# FX Market Depth and Exchange Rate Volatility*

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**Abstract**

Using security-level holdings of globally diversified mutual funds, this paper applies a granular instrumental variable approach to identify currency demand shocks at the bilateral exchange rate level. These shocks cause significant exchange rate movements in both emerging market (EM) and advanced economy (AE) currencies, consistent with the view that FX markets are inelastic—or "shallow." The estimates show that for flows of the same size, EM currencies respond about nine times more than AE currencies, underscoring their much lower market depth. The results further reveal state dependence along two dimensions. First, during periods of high expected exchange rate volatility, FX markets are highly inelastic, whereas in tranquil periods they are nearly perfectly elastic. Second, in episodes of mutual fund outflows, FX markets are shallower than during inflows. The first property holds for both EM and AE currencies, while the second is specific to EMs. A quantitative small open economy model with segmented FX markets featuring limited risk-bearing capacity and balance sheet constraints rationalizes these empirical findings.

*JEL Codes*: E44, F31, F32, F36, G15, G23

*Keywords*: Foreign Exchange Markets, Market Depth, Currency Demand Shocks, Mutual Fund Flows, Granular Instrumental Variables, State Dependence

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# 1 Introduction

Exchange rate movements play a central role in the transmission of shocks across countries, shaping trade flows, capital allocation, and monetary policy. While much of the traditional literature has focused on macroeconomic fundamentals in explaining exchange rate dynamics (see, among others, Meese & Rogoff, 1983; Engel & West, 2005; Cheung et al., 2005; Devereux & Engel, 2002), a growing body of evidence shows that financial flows in foreign exchange (FX) markets can exert powerful and persistent effects, helping to account for the well-documented disconnect between exchange rates and fundamentals (see, among others, Evans & Lyons, 2002; Gabaix & Maggiori, 2015; Itskhoki & Mukhin, 2021). These findings point to a key empirical regularity: FX markets are often "shallow," meaning that the supply of currency by market intermediaries is inelastic to shifts in demand. Understanding the extent of this elasticity, and the conditions under which it varies, is crucial for interpreting exchange rate fluctuations and for assessing the scope of policy interventions.

This paper estimates the extent of this FX markets friction using microdata on security holdings of globally diversified mutual funds. The security level nature of the data makes it possible to track whenever the funds buy or sell specific currencies and thereby construct a measure of changes in currency demand at the bilateral exchange rate level. Next, exogenous variation is isolated using a granular instrumental variable (GIV) strategy (Gabaix & Koijen, 2024). The instrument exploits idiosyncratic rebalancing shocks at the fund level, which shift currency demand without being systematically related to macroeconomic conditions or aggregate market sentiment. This approach delivers causal estimates of how currency flows translate into exchange rate changes, providing a direct measure of FX market depth.

The empirical analysis yields four main findings. First, FX markets are far from perfectly elastic: demand shocks cause economically and statistically significant exchange rate responses. Pooling all currencies, mutual fund inflows (outflows) equal to 1% of annual GDP lead to an exchange rate appreciation (depreciation) of about 0.16% at a quarterly frequency. Second, market depth differs sharply across currencies. For emerging markets (EMs), flows of 1% of annual GDP move exchange rates by 0.78%, whereas for advanced economies (AEs) the effect is only 0.09%. Third, FX market depth is state dependent along two dimensions. During periods of high expected exchange rate volatility, markets become markedly less elastic, amplifying the price impact of flows: for EM currencies, a 1% flow moves the exchange rate by 1.86% in such episodes, compared with 0.78% on average. In tranquil periods, by contrast, markets resemble the frictionless benchmark. In addition, for EM currencies, FX markets are considerably shallower during outflow episodes than during inflows, underscoring that the direction of flows shapes the exchange rate response. For AEs, volatility is the dominant conditioning factor, while inflow–outflow asymmetry is absent. Fourth, currency demand shocks shape both uncovered and covered interest parity (UIP and CIP) deviations: they leave interest rate differentials largely unchanged, so ex-post UIP deviations closely track the exchange rate response, and they shift forward premia, giving rise to fluctuations in CIP deviations.

Examining the dynamics, the exchange rate impact is relatively short-lived, remaining significant for roughly two quarters. Robustness checks confirm the main results: they are not altered in a meaningful way when excluding mutual funds that employ FX hedging strategies and insensitive to alternative controls, but they vary importantly with the exchange rate regime.

To interpret these empirical findings and shed light on the underlying mechanisms, the final section develops a quantitative small open economy model with currency demand shocks and segmented FX markets characterized by limited risk-bearing capacity and balance sheet constraints. These frictions give rise to both UIP and CIP deviations. The model reproduces the state dependence observed in the data, with FX market depth varying systematically with conditional exchange rate volatility and the direction of flows, and it matches the quantitative magnitude of the exchange rate responses.

**Contribution** This paper makes three main contributions to the literature. First, by exploiting security-level holdings of globally diversified mutual funds, it measures bilateral currency demand shifts for a wide range of currencies spanning both advanced and emerging market economies. While this data have been used to study other questions in international finance, they have not previously been applied to identify the causal impact of currency demand flows on exchange rates.[1] This is important because existing studies typically focus on either AE or EM currencies and rely on different data sources, frequencies, and methodologies, making quantitative comparisons difficult. Second, the paper provides new evidence that FX market depth is state dependent, varying systematically with expected volatility and the direction of flows. Third, it proposes a quantitative structural model with a state-dependent portfolio balance channel that rationalizes these empirical findings.

**Related Literature** This paper relates to several strands of research. It connects first to the order flow literature, which shows that trades in FX markets transmit information and influence prices. Evans & Lyons (2002) use high-frequency interdealer data to document a strong contemporaneous link between order flow and exchange rates, while Mancini et al.

[1] See Related Literature below.

(2013) analyze liquidity commonality and risk premia across currency pairs. Both emphasize short-term dynamics in interdealer markets, whereas this analysis focuses on quarterly shifts in currency demand driven by mutual funds' rebalancing. It is therefore closely tied to work on portfolio rebalancing and cross-border capital flows. Hau & Rey (2006) and Camanho et al. (2022) show how equity market movements and global rebalancing shape exchange rates through equity flows in advanced economies. Although the empirical strategy is closely related to Camanho et al. (2022), this paper takes a different perspective by analyzing how international capital flows across asset classes affect exchange rates in both advanced and emerging economies. This also differentiates the paper from Raddatz et al. (2017) and Beltran & He (2024), who emphasize benchmark-driven reallocations in emerging market equity and debt, respectively. Another related body of work studies foreign exchange interventions, an important form of international capital flow with direct policy relevance. Fatum & M. Hutchison (2003) and Hertrich & Nathan (2023) find significant short-run effects on the exchange rate in AE currency markets using daily event study approaches, while Adler et al. (2019), Fratzscher et al. (2019) and Blanchard et al. (2015) document effectiveness in broader cross-country panels at lower frequencies, with results that vary systematically across currencies and policy regimes. Beyond the empirical literature, several theoretical contributions conceptualize the portfolio balance channel in FX markets, from Kouri (1976) to more recent frameworks such as Bacchetta & Van Wincoop (2006), Gabaix & Maggiori (2015), and Itskhoki & Mukhin (2021, 2023). Methodologically, this paper adopts the granular instrumental variable approach of Gabaix & Koijen (2024), which has been applied to portfolio rebalancing and exchange rates (Camanho et al., 2022), to credit risk (Galaasen et al., 2020), and to corporate leverage and monetary transmission (Holm-Hadulla & Thürwächter, 2024). Finally, the mutual fund holdings data used in this paper has also been employed to study a range of other questions in international finance, including the role of international currencies (Maggiori et al., 2019, 2020; Lilley et al., 2022) and tax havens (Coppola et al., 2021), the internationalization of Chinese bond markets (Clayton et al., 2025), an empirical decomposition of equity price growth rates (Rey et al., 2024), and the global safe-haven role of US equities (Chen et al., 2025).

**Outline** The remainder of the paper is structured as follows. Section 2 presents a simple framework to guide the empirical estimation and outlines the identification. Section 3 describes the data, defines the rebalancing measure, and details the implementation of the granular IV approach. Section 4 reports the main results, starting with contemporaneous effects and then turning to dynamics and robustness checks. Section 5 rationalizes the empirical findings within a quantitative structural model. Section 6 concludes by summarizing the key contributions and discussing promising avenues for future research.

# 2 Theory and Identification

In a frictionless FX market, many participants can trade freely across currencies, so demand shocks are absorbed without affecting prices. In reality, FX markets are segmented: most end users of foreign currency—such as asset managers, corporations, and households—do not trade directly with each other but instead transact through a relatively small set of FX dealers. These dealers, referred to here as intermediaries, stand between buyers and sellers and take positions onto their own balance sheets. Because holding an open currency position exposes them to exchange rate volatility, intermediaries require compensation to bear that risk. Mutual funds interact with these intermediaries whenever they adjust their net positions across currencies, regardless of the asset class involved. In such a market structure, even modest shifts in demand can move exchange rates. The magnitude of this price impact depends on intermediaries' risk aversion and the perceived riskiness of the currency. The empirical goal of this paper is to estimate this market depth using bilateral mutual fund flow data and exogenous variation in currency demand.

To formalize this idea, consider a stylized model of FX market segmentation following Bacchetta & Van Wincoop (2006). There are overlapping generations of intermediaries that live for two periods and make only one investment decision. At time $t$, they intermediate by taking on a long (short) position in foreign currency and an offsetting short (long) position in domestic currency. Their profits at time $t+1$ are $\pi_{t+1} = (\Delta s_{t+1} + i_t^* - i_t)b_t$ where $b_t$ is the foreign currency position, $\Delta s_{t+1}$ is the log change of the exchange rate, defined as the domestic currency price of foreign currency, and $i_t^*$ and $i_t$ are the foreign and domestic interest rates, respectively. The excess return of foreign currency then is $er_{t+1} = \Delta s_{t+1} + i_t^* - i_t$. Intermediaries have constant absolute risk aversion (CARA) preferences, so their problem is

$$\max_{b_t} -\mathbb{E}_t \left[ e^{-\omega \pi_{t+1}} \right]$$

subject to $\pi_{t+1}$ as above. Assuming conditional normality $er_{t+1}|\mathcal{F}_t \sim N\left(\mu_t, \sigma_t^2\right)$ where $\mathcal{F}_t$ denotes the information set available at time $t$, this problem yields a modified UIP condition of the form

$$\mathbb{E}_t \left[\Delta s_{t+1}\right] + i_t^* - i_t = \omega \sigma_t^2 b_t. \tag{1}$$

where $\sigma_t^2 = var_t(\Delta s_{t+1})$ is defined as the conditional exchange rate volatility. The term $\omega \sigma_t^2$ measures the extent to which intermediation gives rise to endogenous deviations from UIP and is the focus of the estimation. It consists of the intermediaries' risk aversion parameter $\omega$ and a (possibly) state-dependent component, namely the conditional exchange rate volatility $\sigma_t^2$.

