutes matter, *Available at SSRN 4292266*.

Coeurdacier, Nicolas, and Pierre-Olivier Gourinchas, 2016, When bonds matter: Home bias in goods and assets, *Journal of Monetary Economics* 82, 119–137.

Coeurdacier, Nicolas, and Helene Rey, 2013, Home bias in open economy financial macroeconomics, *Journal of Economic Literature* 51, 63–115.

Coppola, Antonio, 2025, In safe hands: The financial and real impact of investor composition over the credit cycle, *Review of Financial Studies* 38, 2275–2325.

Coppola, Antonio, Arvind Krishnamurthy, and Chenzi Xu, 2024, Liquidity, debt denomination, and currency dominance, NBER Working Paper 30984, National Bureau of Economic Research.

Correa, Ricardo, Wenxin Du, and Gordon Y. Liao, 2020, U.S. banks and global liquidity, NBER Working Paper 27491, National Bureau of Economic Research.

d'Avernas, Adrien, Damon Petersen, and Quentin Vandeweyer, 2024, The central bank balance sheet and treasury market disruptions, *Available at SSRN 4826919*.

Dávila, Eduardo, Daniel Graves, and Cecilia Parlatore, 2024, The value of arbitrage, *Journal of Political Economy* 132, 1947–1993.

Dick-Nielsen, Jens, 2014, How to clean enhanced trace data, *Available at SSRN 2337908*.

Du, Wenxin, Benjamin Hébert, and Amy Wang Huber, 2023, Are intermediary constraints priced?, *Review of Financial Studies* 36, 1464–1507.

Du, Wenxin, and Amy Huber, 2024, Dollar asset holding and hedging around the globe, NBER Working Paper 32453, National Bureau of Economic Research.

Du, Wenxin, Alexander Tepper, and Adrien Verdelhan, 2018, Deviations from covered interest rate parity, *Journal of Finance* 73, 915–957.

Faia, Ester, Juliana Salomao, and Alexia Ventula Veghazy, 2025, Market segmentation and international bond prices: The role of ECB asset purchases, *American Economic Journal: Macroeconomics* 17, 391–421.

Florez-Orrego, Sergio, Matteo Maggiori, Jesse Schreger, Ziwen Sun, and Serdil Tinda, 2024, Global capital allocation, *Annual Review of Economics* 16, 623–653.

French, Kenneth R., and James M. Poterba, 1991, Investor diversification and international equity markets, *American Economic Review: Papers & Proceedings* 81, 222–226.

Gabaix, Xavier, 2011, The granular origins of aggregate fluctuations, *Econometrica* 79, 733–772.

Gabaix, Xavier, and Ralph SJ Koijen, 2023, In search of the origins of financial fluctuations: The inelastic markets hypothesis, *Available at SSRN 3686935*.

Gabaix, Xavier, and Ralph SJ Koijen, 2024, Granular instrumental variables, *Journal of Political Economy* 132, 2274–2303.

Gürkaynak, Refet S., Brian Sack, and Jonathan H. Wright, 2007, The U.S. Treasury yield curve: 1961 to the present, *Journal of Monetary Economics* 54, 2291–2304.

Hacioglu Hoke, Sinem, Daniel A. Ostry, Hélène Rey, Adrien Rousset Planat, Vania Stavrakeva, and Jenny Tang, 2026, Topography of the FX derivatives market: A view from London, Working Paper 34588, National Bureau of Economic Research.

Hau, Harald, Peter Hoffmann, Sam Langfield, and Yannick Timmer, 2021, Discriminatory pricing of over-the-counter derivatives, *Management Science* 67, 6660–6677.

Hau, Harald, and Hélene Rey, 2004, Can portfolio rebalancing explain the dynamics of equity returns, equity flows, and exchange rates?, *American Economic Review* 94, 126–133.

Hau, Harald, and Hélene Rey, 2006, Exchange rates, equity prices, and capital flows, *Review of Financial Studies* 19, 273–317.

Hommel, Nicolas, and Thibaut Piquard, 2025, Firms' foreign exchange hedging, Working Paper.

ICMA, 2023, 44th European Repo Market Survey, *Available at www.icmagroup.org*.

Ivashina, Victoria, David S. Scharfstein, and Jeremy C. Stein, 2015, Dollar funding and the lending behavior of global banks, *Quarterly Journal of Economics* 130, 1241–1281.

Jansen, Kristy A.E., 2025, Long-term investors, demand shifts, and yields, *Review of Financial Studies* 38, 114–157.

Keller, Lorena, 2024, Arbitraging covered interest rate parity deviations and bank lending, *American Economic Review* 114, 2633–2667.

Khetan, Umang, 2024, Synthetic dollar funding, *Available at SSRN 4863575*.

Kloks, Peteris, Edouard Mattille, and Angelo Ranaldo, 2024, Hunting for dollars.

Koijen, Ralph SJ, François Koulischer, Benoît Nguyen, and Motohiro Yogo, 2021, Inspecting the mechanism of quantitative easing in the euro area, *Journal of Financial Economics* 140, 1–20.

Koijen, Ralph SJ, and Motohiro Yogo, 2024, Exchange rates and asset prices in a global demand system, NBER Working Paper 27342, National Bureau of Economic Research.

Kubitza, Christian, forthcoming, Investor-driven corporate finance: Evidence from insurance markets, *Review of Financial Studies*.

Lenoci, Francesca D., and Elisa Letizia, 2021, Classifying counterparty sector in EMIR data, in *Data Science for Economics and Finance: Methodologies and Applications*, 117–143 (Springer International Publishing).

Liao, Gordon Y., 2020, Credit migration and covered interest rate parity, *Journal of Financial Economics* 138, 504–525.

Maggiori, Matteo, Brent Neiman, and Jesse Schreger, 2020, International currencies and capital allocation, *Journal of Political Economy* 128, 2019–2066.

Moskowitz, Tobias J., Chase P. Ross, Sharon Y. Ross, and Kaushik Vasudevan, forthcoming, Risk, specialization, and covered-interest parity, *Journal of Finance*.

Opie, Wei, and Steven Riddiough, 2024, On the use of currency forwards: Evidence from international equity mutual funds, *Available at SSRN 4432796*.

Rime, Dagfinn, Andreas Schrimpf, and Olav Syrstad, 2022, Covered interest parity arbitrage, *Review of Financial Studies* 35, 5185–5227.

Sialm, Clemens, and Qifei Zhu, 2024, Currency management by international fixed income mutual funds, *Journal of Finance* 79, 4037–4081.