Intermediaries accommodate currency demand from mutual funds $m_t$ and a residual currency demand by other institutional or individual investors $\varepsilon_t$ such that the market clearing condition can be written as

$$b_t - b_{t-1} = m_t + \varepsilon_t, \tag{2}$$

where both $m_t$ and $\varepsilon_t$ are expressed as flows. The mutual funds' aggregate currency demand can be further decomposed into

$$m_t = \eta_t + u_t, \tag{3}$$

where $\eta_t$ denotes the common factor and $u_t$ is the idiosyncratic factor. The common factor $\eta_t$ is the market-wide component of mutual fund flows that moves in the same direction across many funds and other institutional investors, typically driven by systematic shocks such as macroeconomic news, shifts in global risk sentiment, or broad benchmark rebalancing. Hence, it is correlated with the residual currency demand $\mathbb{E}[\eta_t \varepsilon_t] \neq 0$. In contrast, the idiosyncratic factor $u_t$ is the fund-specific component of aggregate currency demand, reflecting shocks unique to a given fund such as investor subscriptions or redemptions or portfolio rebalancing tied to security-specific events. It is therefore uncorrelated with the common factor and the residual currency demand of other institutional or individual investors $\mathbb{E}[\eta_t u_t] = \mathbb{E}[\varepsilon_t u_t] = 0$.

Assuming that $m_t$, $i_t$, and $i_t^*$ are observable, $\omega\sigma_t^2$ can be identified in this framework provided that the common factor $\eta_t$ can be distinguished from the idiosyncratic factor $u_t$. The next section outlines the measurement of $m_t$ using mutual fund security holdings data and applies a GIV approach, employing $u_t$ as an instrument for $m_t$ to estimate $\omega\sigma_t^2$. The identification strategy underlying this approach, along with the construction of the data is discussed in detail in the next Section 3. A full structural quantitative model that embeds these mechanisms and evaluates their implications is presented in Section 5.

# 3 Data and Empirical Strategy

This section begins by describing the security holdings data obtained from Morningstar. It then describes how mutual fund rebalancing is measured in the dataset, providing a way to capture shifts in currency demand. Finally, it details the implementation of the granular IV strategy, building on the stylized framework introduced in the previous section.

### 3.1 Data Description

The dataset covers quarterly holdings of 20,594 mutual funds from 2005:Q4 to 2024:Q4, invested in 30 currencies, comprising 16 EM and 14 AE currencies.[2] The funds are available for sale in 93 countries, and each fund's portfolio is denominated in a specific currency, referred to as the portfolio currency. The portfolio currency can be considered the fund's "home" currency, as it is used as the basis to calculate the fund's returns to investors. While the sample comprises 27 distinct portfolio currencies, more than 90% of total assets are held by funds whose portfolios are denominated in one of six major currencies: The US dollar, euro, British pound, Canadian dollar, Swedish krona, or the Swiss franc. The mutual funds are internationally invested in the sense that their holdings are denominated in at least two different currencies with a minimum portfolio weight on the currencies of 2%. Furthermore, all of the funds in the sample hold at least 1 Million USD Assets under Management (AUM). Appendix A provides details on the sample construction. Overall, the funds in the sample hold approximately 2.7 trillion USD in total assets at the end of 2024, as shown in Figure 1, with about 0.9 trillion USD denominated in external assets, defined as assets not denominated in the funds' respective portfolio currencies. Most external assets are invested in AE currencies, with the US dollar being dominant. Among EM currencies, the Chinese yuan and Indian rupee account for substantial shares.[3]

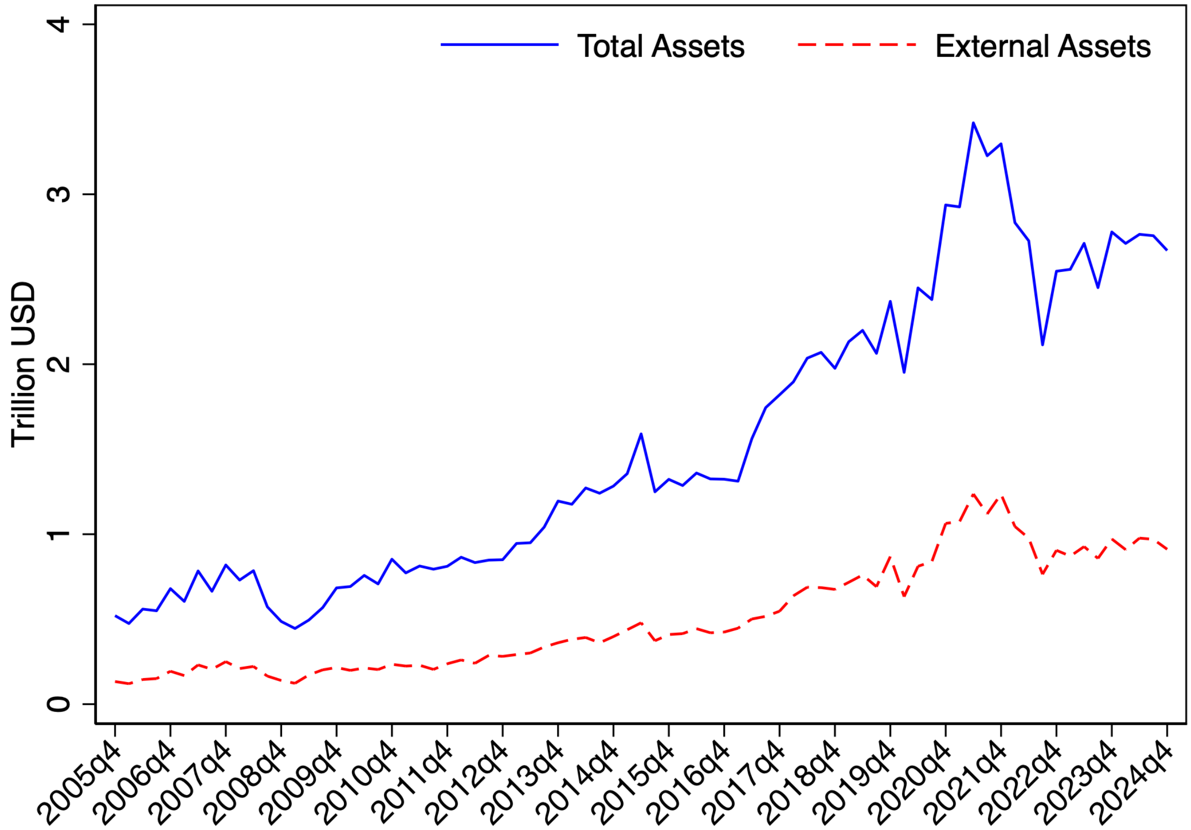
Turning from the aggregate to the fund level, Table 1 lists mutual fund characteristics. In any given quarter, the median mutual fund in the sample has 76 Million USD assets under management which are invested in three currencies. Note that the size distribution of mutual funds exhibits a long right tail, a feature that is important for the granular IV identification and will be discussed in Section 3.3. Furthermore, more than 50% of funds' holdings are held in their respective portfolio currencies on average. The holdings are spread across asset classes, with directly held equity and fixed income averaging 50% and 22%, respectively. The remainder is largely invested in other funds, with cash comprising less than 1%.

### 3.2 Rebalancing Measure

Consider fund $i \in \mathcal{I}$ that holds securities $s \in \mathcal{S}_i$ where $\mathcal{I}$ is the set of all funds and $\mathcal{S}_i$ denotes the set of securities that fund $i$ holds. For each security $s$ that fund $i$ holds at

[2]The 16 EM currencies in the sample are BRL, CLP, CNY, CZK, HUF, IDR, INR, KRW, MXN, MYR, PLN, RON, RUB, THB, TRY and ZAR. The 14 AE currencies in the sample are AUD, CAD, CHF, DKK, EUR, GBP, JPY, NOK, NZD, SEK, SGD, USD, HKD and ILS.

[3]See Figure B.1 for a decomposition of external assets by currency.




Notes: The figure shows total and external assets of the mutual funds in the sample. External assets are defined as all assets that are not denominated in the funds' portfolio currency.

Figure 1: Total and External Assets

Table 1: Mutual Fund Characteristics

| | N | Mean | SD | Min | p25 | p50 | p75 | Max |
|---|---|---|---|---|---|---|---|---|
| AUM (Mil USD) | 323976 | 362.16 | 1252.23 | 1.00 | 21.49 | 76.26 | 272.90 | 149359.70 |
| Currencies held | 323976 | 3.32 | 1.74 | 2.00 | 2.00 | 3.00 | 4.00 | 19.00 |
| Home Currency Share | 323976 | 55.38 | 33.83 | 0.00 | 23.80 | 63.22 | 86.50 | 98.00 |
| Equity Share | 323976 | 50.45 | 46.46 | 0.00 | 0.00 | 56.51 | 100.00 | 100.00 |
| Fixed Income Share | 323976 | 21.62 | 37.05 | 0.00 | 0.00 | 0.00 | 26.36 | 100.00 |
| Cash Share | 323976 | 0.59 | 3.76 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |
| Fund of Funds Share | 323976 | 26.80 | 40.84 | 0.00 | 0.00 | 0.00 | 60.94 | 100.00 |
| Other Investments Share | 323976 | 0.54 | 4.06 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |

Notes: Observations are at the fund–quarter level. AUM stands for (total) assets under management and the shares are expressed in percent. The Home Currency Share is computed as the share of assets denominated in the funds' respective portfolio currencies. Other Investments primarily include alternatives and commodities.

time $t$, the quantity is denoted by $Q_{i,s,t}$ and the price by $P_{s,t}$. Furthermore, each security $s$ is denominated in a currency $c \in \mathcal{C}$. In particular, we can decompose $\mathcal{S}_i$ into subsets of securities $\mathcal{S}_{i,c}$ denominated in a specific currency $c$. Then, we can define the assets under management (AUM) of fund $i$ in currency $c$ as $W_{i,c,t} = \sum_{s\in\mathcal{S}_{i,c}} P_{s,t}Q_{i,s,t}$ while the total AUM of fund $i$ is given by $W_{i,t} = \sum_{s\in\mathcal{S}_i} P_{s,t}Q_{i,s,t}$. Now, we can define the weight of currency $c$ in the portfolio of fund $i$ at time $t$ as:

$$\omega_{i,c,t} = \frac{W_{i,c,t}}{W_{i,t}} \tag{4}$$

Next, consider the buy-and-hold portfolio weight at $t$, defined as the portfolio weight computed with prices at $t$ but quantities from $t-1$. Proceeding analogously to above, the buy-and-hold portfolio weight $\tilde{\omega}_{i,c,t}$ is composed of the fund's buy-and-hold AUM in currency $c$, given by $\tilde{W}_{i,c,t} = \sum_{s\in\mathcal{S}_{i,c}} P_{s,t}Q_{i,s,t-1}$, and the total buy-and-hold AUM $\tilde{W}_{i,t} = \sum_{s\in\mathcal{S}_i} P_{s,t}Q_{i,s,t-1}$:

$$\tilde{\omega}_{i,c,t} = \frac{\tilde{W}_{i,c,t}}{\tilde{W}_{i,t}} \tag{5}$$

Note that the buy-and-hold portfolio captures the portfolio that would have prevailed if the fund didn't adjust its relative exposure to different currencies between period $t-1$ and $t$. This definition implies that the portfolio $\omega_{i,c,t}$ can still be identical to the buy-and-hold portfolio weight $\tilde{\omega}_{i,c,t}$ even if the fund has bought or sold securities between period $t-1$ and $t$. This is the case if the fund only adjusted the absolute, rather than the relative, exposure to currencies by selling or buying securities. Formally, we define the fund $i$'s adjustment in the relative exposure to currency $c$, or *rebalancing*, between period $t-1$ to $t$ as

$$m_{i,c,t} = \omega_{i,c,t} - \tilde{\omega}_{i,c,t} \tag{6}$$

This measure captures the quantity (or volume) effects as opposed to valuation (or price) effects in funds' portfolio weight changes. To emphasize this difference, portfolio weight changes, defined as

$$\Delta\omega_{i,c,t} = \omega_{i,c,t} - \omega_{i,c,t-1} \tag{7}$$

contain both quantity and valuation effects and are therefore not equal to the rebalancing measure in general i.e., $m_{i,c,t} \neq \Delta\omega_{i,c,t}$.

Each fund $i$ is denominated in a specific currency $c$, referred to as the portfolio currency.[4] Consequently, we define the set of funds with portfolio currency $c$ as $\mathcal{I}_c$. If fund $i \in \mathcal{I}_{c_A}$

[4]For the majority of funds, the portfolio currency of the fund corresponds to the local currency of the domicile of the fund e.g., the overwhelming majority of funds domiciled in the United States have USD as their portfolio currency and similarly for the eurozone and EUR. Since the relevant dimension in the analysis is the currency and the domicile of the fund does not play any role, any exceptions to this rule (e.g., USD funds domiciled in the eurozone) do not impact the methodology.

increases its exposure to currency $c_B$ (and hence $m_{i,c_B,t} > 0$), it buys currency $c_B$ and tends to sell the portfolio currency $c_A$ on a relative basis. Since the ultimate aim is to measure the exchange rate impact of rebalancing, the natural choice for the level of analysis is the currency pair $c_A/c_B$.

Next, we aggregate based on (6) to obtain a rebalancing measure at the currency pair level

$$m_{c_A/c_B,t} = \sum_{i \in \mathcal{I}_{c_A}} m_{i,c_B,t} S_{i,t-1} - \sum_{i \in \mathcal{I}_{c_B}} m_{i,c_A,t} S_{i,t-1}, \tag{8}$$

where $S_{i,t-1} = \frac{W_{i,t-1}}{\sum_{m \in \mathcal{I}_{c_A}} W_{m,t-1} + \sum_{s \in \mathcal{I}_{c_B}} W_{s,t-1}}$ measure the (lagged) relative size of fund investments. $m_{c_A/c_B,t}$ is the size-weighted average (net) rebalancing from currency $c_A$ to $c_B$. More precisely, funds increase (decrease) their exposure to currency $c_B$ relative to $c_A$ in aggregate if $m_{c_A/c_B,t} > 0$ ($m_{c_A/c_B,t} < 0$). As (8) shows, this measure consists of the size-weighted average rebalancing towards currency $c_B$ of funds with portfolio currency $c_A$, substracted by the size-weighted average rebalancing towards currency $c_A$ of funds with portfolio currency $c_B$. The corresponding unweighted average is given by

$$\overline{m}_{c_A/c_B,t} = \frac{1}{|\mathcal{I}_{c_A}|} \sum_{i \in \mathcal{I}_{c_A}} m_{i,c_B,t} - \frac{1}{|\mathcal{I}_{c_B}|} \sum_{i \in \mathcal{I}_{c_B}} m_{i,c_A,t}, \tag{9}$$

where $|\mathcal{I}|$ denotes the number of elements in set $\mathcal{I}$. Proceeding analogously, we use (7) to obtain an aggregate measure for weight changes:

$$\Delta\omega_{c_A/c_B,t} = \sum_{i \in \mathcal{I}_{c_A}} \Delta\omega_{i,c_B,t} S_{i,t-1} - \sum_{i \in \mathcal{I}_{c_B}} \Delta\omega_{i,c_A,t} S_{i,t-1}. \tag{10}$$

### 3.3 Granular IV Implementation

**Decomposition** Mutual funds' rebalancing, defined in (6), can be separated into a common and an idiosyncratic component. The common factor varies across currency pairs but is shared by all funds within a pair, while the idiosyncratic factor captures fund-specific deviations. For a fund $i$ with portfolio currency $c_A$ and investment currency $c_B$,

$$m_{i,c_A/c_B,t} = \lambda_{i,c_A/c_B,t} \eta_{c_A/c_B,t} + u_{i,c_A/c_B,t}, \tag{11}$$

where $\eta_{c_A/c_B,t}$ denotes the common factor, $u_{i,c_A/c_B,t}$ the idiosyncratic component, and $\lambda_{i,c_A/c_B,t}$ measures the exposure of fund $i$ to the common factor. The common factor captures the endogenous response of funds to past or expected exchange rate movements, while the idiosyncratic term reflects fund-specific views, strategies, or other idiosyncratic drivers of rebalancing, such as investor inflows or withdrawals.

**Homogeneous Exposure to the Common Factor** When all funds within a currency pair share the same exposure to the common factor ($\lambda_{i,c_A/c_B,t} = \lambda_{c_A/c_B,t}\ \forall i$), the granular instrument simplifies to the difference between weighted and unweighted average rebalancing

$$\begin{aligned} z_{c_A/c_B,t} &= m_{c_A/c_B,t} - \overline{m}_{c_A/c_B,t} \\ &= (\lambda_{c_A/c_B,t}\eta_{c_A/c_B,t} + u_{c_A/c_B,t}) - (\lambda_{c_A/c_B,t}\eta_{c_A/c_B,t} + \overline{u}_{c_A/c_B,t}) \\ &= u_{c_A/c_B,t} - \overline{u}_{c_A/c_B,t} = u_{c_A/c_B,t}, \end{aligned} \tag{12}$$

where $u_{c_A/c_B,t}$ is the weighted average of the idiosyncratic factor

$$u_{c_A/c_B,t} = \sum_{i \in \mathcal{I}_{c_A}} u_{i,c_B,t} S_{i,t-1} - \sum_{i \in \mathcal{I}_{c_B}} u_{i,c_A,t} S_{i,t-1}, \tag{13}$$

computed analogous to (8) and the unweighted average of the idiosyncratic factor is zero by construction ($\overline{u}_{c_A/c_B,t} = 0$). The weighted average $m_{c_A/c_B,t}$ captures aggregate rebalancing and can be similarly decomposed as $m_{c_A/c_B,t} = \lambda_{c_A/c_B,t}\eta_{c_A/c_B,t} + u_{c_A/c_B,t}$. It thus represents mutual funds' currency demand shifts and directly corresponds to (3) in the stylized framework.

**Heterogeneous Exposure to the Common Factor** When funds differ in their exposure to the common factor ($\lambda_{i,c_A/c_B,t}$ varies across $i$), the difference $m_{c_A/c_B,t} - \overline{m}_{c_A/c_B,t}$ is no longer purely idiosyncratic, as it still embeds residual common variation. To recover the truly idiosyncratic component, the common factor is first estimated under the assumption of homogeneous exposure, yielding $\hat{\eta}_{c_A/c_B,t}$. Fund-level residuals are then computed as $\hat{u}_{i,c_A/c_B,t} = m_{i,c_A/c_B,t} - \hat{\eta}_{c_A/c_B,t}$. Principal components extracted from these residuals at the currency-pair-time level capture any remaining systematic co-movement across funds. The residuals are subsequently regressed on these principal components, and the fitted residuals—now purged of heterogeneous exposure to the common factor—are aggregated according to (13) to construct the final instrument.

**Estimation Equation** The main variable of interest used as dependent variable is the log difference in the bilateral spot exchange rate of currency pair $c_A/c_B$ denoted as $\Delta e_{c_A/c_B,t}$. The exchange rate is defined as the price of one unit of currency $c_B$ in units of currency $c_A$ so that an increase (decrease) in $\Delta e_{c_A/c_B,t}$ is an appreciation (depreciation) of $c_B$ relative to $c_A$.The baseline estimation follows a standard two-stage least squares procedure. More specifically, the second stage is given by

$$\Delta e_{c_A/c_B,t} = \beta \widehat{m}_{c_A/c_B,t} + \mathbf{X}'_{c_A/c_B,t-1}\Phi + \sum_{s=1}^{4} \psi_s \Delta e_{c_A/c_B,t-s} + \alpha_{c_A/c_B} + \gamma_t + \epsilon_{c_A/c_B,t}, \tag{14}$$

where $\beta$ is the coefficient of interest and $\widehat{m}_{c_A/c_B,t}$ are the predicted values from the first stage. If $\beta > 0$, mutual funds' rebalancing from currency $c_A$ to $c_B$ causes an appreciation of currency $c_B$ relative to $c_A$ and vice versa. The specification includes four lags of the dependent variable, $\alpha_{c_A/c_B,t}$ is a currency pair fixed effect, $\gamma_t$ is a time fixed effect and $\mathbf{X}_{c_A/c_B,t}$ is a vector of controls which includes macro-financial variables. In particular, the set of controls consists of interest rate differentials at 3-month, 1-year, 5-year, and 10-year maturities, the 3-month forward premium of the exchange rate, the 3-month implied exchange rate volatility and the 3-month risk reversal which are all lagged by one period.

**Instrument Validity** A valid instrument must satisfy two conditions: exogeneity and relevance. Exogeneity requires that the instrument be uncorrelated with the error term:

$$\sum_i \mathbb{E}\left[S_{i,t-1} u_{i,c_A/c_B,t} \epsilon_{c_A/c_B,t}\right] = 0. \tag{15}$$

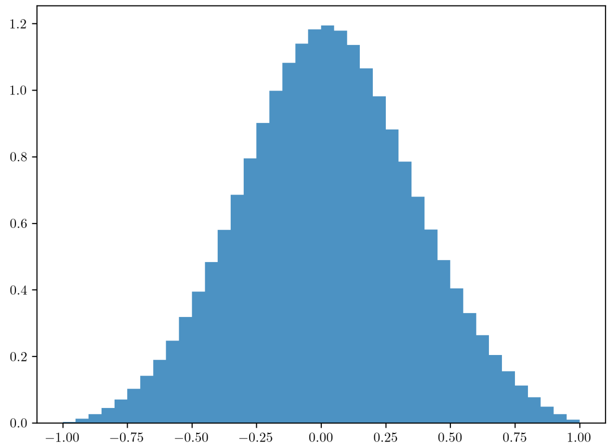
While this condition cannot be tested directly in the data, it is satisfied if either the idiosyncratic fund-specific shocks $u_{i,c_A/c_B,t}$ are randomly distributed or the fund-specific weights $S_{i,t-1}$ are randomly distributed. In either case, exogeneity holds. The decomposition into a common and an idiosyncratic factor, together with the additional principal components analysis, is designed to achieve the former by isolating the random component of fund-level shocks. Diagnostic checks indicate that the estimated idiosyncratic shocks are neither correlated across funds within a currency pair nor serially correlated over time. Regarding the distribution of the fund-specific weights $S_{i,t-1}$, their lagged nature makes them less likely to be correlated with contemporaneous shocks, a pattern supported by the data. Figure 2 shows the distributions of these correlations.[5]

Relevance, in turn, requires that the instrument be correlated with the endogenous regressor

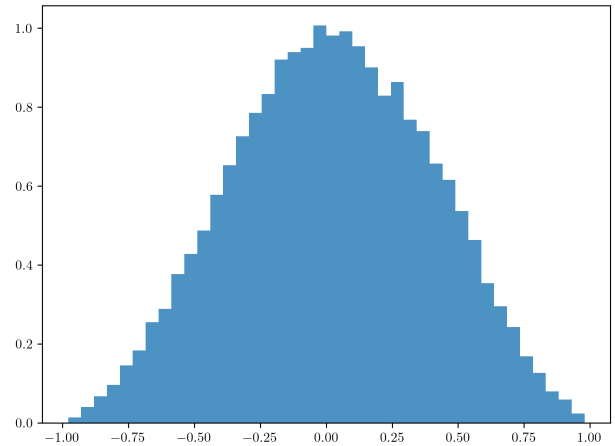
$$\sum_i \mathbb{E}\left[S_{i,t-1} u_{i,c_A/c_B,t} m_{c_A/c_B,t}\right] \neq 0, \tag{16}$$

which holds when the weighted idiosyncratic component contributes meaningfully to aggregate rebalancing. The definition (12) clarifies that the granular IV $z_{c_A/c_B,t}$ relies on (i) the

[5] The average pairwise correlation of the idiosyncratic factors is 0.0269, the average correlation of idiosyncratic factors with weights is 0.0227, and the average fund-specific autocorrelation is 0.0638.



(a) Pairwise Correlation



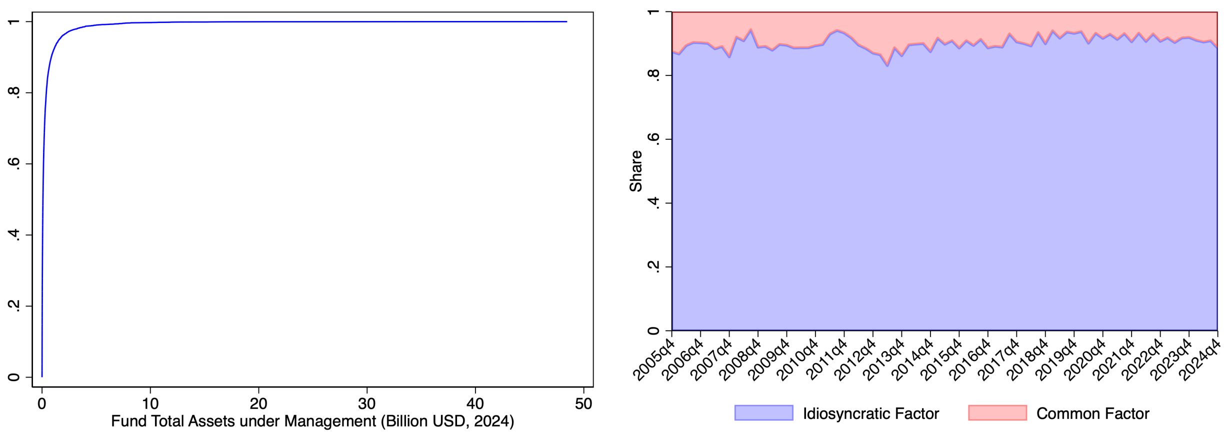
(b) Correlation with Weights

Notes: Figure 2a shows the distribution of pairwise correlations of the estimated idiosyncratic factors $u_{i,c_A/c_B,t}$. Correlations have been calculated between funds within a given currency pair. Figure 2b shows the distribution of correlations of the estimated idiosyncratic factors $u_{i,c_A/c_B,t}$ with the weights $S_{i,t-1}$ on a currency-pair-fund level. To calculate the correlations in both figures, the sample has been restricted to funds with at least eight observations.

Figure 2: Correlations of Fund-Level Idiosyncratic Factors

weighted idiosyncratic factor being different from zero (i.e., the distribution of fund size is asymmetric) and (ii) the idiosyncratic factor constitutes a sufficiently strong driver of rebalancing on a fund level. A striking feature of the mutual funds in the sample is the fat right tail in the distribution of their size (as measured by AUM) indicating that condition (i) is satisified. This attribute is emphasized in Figure 3a which shows the empirical distribution of funds' assets under management at the end of 2024. Furthermore, condition (ii) is addressed in Figure 3b. It depicts the $R^2$ over time of a regression of rebalancing on its common and idiosyncratic factor on a fund level following the decomposition defined in (11) under the assumption of homogeneous exposure to the common factor. The plot shows that the common and idiosyncratic factor are relatively stable over the sample period, explaining around 10% and 90% of rebalancing, respectively. Finally, the Montiel–Pflueger $F$-statistic reported in Section 4 provides a formal measure of instrument strength in the first stage, quantifying the extent to which the relevance condition is met.

Table 2 lists summary statistics of the key variables in the final data set which are measured on a currency pair level at a quarterly frequency. Measured in dollar amounts, the rebalancing measure has a standard deviation of 506 Million USD over the sample period which is around 2.5% of the average portfolio as measured by $m_{c_A/c_B,t}$. The granular IV is characterized by less variation with a standard deviation of 1.5% while the weight changes $\Delta\omega_{c_A/c_B,t}$ which




(a) Fund Size Distribution (CDF)

(b) Rebalancing Components

Notes: Figure 3a shows the empirical cumulative distribution function of the funds' total assets under management at the end of 2024. Figure 3b depicts the decomposition of funds' rebalancing into the common and idiosyncratic factor as defined in (11) under the assumption of homogeneous exposure to the common factor. The depicted share of the common and idiosyncratic factor corresponds the $R^2$ of a regression of funds' rebalancing $m_{i,c_A/c_B,t}$ on fixed effects $\eta_{c_A/c_B,t}$ and residuals $u_{i,c_A/c_B,t}$ separately.

Figure 3: Fund Size Distribution and Rebalancing Decomposition

Table 2: Summary Statistics

| | N | Mean | SD | Min | p25 | p50 | p75 | Max |
|---|---|---|---|---|---|---|---|---|
| Rebalancing (Mil USD) | 13105 | -34.88 | 505.77 | -13581.01 | -6.93 | -0.02 | 5.16 | 3512.60 |
| Rebalancing $m_{c_A/c_B,t}$ | 13105 | 0.08 | 2.54 | -32.25 | -0.65 | -0.02 | 0.64 | 37.68 |
| Granular IV $z_{c_A/c_B,t}$ | 13105 | -0.01 | 1.47 | -21.07 | -0.36 | 0.00 | 0.40 | 15.42 |
| Weight Change $\Delta\omega_{c_A/c_B,t}$ | 13105 | 0.16 | 3.26 | -45.95 | -0.79 | -0.03 | 0.78 | 60.39 |
| Spot Rate Change $\Delta e_{c_A/c_B,t}$ | 13105 | -0.14 | 5.20 | -44.42 | -2.87 | -0.10 | 2.56 | 46.33 |

Notes: Observations are at the currency pair–quarter level. The listed variables $m_{c_A/c_B,t}$, $z_{c_A/c_B,t}$, $\Delta\omega_{c_A/c_B,t}$ and $\Delta e_{c_A/c_B,t}$ are expressed in percent.

are additionally driven by valuation effects are more volatile with a standard deviation of 3.3%. Finally, the volatility of the spot exchange rates included in the sample amounts to 5.2%.

# 4 Results

This section presents the main empirical findings. It begins with contemporaneous effects, showing how mutual fund rebalancing flows translate into immediate exchange rate movements and documenting heterogeneity across advanced and emerging market currencies, as well as clear state dependence. The analysis then turns to dynamic responses, using local projections to assess the persistence of flow-induced exchange rate changes. Finally, a set of robustness checks demonstrates that the results are not driven by hedging behavior, remain stable across alternative control specifications, and vary systematically with the exchange rate regime.

## 4.1 Contemporaneous Effects

Baseline results are presented in Table 3. Column (1) reports an OLS regression using weight changes $\Delta\omega_{c_A/c_B,t}$ as the explanatory variable. The coefficient is positive and statistically significant. However, since $\Delta\omega_{c_A/c_B,t}$ reflects both rebalancing and valuation effects, the estimate may partly capture a mechanical relationship arising from the co-movement of portfolio weights with valuation changes. Column (2) addresses this by using the rebalancing measure $m_{c_A/c_B,t}$, which excludes valuation effects. The coefficient indeed drops substantially and becomes statistically insignificant. Column (3) reports the 2SLS estimates, where $m_{c_A/c_B,t}$ is instrumented with $z_{c_A/c_B,t}$ according to the second-stage specification in (14). The resulting GIV estimate reveals a large and highly significant coefficient: FX purchases (sales) lead to appreciations (depreciations) of the corresponding currency. The coefficient is rescaled to yield a more easily interpretable measure:

$$\Gamma = \frac{\beta}{100\phi}, \tag{17}$$

where $\phi$ denotes the average AUM-to-GDP ratio and is computed as

$$\phi = \frac{1}{|\mathcal{N}|} \sum_{(c_A,c_B,t)\in\mathcal{N}} \frac{W_{c_A,c_B,t}}{\min\big(Y_{c_A,t},\, Y_{c_B,t}\big)},$$

where $\mathcal{N}$ denotes the set of all currency-pair–time observations, $W_{c_A,c_B,t}$ are the total AUM in the sample associated with currency pair $c_A/c_B$ at time $t$ and $Y_{c,t}$ is the nominal annualized GDP of currency area $c$ at time $t$. Accordingly, the estimate in column (3) implies that a rebalancing flow equivalent to 1% of annual GDP (of the smaller currency region) leads to an exchange rate movement of approximately 0.16%.[6] The Montiel-Pflueger $F$-statistic confirms a strong first stage.[7] Finally, column (4) adds macro-financial controls, and column (5) additionally allows for heterogeneous exposure to the common factor by extracting the first five principal components of the rebalancing residual.[8] Both modifications change the results only in a minor way.

Table 3: Baseline

| | (1) OLS | (2) OLS | (3) GIV | (4) GIV | (5) GIV |
|---|---|---|---|---|---|
| Weight Changes $\Delta\omega_{c_A/c_B,t}$ | 0.127*** | | | | |
| | [0.040] | | | | |
| Rebalancing $m_{c_A/c_B,t}$ | | -0.017 | 0.337*** | 0.334*** | 0.348** |
| | | [0.039] | [0.118] | [0.117] | [0.139] |
| Observations | 10148 | 10148 | 10148 | 10148 | 10148 |
| Adjusted $R^2$ | 0.053 | 0.050 | 0.033 | 0.046 | 0.045 |
| Scaled Coefficient $\Gamma$ | | | 0.164 | 0.163 | 0.169 |
| Montiel–Pflueger $F$-stat. | | | 50.051 | 50.544 | 37.439 |
| Macro-financial Controls | | | | ✓ | ✓ |
| PC Controls | | | | | ✓ |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, and include four lags of the dependent variable. The macro-financial controls include lagged interest rate differentials at 3-month, 1-year, 5-year, and 10-year maturities, the 3-month forward premium of the exchange rate, the 3-month implied exchange rate volatility and the 3-month risk reversal. PC controls extract the first five principal components of the rebalancing residual to allow for heterogeneous exposure to the common factor as explained in Section 3.3.

The baseline results in Table 3, while informative, mask substantial heterogeneity due to their pooled nature. To address this, Table 4 reports granular IV estimates across subsamples. A first distinction is made between AE and EM currency pairs.[9] For both groups, the effect of rebalancing is positive and statistically significant. The only caveat is that, for AE currencies, the Montiel–Pflueger $F$-statistic is marginally below the 10% threshold of 23.1. While the coefficient for EMs is only slightly higher than for AEs, this difference is magnified for the implied inverse elasticity $\Gamma$, reflecting the lower average scale of mutual fund holdings relative to GDP in EMs. The estimates imply that a rebalancing of 1% of annual GDP moves the exchange rate by approximately 0.09% for AE pairs and 0.78% for EM pairs.

[6] Note that the average AUM-to-GDP ratio $\phi$ is around 2% in the regression samples (3)-(5) of Table 3.

[7] In both cases (3) and (4), the null of weak instruments can be rejected at a 5% significance level and at a weak instrument threshold of $\tau = 5\%$ (Olea & Pflueger, 2013).

[8] Table B.1 reports the sensitivity of the estimates in column (5) to varying the number of principal components.

[9] A currency pair is classified as AE if both currencies are from advanced economies, and as EM if at least one is from an emerging market.

Table 4: Granular IV – Currencies and States

| | (1) EM | (2) AE | (3) High Vol | (4) Low Vol | (5) Outflows | (6) Inflows |
|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.363** | 0.303* | 0.624*** | 0.063 | 0.408*** | 0.304** |
| | [0.143] | [0.158] | [0.186] | [0.082] | [0.154] | [0.120] |
| Observations | 6109 | 5178 | 5222 | 6051 | 6477 | 4782 |
| Adjusted $R^2$ | 0.064 | 0.035 | 0.056 | 0.110 | 0.073 | 0.055 |
| Scaled Coefficient $\Gamma$ | 0.780 | 0.087 | 0.323 | 0.035 | 0.229 | 0.156 |
| Montiel–Pflueger $F$-stat. | 34.848 | 21.217 | 36.894 | 36.316 | 50.287 | 47.065 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable.

The exchange rate response is further examined across different states of the economy. For each currency pair, observations are classified as high or low expected volatility depending on whether implied exchange rate volatility is above or below its median over the sample period. Columns (3) and (4) of Table 4 report the corresponding results. FX markets appear considerably shallower during periods of high expected volatility. The estimated coefficient is larger and highly significant in high-volatility states, whereas in low-volatility states it is statistically insignificant and close to zero. An additional distinction is made between outflows and inflows. An observation is classified as an outflow whenever the currency with the smaller (lagged) total amount of mututal fund investments experiences a rebalancing away from its currency ($m_{c_A/c_B,t} < 0$ and $W_{c_A,t-1} > W_{c_B,t-1}$). Conversely, it is classified as an inflow when the same currency experiences rebalancing towards it ($m_{c_A/c_B,t} \geq 0$ and $W_{c_A,t-1} > W_{c_B,t-1}$). Note that outflows (inflows) are defined as negative (positive) values of the rebalancing measure, so the interpretation of the coefficients is unchanged: a positive GIV coefficient implies that outflows lead to an exchange rate depreciation, while inflows lead to an appreciation. As in high-volatility episodes, the exchange rate effect increases during outflows, though to a lesser extent (column 5). In contrast, the effect is rather muted during inflows but remains significant (column 6).

Table 5 shows that the state-dependent effects generally also hold when focusing exclusively on EM currencies, although two points deserve mention. First, in column (2), the Montiel–Pflueger $F$-statistic for high-volatility periods falls just below the 10% threshold, indicating a relatively weak first stage. Second, while the coefficients in columns (4) and (5) are nearly identical, the scaled coefficient $\Gamma$ differs substantially, consistent with the pattern observed in Table 4. For AE currencies (Table 6), the results are directionally similar across

Table 5: Granular IV – States for EM Currencies

| | (1) All | (2) High Vol | (3) Low Vol | (4) Outflows | (5) Inflows |
|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.363** | 0.947*** | 0.019 | 0.376** | 0.379** |
| | [0.143] | [0.281] | [0.085] | [0.167] | [0.186] |
| Observations | 6109 | 2653 | 3442 | 3722 | 2365 |
| Adjusted $R^2$ | 0.064 | 0.041 | 0.143 | 0.095 | 0.089 |
| Scaled Coefficient $\Gamma$ | 0.780 | 1.856 | 0.044 | 1.159 | 0.548 |
| Montiel–Pflueger $F$-stat. | 34.848 | 18.586 | 38.624 | 54.643 | 57.256 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable.

Table 6: Granular IV – States for AE Currencies

| | (1) All | (2) High Vol | (3) Low Vol | (4) Outflows | (5) Inflows |
|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.303* | 0.376** | 0.286 | 0.543 | 0.218 |
| | [0.158] | [0.165] | [0.255] | [0.387] | [0.147] |
| Observations | 5178 | 2566 | 2607 | 2755 | 2417 |
| Adjusted $R^2$ | 0.035 | 0.045 | 0.054 | 0.029 | 0.054 |
| Scaled Coefficient $\Gamma$ | 0.087 | 0.111 | 0.080 | 0.145 | 0.068 |
| Montiel–Pflueger $F$-stat. | 21.217 | 44.540 | 5.577 | 7.620 | 14.769 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable.

volatility regimes, although less pronounced (columns 2 and 3). By contrast, the pattern disappears when comparing outflows to inflows (columns 4 and 5).

Table 7: Granular IV – Effect on 3-Month Interest Rate Differentials

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.004 | 0.007 | -0.006 | 0.022 | -0.003 | 0.004 | -0.009 |
| | [0.011] | [0.015] | [0.012] | [0.020] | [0.011] | [0.020] | [0.015] |
| Observations | 11062 | 5965 | 5097 | 5176 | 5872 | 6369 | 4667 |
| Adjusted $R^2$ | 0.961 | 0.963 | 0.927 | 0.954 | 0.971 | 0.958 | 0.968 |
| Montiel–Pflueger $F$-stat. | 51.651 | 34.336 | 22.413 | 37.448 | 35.255 | 49.013 | 50.687 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the interest rate differential at a 3-month maturity $\Delta i_{c_A/c_B,3M,t} = i_{c_B,3M,t} - i_{c_A,3M,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls (excluding interest rate differentials) and four lags of the dependent variable.

**UIP Deviations** The analysis thus far has focused on the effect of identified currency demand shocks on the spot exchange rate. If these effects operate through a portfolio balance channel, the resulting exchange rate movements should translate approximately one-for-one into UIP deviations, since interest rate differentials are not directly affected by the shocks. To test this implication, regressions analogous to the ones above are estimated with the interest rate differentials and ex-post UIP deviations, rather than the exchange rate change, as the dependent variable.[10] The interest rate differentials are defined as $\Delta i_{c_A/c_B,l,t} = i_{c_B,l,t} - i_{c_A,l,t}$ where $l$ denotes the maturity and the ex-post UIP deviations are computed as

$$UIP_{c_A/c_B,l,t} = \Delta i_{c_A/c_B,l,t} + \Delta e_{c_A/c_B,t}.$$

The results, reported in Table 7, confirm that mutual funds' rebalancing has no significant impact on interest rate differentials. Consequently, the estimated effects on ex-post UIP deviations, shown in Table 8, closely track those found for exchange rates. Note that the interest rate differentials and ex-post UIP deviations reported here are based on a three-month maturity ($l = 3$M), while results for longer maturities are provided in Appendix B in Tables B.4–B.9.

**CIP Deviations** A further extension of the analysis examines how currency demand shocks affect forward exchange rates. Define the 3-month CIP deviation as

$$CIP_{c_A/c_B,3M,t} = \Delta i_{c_A/c_B,3M,t} - \rho_{c_A/c_B,t},$$

[10]Therefore, interest rate differentials are excluded from the macro-financial controls.

Table 8: Granular IV – Effect on 3-Month UIP Deviations

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.332*** | 0.353** | 0.283* | 0.650*** | 0.064 | 0.400** | 0.309** |
| | [0.124] | [0.160] | [0.154] | [0.206] | [0.088] | [0.175] | [0.124] |
| Observations | 11062 | 5965 | 5097 | 5176 | 5872 | 6369 | 4667 |
| Adjusted $R^2$ | 0.249 | 0.315 | 0.083 | 0.161 | 0.410 | 0.269 | 0.242 |
| Montiel–Pflueger $F$-stat. | 52.118 | 34.281 | 22.878 | 37.956 | 35.467 | 49.585 | 50.372 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the ex-post UIP deviation at a 3-month horizon $UIP_{c_A/c_B,3M,t} = \Delta e_{c_A/c_B,t} + \Delta i_{c_A/c_B,3M,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls (excluding interest rate differentials) and four lags of the dependent variable.

Table 9: Granular IV – Effect on Forward Premium and 3-Month CIP Deviations

| | Forward Premium | | | CIP Deviation | | |
|---|---|---|---|---|---|---|
| | (1) All | (2) EM | (3) AE | (4) All | (5) EM | (6) AE |
| Rebalancing $m_{c_A/c_B,t}$ | -0.062* | -0.086* | -0.008 | 0.058* | 0.088* | -0.002 |
| | [0.035] | [0.051] | [0.012] | [0.033] | [0.051] | [0.013] |
| Observations | 11287 | 6109 | 5178 | 11062 | 6016 | 5097 |
| Adjusted $R^2$ | 0.875 | 0.870 | 0.932 | 0.640 | 0.630 | 0.764 |
| Montiel–Pflueger $F$-stat. | 51.608 | 34.916 | 20.922 | 52.087 | 35.119 | 22.073 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the forward premium $\rho_{c_A/c_B,t}$ in the regressions listed in columns (1)–(3) and the CIP deviation $CIP_{c_A/c_B,3M,t}$ in columns (4)–(6). All regressions control for currency pair and time fixed effects, four lags of the dependent variable, lagged implied exchange rate volatility and lagged implied risk reversal. The regressions in columns (1)–(3) additionally include lagged interest rate differentials as controls.

where $\rho_{c_A/c_B,t}$ is the market-implied forward premium for hedging currency $c_B$ against $c_A$, i.e., buying $c_A$ and selling $c_B$ forward.[11] A positive value of $CIP_{c_A/c_B,3M,t}$ implies a potential risk-free arbitrage opportunity: a hypothetical investor could earn a risk-free profit by taking a long position in $c_B$ and a corresponding hedged position in $c_A$. Because forward pricing reflects supply and demand conditions in spot markets, and the results above show that currency demand shocks move spot exchange rates, such shocks may also affect forward markets.[12] To test this, Table 9 reports granular IV estimates using the forward premium (columns 1–3) and the CIP deviation (columns 4–6) as dependent variables. The results show that currency demand flows reduce the forward premium (i.e., they appreciate $c_B$ relative to $c_A$ in forward markets), which translates into a positive effect on CIP deviations. Breaking the results down by currency type further reveals that this effect is statistically significant only for EM currencies and insignificant for AE currencies.

## 4.2 Dynamic Effects

Moving beyond contemporaneous effects, this section considers varying time horizons $h$ to estimate local projections (Jordà, 2005) of the form

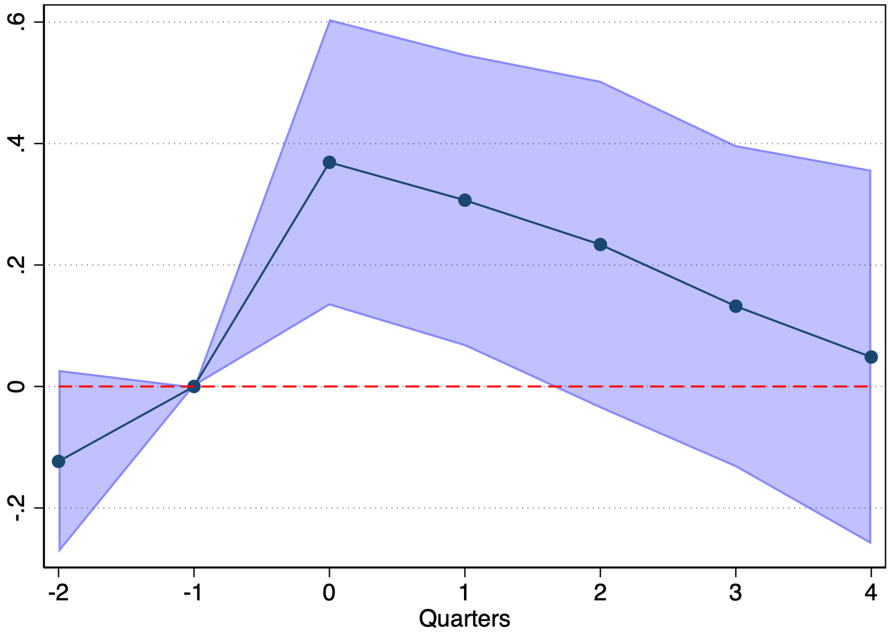
$$\Delta e_{c_A/c_B,t+h} = \beta_h \widehat{m}_{c_A/c_B,t+h} + \alpha_{c_A/c_B,h} + \gamma_{t,h} + \mathbf{X}'_{c_A/c_B,t-2}\Phi + \sum_{s=2}^{4} \psi_s \Delta e_{c_A/c_B,t-s} + \varepsilon_{c_A/c_B,t,h}, \quad (18)$$

where $\Delta e_{c_A/c_B,t+h} = e_{c_A/c_B,t+h} - e_{c_A/c_B,t-1}$ with time horizons $-2 \leq h \leq 4$. Note that $h = 0$ is very similar to the baseline regression in (14). In addition to this linear specification, a state-dependent version is also estimated following approaches commonly used in the empirical macroeconomics literature.[13] The corresponding specification and details are provided in Appendix B. Figure 4 presents the local projection based on the baseline linear specification in (18). The estimated effect is relatively short-lived, with statistical significance at the 5% level limited to the first two horizons $h = 0$ and $h = 1$. By horizon $h = 4$, the effect has largely dissipated and is close to zero.

[11] The forward premium is computed as $\rho_{c_A/c_B,t} = 4\left(\log\left(F_{c_A/c_B,3M,t}\right) - \log\left(S_{c_A/c_B,t}\right)\right)$, where $F_{c_A/c_B,3M,t}$ is the 3-month outright forward exchange rate of currency $c_B$ against $c_A$ at time $t$ and $S_{c_A/c_B,t}$ is the spot exchange rate at time $t$. Both forward and spot exchange rates are defined as units of currency $c_B$ per $c_A$. More details are provided in Appendix A.

[12] The underlying friction behind CIP deviations is the presence of balance sheet constraints faced by financial intermediaries (Du & Schreger, 2022), which differ from the limited risk-bearing capacity typically associated with UIP deviations. This distinction is made explicit in the quantitative model presented in Section 5.

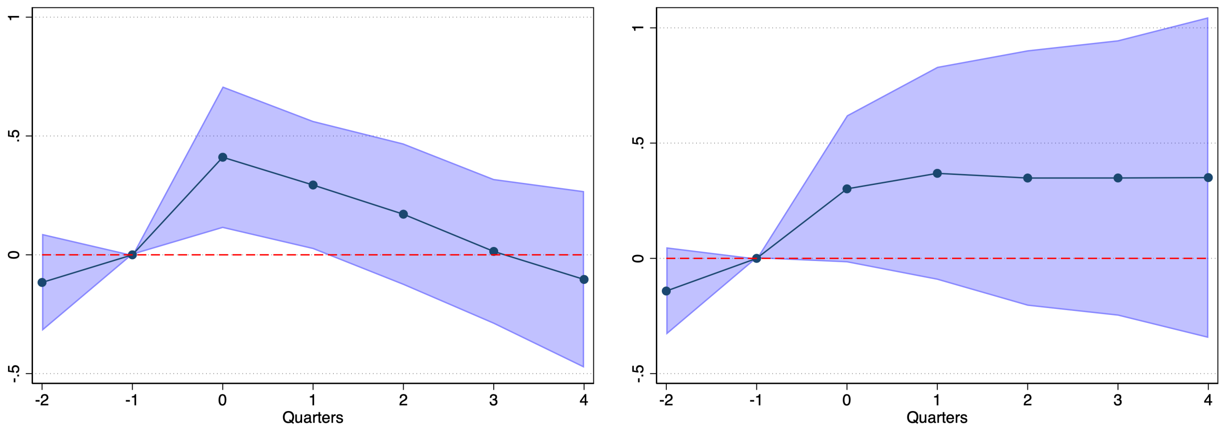
[13] See, among others, Ramey & Zubairy (2018), Auerbach & Gorodnichenko (2013), and Jordà et al. (2020) for applications, and Gonçalves et al. (2024) for an overview.




Notes: The blue area corresponds to the 95% confidence interval and is computed based on standard errors clustered by currency pair and time. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable.

Figure 4: Dynamic Exchange Rate Effects – Baseline

Figure 5 displays the dynamic responses separately for EM and AE currencies. The pattern for EM currencies closely resembles the baseline, with the main difference being a stronger contemporaneous effect at horizon $h = 0$, which then dissipates more rapidly. For AE currencies, the exchange rate response appears slightly more persistent, although the confidence intervals are wider and the effects are not statistically significant at the 5% level. Figure 6 shows the results from the state-dependent specification, using high- and low-volatility states as defined in Section 4.1. The estimates reveal a pronounced difference in exchange rate responses across the two regimes. In the high-volatility regime, the effect is statistically significant at the 5% level for two quarters and remains relatively persistent thereafter, although the significance slightly falls below the 5% threshold at longer horizons. In contrast, there is no statistically significant response in the low-volatility regime, and the confidence intervals remain relatively narrow throughout.

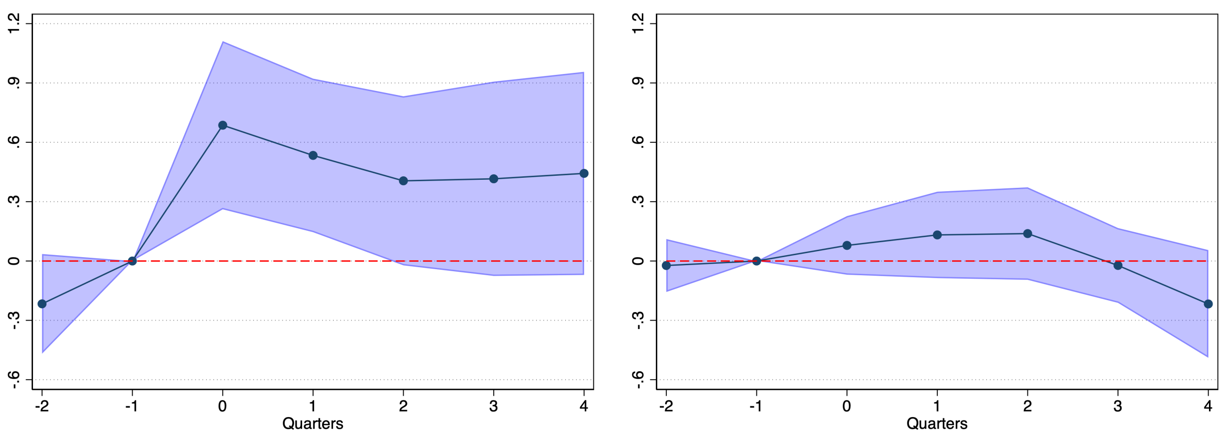



(a) EM Currencies

(b) AE Currencies

Notes: The blue area corresponds to the 95% confidence interval and is computed based on standard errors clustered by currency pair and time. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable.

Figure 5: Dynamic Exchange Rate Effects – Currency Classification




(a) High Volatility

(b) Low Volatility

Notes: The blue area corresponds to the 95% confidence interval and is computed based on standard errors clustered by currency pair and time. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable. Observations are classified as high or low volatility depending on whether implied exchange rate volatility is above or below its currency pair median over the sample period.

Figure 6: Dynamic Exchange Rate Effects – Volatility Regime

## 4.3 Robustness

**Hedging** The rebalancing measures used in the analysis above do not account for potential forward positions held by mutual funds. This raises the concern that observed rebalancing may not fully reflect changes in currency demand if mutual funds hedge their exposures through forwards. While reported holdings data generally include forward positions, information on the direction and currency composition of these positions is only partially available. As a robustness check, the sample is restricted to funds for which no FX forward positions are observed in any quarter. The remaining funds have relatively higher equity exposure, which tends to be hedged to a lesser extent than fixed income.[14] The results of the granular IV estimation on this restricted sample, shown in Table 10, indicate that the main findings are robust, with only minor quantitative changes.

Table 10: Granular IV – Unhedged Funds

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.235*** | 0.218** | 0.267** | 0.445*** | 0.072 | 0.275** | 0.194** |
| | [0.087] | [0.107] | [0.110] | [0.148] | [0.080] | [0.111] | [0.085] |
| Observations | 10674 | 5639 | 5035 | 4929 | 5731 | 6118 | 4528 |
| Adjusted $R^2$ | 0.047 | 0.061 | 0.041 | 0.071 | 0.096 | 0.062 | 0.056 |
| Scaled Coefficient $\Gamma$ | 0.120 | 0.438 | 0.075 | 0.218 | 0.038 | 0.146 | 0.094 |
| Montiel–Pflueger $F$-stat. | 55.957 | 33.252 | 35.488 | 47.307 | 40.419 | 52.802 | 83.830 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable.

**Principal Components Controls** While Table 3 reports the baseline GIV estimates including PC controls, the other regression results in Section 4.1 only include macro-financial controls. To demonstrate how the other findings change by the inclusion of PC controls, Table 11 presents GIV estimates separately for EM and AE currencies, as well as for high versus low expected volatility states and outflows versus inflows. The coefficients decline, and standard errors increase in columns (2) and (3). Although the estimates remain significant at the 10% level for EM currencies in column (2), this is no longer the case for AE currencies in column (3). By contrast, the state-dependent results along the volatility dimension (columns 4–5) and the direction of flows (columns 6–7) remain highly significant and tend to strengthen.

**No Controls** As an additional robustness check both principal components and macro-

[14] The summary statistics for these unhedged mutual funds are presented in Table B.2.

Table 11: Granular IV – With PC and Macro-Financial Controls

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.348** | 0.311* | 0.428 | 0.743*** | -0.046 | 0.576** | 0.286* |
| | [0.139] | [0.160] | [0.270] | [0.216] | [0.104] | [0.223] | [0.146] |
| Observations | 10148 | 5167 | 4981 | 4766 | 5369 | 5841 | 4289 |
| Adjusted $R^2$ | 0.045 | 0.064 | 0.027 | 0.047 | 0.091 | 0.048 | 0.058 |
| Scaled Coefficient $\Gamma$ | 0.169 | 0.576 | 0.118 | 0.351 | -0.023 | 0.292 | 0.132 |
| Montiel–Pflueger $F$-stat. | 37.439 | 23.357 | 18.316 | 33.050 | 24.791 | 26.832 | 42.148 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls, four lags of the dependent variable and the first five principal components are extracted from the rebalancing residual.

financial variables are excluded as controls from the GIV regressions. As Table 12 reveals, this change only has a minor quantitative impact on the GIV coefficients and standard errors while decreasing the $R^2$ of the regressions due to the exclusion of explanatory variables.

Table 12: Granular IV – Without PC and Macro-Financial Controls

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.340*** | 0.357** | 0.295* | 0.642*** | 0.062 | 0.397** | 0.323** |
| | [0.115] | [0.144] | [0.156] | [0.191] | [0.080] | [0.154] | [0.123] |
| Observations | 11287 | 6109 | 5178 | 5222 | 6051 | 6477 | 4782 |
| Adjusted $R^2$ | 0.036 | 0.044 | 0.025 | 0.043 | 0.081 | 0.059 | 0.041 |
| Scaled Coefficient $\Gamma$ | 0.183 | 0.767 | 0.085 | 0.332 | 0.035 | 0.223 | 0.165 |
| Montiel–Pflueger $F$-stat. | 51.232 | 34.353 | 21.141 | 37.025 | 35.695 | 49.993 | 45.601 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects and four lags of the dependent variable.

**Exchange Rate Regime** Besides the distinction between AE and EM currencies, the exchange rate regime is also an important differentiator for the FX market supply elasticity. Under a (credible) peg, mutual fund flows should generally not have a significant impact on the exchange rate. The estimated significant exchange rate effect should therefore stem from either managed or freely floating regimes. To test this thesis, we classify the exchange rates into pegs, managed floats and freely floats following the classification of Reinhart & Rogoff (2004); Ilzetzki et al. (2019). Since their classification is on a currency level, but the analysis is on a bilateral exchange rate level, the following transformation is employed: The classification of the currency pair corresponds to the stricter regime of the two currencies.[15]

[15] For example, the currency pair HKD/EUR is classified as a peg since the Hong Kong dollar is pegged

Table 13 reports the GIV estimates separately by exchange rate regime. For pegged currency pairs, the coefficients are insignificant across all specifications, consistent with limited exchange rate flexibility. For managed-float pairs, the estimated effects are positive and highly significant, indicating a strong link between currency demand shocks and exchange rate movements. Results for freely floating currencies, shown in column (4), are more mixed. The coefficients are small and insignificant in the baseline sample in Table 13a but become larger and significant when the sample is restricted to the post–global financial crisis period, beginning in 2009:Q3, and the regressions are weighted by the size of flows within currency pairs in Table 13b. These adjustments generally strengthen the results, with a particularly pronounced effect for freely floating currencies. Restricting the sample to the post-GFC period removes earlier periods that were characterized by high exchange rate volatility and relatively thin coverage in the mutual fund data, when flow sizes were small compared with later years. Weighting by flow size, in turn, assigns greater importance to observations from periods with larger cross-border fund flows. Together, these adjustments reveal a stronger and more stable relationship between currency demand shocks and exchange rate changes under freely floating regimes.

**Fund Categories** As shown in Table 1, mutual funds in the sample are heterogeneous in their investment strategies. To assess whether the documented exchange rate effects are driven by particular types of funds, the sample is split by broad categories provided by Morningstar. The two largest categories are equity and fixed income funds, accounting on average for around 55% and 21% of total assets, respectively. These two subsamples are then separately aggregated to construct distinct measures of rebalancing. Interestingly, the two measures are only weakly correlated (0.1), highlighting the different allocation strategies across currencies pursued by the two fund types. The granular IV estimates are reported in Table 14, with results for equity funds in column (2) and for fixed income funds in column (3). Currency demand flows from both types of funds lead to significant exchange rate movements, with coefficients of similar magnitude in percentage terms. However, the scaled coefficient $\Gamma$, which accounts for the size of flows, is roughly three times smaller for equity funds than for fixed income funds. As shown in Table B.10, this discrepancy is partly explained by the greater prevalence of FX hedging among fixed income funds.

to the US dollar while the euro is freely floating.

Table 13: Granular IV – Exchange Rate Regime

(a) Full Sample and Unweighted

| | (1) All | (2) Peg | (3) Managed Floating | (4) Freely Floating |
|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.338*** | 0.060 | 0.640*** | 0.268 |
| | [0.114] | [0.077] | [0.172] | [0.586] |
| Observations | 11287 | 3762 | 5775 | 1532 |
| Adjusted $R^2$ | 0.049 | 0.048 | 0.021 | 0.063 |
| ER Volatility | 5.16 | 4.18 | 5.33 | 5.58 |
| Scaled Coefficient $\Gamma$ | 0.182 | 0.029 | 0.446 | 0.083 |
| Montiel–Pflueger $F$-stat. | 51.609 | 20.288 | 51.374 | 18.699 |

(b) Post-GFC and Weighting by Flow Size

| | (1) All | (2) Peg | (3) Managed Floating | (4) Freely Floating |
|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.428*** | 0.054 | 0.757*** | 1.639** |
| | [0.151] | [0.085] | [0.274] | [0.752] |
| Observations | 10069 | 3355 | 5147 | 1362 |
| Adjusted $R^2$ | 0.065 | 0.083 | 0.061 | 0.051 |
| ER Volatility | 4.97 | 4.06 | 5.08 | 5.29 |
| Scaled Coefficient $\Gamma$ | 0.224 | 0.026 | 0.521 | 0.480 |
| Montiel–Pflueger $F$-stat. | 41.457 | 33.041 | 16.392 | 74.226 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable. Table 13b restricts the sample to periods after the end of the great financial crisis (GFC) starting in 2009:Q3 and the observations are weighted by the size of the flows as a percentage of GDP within currency pairs.

Table 14: Granular IV – Fund Categories

| | (1) All | (2) Equity | (3) Fixed Income |
|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.337*** | 0.169* | 0.131*** |
| | [0.118] | [0.086] | [0.048] |
| Observations | 10148 | 9875 | 6609 |
| Adjusted $R^2$ | 0.033 | 0.043 | 0.055 |
| Scaled Coefficient $\Gamma$ | 0.164 | 0.107 | 0.336 |
| Montiel–Pflueger $F$-stat. | 50.051 | 84.353 | 20.792 |
| Rebalancing SD | 2.31 | 2.60 | 3.31 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable.

# 5 Model

To reconcile the empirical findings, this section develops a standard small open economy model with stochastic endowments and segmented international financial markets, building on the framework of Itskhoki & Mukhin (2021, 2023). As in their setup, the international financial sector consists of two types of agents: noise traders and financiers. Noise traders generate exogenous currency demand shocks, which can be interpreted as a reduced-form representation of the idiosyncratic component of mutual funds' currency demand flows documented in the empirical analysis. Financiers intermediate funds across currencies and are risk-averse, giving rise to deviations from UIP in equilibrium as they require compensation for bearing currency risk. The key extension relative to Itskhoki & Mukhin (2021, 2023) is the introduction of balance sheet constraints in the form of exposure limits on financiers' domestic currency positions. These constraints generate CIP deviations as a distinct subset of UIP deviations, enabling the model to capture both and their interaction with currency demand shocks.

## 5.1 Outline

**Utility Function** Consider an economy that is populated by a large number of identical, infinitely-lived households with preferences described by the following utility function

$$\sum_{t=0}^{\infty} \mathbb{E}_0 \left[\beta^t u\left(C_{T,t}, C_{NT,t}\right)\right],$$

where

$$u(C_{T,t}, C_{NT,t}) = \frac{1}{1-\sigma}\left(\underbrace{\left[\alpha\left(C_{T,t}\right)^{\frac{\xi-1}{\xi}} + (1-\alpha)\left(C_{NT,t}\right)^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi}{\xi-1}}}_{C_t}\right)^{1-\sigma}.$$

Households derive utility from total consumption $C_t$ that consists of tradable goods $C_{T,t}$ and nontradable goods $C_{NT,t}$. Furthermore, $\beta \in (0,1)$ denotes the subjective discount factor, $1/\sigma$ is the intertemporal elasticity of substitution, $\xi$ is the elasticity of substitution between tradable and nontradable goods, and $\alpha \in (0,1)$ controls the share of tradables in the total consumption basket.

**Households' Budget Constraint** Each period $t$, households receive stochastic endowments of tradable and nontradable goods, denoted by $Y_{T,t}$ and $Y_{NT,t}$, respectively. The endowments are exogenous and follow a first-order Markov process i.e., $\log Y_{T,t} = \rho_T \log Y_{T,t-1}+$

$\sigma_T \epsilon_t,\ \epsilon_t \sim \mathcal{N}(0,1)$ and $\log Y_{NT,t} = \rho_{NT} \log Y_{NT,t-1} + \sigma_{NT} \varepsilon_t,\ \varepsilon_t \sim \mathcal{N}(0,1)$. Furthermore, households have access to a one period local currency bond $B_t$ that pays gross nominal interest rate $R_t$. A representative household's sequential budget constraint is then given by

$$P_{T,t} C_{T,t} + P_{NT,t} C_{NT,t} \leq P_{T,t} Y_{T,t} + P_{NT,t} Y_{NT,t} - B_t + B_{t-1} R_{t-1} + \Pi_{D,t} + \Pi_{N,t}$$

where $\Pi_{D,t}$ and $\Pi_{N,t}$ denote the profits of the financiers and noise traders, respectively. Note that this formulation of the budget constraint implies that the financial sector (i.e., financiers and noise traders) is fully domestically owned.[16]

The law of one price is assumed to hold for tradable goods, and the foreign price level is normalized to unity, implying that the price of tradables equals the nominal exchange rate, $P_{T,t} = \mathcal{E}_t$. Assuming that monetary policy fully stabilizes the price of nontradable goods, the price of nontradables is likewise normalized to unity ($P_{NT,t} = 1$), so that $\mathcal{E}_t$ can also be interpreted as the relative price of tradable goods.

**Households' Optimality** The choice of $B_t$ is characterized by the household Euler equation:

$$R_t \mathbb{E}_t \left[ \Theta_{t+1} \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} \right] = 1, \tag{19}$$

where $\Theta_{t+1}$ denotes the stochastic discount factor (SDF) of domestic households

$$\Theta_{t+1} = \beta \frac{u_1(C_{T,t+1}, C_{NT,t+1})}{u_1(C_{T,t}, C_{NT,t})} = \beta \left( \frac{C_{t+1}}{C_t} \right)^{\frac{1-\sigma\xi}{\xi}} \left( \frac{C_{T,t+1}}{C_{T,t}} \right)^{-\frac{1}{\xi}}.$$

In addition, combining the first-order conditions with respect to $C_{T,t}$ and $C_{NT,t}$ allows us to obtain the equilibrium expenditure switching condition, which pins down the exchange rate

$$\mathcal{E}_t = \frac{u_1(C_{T,t}, C_{NT,t})}{u_2(C_{T,t}, C_{NT,t})} = \frac{\alpha}{1-\alpha} \left( \frac{C_{NT,t}}{C_{T,t}} \right)^{\frac{1}{\xi}}. \tag{20}$$

**Noise Traders** In FX markets, noise traders are the source of currency demand shocks. More precisely, they hold a zero capital portfolio of foreign currency bonds $N_t^*$ and local currency bonds $N_t$ such that $N_t + \mathcal{E}_t N_t^* = 0$. They are modeled as non-optimizing agents who randomly buy (sell) foreign currency bonds $N_t^* > 0$ ($N_t^* < 0$) and sell (buy) domestic currency bonds $N_t < 0$ ($N_t > 0$). More precisely, $N_t^*$ is exogenous and follows a first-order Markov process with persistence $\rho_N$ and standard deviation $\sigma_N$ i.e., $N_t^* = \exp(n_t^*) - 1,\ n_t^* = \rho_N n_{t-1}^* + \sigma_N u_t,\ u_t \sim \mathcal{N}(0,1)$

[16] This assumption is retained for tractability and discussed below.

**Financiers** Financiers intermediate funds by holding a zero-capital portfolio $(D_t, D_t^*)$ that satisfies $D_t + \mathcal{E}_t D_t^* = 0$. They have mean-variance preferences given by

$$\mathbb{E}_t \left[ \Theta_{t+1} \tilde{R}_{t+1}^* D_t^* \right] - \frac{\omega}{2} \operatorname{var}_t \left( \tilde{R}_{t+1}^* D_t^* \right).$$

Note that the SDF of domestic households $\Theta_{t+1}$ enters the objective function of financiers and that $\omega > 0$ measures the (additional) degree of financiers' risk aversion. The constant world interest rate is denoted by $R^*$, and $\tilde{R}_{t+1}^* = R^* - R_t \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}}$ is the relative excess return on foreign bonds between $t$ and $t+1$.

Financiers face a balance sheet constraint that limits their net investment in domestic currency assets to a fixed foreign-currency amount net of noise trader positions:

$$D_t^* \geq \underline{B}^* - N_t^*. \tag{21}$$

The first-order condition with respect to $D_t^*$ then implies the following risk-augmented UIP condition:

$$R_t \, \mathbb{E}_t \left[ \Theta_{t+1} \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} \right] - R^* \, \mathbb{E}_t \left[ \Theta_{t+1} \right] = \overbrace{-\omega \sigma_t^2 D_t^* + \underbrace{\lambda_t}_{\text{CIP deviation}}}^{\text{UIP deviation}}, \tag{22}$$

where $\lambda_t$ is the Lagrange multiplier associated with the constraint (21).[17]

The ex-ante UIP deviation in (22), defined as the excess return on domestic currency assets, is driven by two components. The first depends on the amount of funds intermediated by financiers, $D_t^*$, and on FX market depth, captured by $\omega\sigma_t^2 > 0$. A larger long exposure of financiers to domestic-currency assets (i.e., a more negative $D_t^*$) increases the required excess return. Moreover, a higher (lower) value of $\omega\sigma_t^2$ corresponds to shallower (deeper) FX markets, implying greater (lower) exchange-rate sensitivity to capital flows. FX market depth is endogenously state-dependent, as it varies with the conditional exchange rate volatility $\sigma_t^2$. This component of the UIP deviation arises solely from currency risk on financiers' balance sheets and does not constitute a CIP deviation.[18]

The second component is associated with the balance sheet constraint itself. A larger long position in domestic currency assets increases the likelihood that the exposure limit $\underline{B}^*$ binds (i.e., $\lambda_t > 0$). This term is independent of risk and therefore represents a deviation from both UIP and CIP.

[17] The complementary slackness conditions are $\lambda_t \geq 0$, $D_t^* - \underline{B}^* + N_t^* \geq 0$, and $(D_t^* - \underline{B}^* + N_t^*)\lambda_t = 0$.

[18] To see this, consider the extreme case of a (credible) peg in which conditional exchange rate volatility is zero by definition i.e., $\sigma_t^2 = 0$.

**Bond Market Clearing** Overall, market clearing in the domestic bond market requires

$$B_t + N_t + D_t = 0,$$

with the net foreign asset (NFA) position in foreign currency defined as

$$B_t^* = D_t^* + N_t^*, \tag{23}$$

which implies $B_t^* = B_t/\mathcal{E}_t$, from domestic bond market clearing combined with the balance sheet equations of the financial sector.

**Resource Constraint** In equilibrium consumption of nontradable goods must equal their endowment

$$C_{NT,t} = Y_{NT,t}. \tag{24}$$

Consolidating the household's budget constraint by exploiting equation (24) and using the profits of the financial sector yields the following economy-wide resource constraint

$$B_t^* - B_{t-1}^* R^* = Y_{T,t} - C_{T,t}. \tag{25}$$

This equation implies that, at the aggregate level, the domestic economy borrows or saves in foreign currency at the world interest rate, which follows from the assumption of full domestic ownership of the financial sector. Relaxing this assumption would introduce wealth effects into the resource constraint, allowing aggregate income to vary with the profits of domestic versus foreign agents in international financial markets. Since such wealth effects are unlikely to be a primary driver of exchange rate dynamics and would add unnecessary complexity, the analysis maintains the standard assumption of full domestic ownership for tractability.

Finally, the definition of the competitive equilibrium is provided in Appendix C along with more technical details of the model.

## 5.2 Calibration

The model is calibrated at a quarterly frequency to represent an emerging market economy, as summarized in Table 15. The households' subjective discount factor is set to $\beta = 0.9767$, corresponding to an annualized value of 0.91, which is standard in the small open economy literature. The world interest rate $R^*$ is set at an annualized value of 4%, also a conventional choice. The relative risk aversion of households is $\sigma = 2$, and the weight of tradable goods in the consumption basket is $\alpha = 0.31$. The elasticity of substitution between tradable and non-tradable goods, governed by the parameter $\xi$, is set to 0.5. This value lies on the more elastic end of the range typically used in the literature and is consistent with models featuring occasionally binding constraints, such as Davis et al. (2023) and Schmitt-Grohé & Uribe (2021).

Table 15: Calibration

| Description | Value | Source/Target |
|---|---|---|
| Subjective discount factor, quarterly | $\beta = 0.9767$ | Standard value DSGE-SOE |
| World interest rate, quarterly | $R^* = 1.01$ | Standard value DSGE-SOE |
| Relative risk aversion | $\sigma = 2$ | Standard value DSGE-SOE |
| Weight on traded goods in CES aggregator | $\alpha = 0.31$ | Standard value DSGE-SOE |
| Elasticity of substitution of T-NT goods | $\xi = 0.5$ | Davis et al. (2023) |
| Financiers' balance sheet constraint | $\underline{B}^* = 0.06$ | $\sigma(CIP)/\sigma(UIP) = 0.3$ |
| Financiers' risk aversion | $\omega = 32.8$ | Baseline EM FX response |
| Persistence of currency demand shocks | $\rho_N = 0.3$ | Baseline EM FX response |
| Standard deviation of currency demand shocks | $\sigma_N = 0.2965$ | Normalization to 5% of GDP |
| Persistence of endowment shocks | $\rho_T = 0.9, \rho_{NT} = 0.9$ | Standard value DSGE-SOE |
| Standard deviation of endowment shocks | $\sigma_T = 0.0002, \sigma_{NT} = 0.0001$ | Standard value DSGE-SOE |

Turning to financiers' balance sheet constraints, the parameter $\underline{B}^*$ governs the strength of CIP deviations in the model. It is calibrated to match the standard deviation ratio of CIP to UIP deviations, which is approximately 0.3 in the sample of EM currency pairs. The financiers' risk aversion parameter $\omega$ and the persistence of currency demand shocks $\rho_N$ are chosen to match the baseline EM FX response estimated from the same sample, as reported in column (1) of Table 4 and Figure 5a. The standard deviation of currency demand shocks, $\sigma_P$, is normalized to 5% of annual GDP. Finally, the endowment shock process is set to be highly persistent, and its volatility is assumed to be larger for tradable than for non-tradable goods, such that the unconditional standard deviations are 3% and 2%, respectively. Overall, this yields an unconditional exchange rate volatility of around 6% in the model which is in line with the data.

The exogenous state variables $S = \{Y_T, Y_{NT}, N^*\}$ are discretized as a first-order Markov process with four grid points for each of the endowment processes $\{Y_T, Y_{NT}\}$ and eight grid points for the currency demand process $N^*$. The endogenous state variable $B^*$ is represented on a grid with 1,000 points. The competitive equilibrium is then computed using time iteration on the Euler equation.

## 5.3 Quantitative Analysis

The model is simulated over a long horizon (2,000,000 quarters) to conduct the quantitative analysis. The objective is to study how currency demand shocks shape exchange rate dynamics and to assess whether the model replicates the state dependence documented in the empirical analysis.

Figure 7 summarizes the simulated dynamics. Episodes of currency demand outflows (inflows) are identified from the stochastic simulation by selecting all non-overlapping 17-period windows in which the peak outflow (inflow) occurs in the middle period. Relevant macroeconomic variables are then averaged across these subsamples. Most variables are expressed as deviations from their stochastic steady state (S.S.), defined as the average over the full simulation period. The figure shows symmetric currency outflows (blue solid line) and inflows (red dotted line), each peaking at around 7.5% of annual GDP in period 0. Their effects on the economy, however, are asymmetric. During outflows, the price impact of currency flows, $\omega\sigma_t^2$, rises as conditional exchange rate volatility $\sigma_t^2$ increases, implying that FX markets become shallower. As a result, the exchange rate depreciates by roughly 7.5% at the peak of outflows. In contrast, inflows deepen FX markets and appreciate the exchange rate, but by a smaller magnitude.

Interest rate differentials $R_t - R^*$ remain unchanged in both scenarios, reflecting the assumption that monetary policy stabilizes the price of non-tradable goods (i.e., $P_{NT,t} = 1$). More precisely, variations in the domestic interest rate $R_t$ are driven by changes in non-tradable consumption, which currency demand shocks do not affect.[19] Because interest rate differentials remain stable, fluctuations in the ex-ante UIP deviation defined in (22) largely mirror the exchange rate response. Interestingly, CIP deviations move in the opposite direction, consistent with the empirical findings reported in Table 9. This pattern arises from financiers' balance sheet constraints, which act as a lower bound on the net foreign asset position in equilibrium. Combining the constraint $D_t^* \geq \underline{B}^* - N_t^*$ with the market clearing condition $B_t^* = D_t^* + N_t^*$ implies $B_t^* \geq \underline{B}^*$. During episodes of currency demand inflows, financial conditions ease as the exchange rate appreciates, encouraging households to borrow more and thereby reducing the net foreign asset position $B_t^*$. This makes it more likely that the balance sheet constraint binds, which in turn tends to increase CIP deviations. Finally, consumption rises during inflow episodes but by a smaller magnitude than it falls during outflow episodes, reflecting the asymmetric exchange rate response. Overall, the dynamics depicted in Figure 7 are qualitatively consistent with the empirical evidence.

[19]For a formal derivation, see Appendix C.

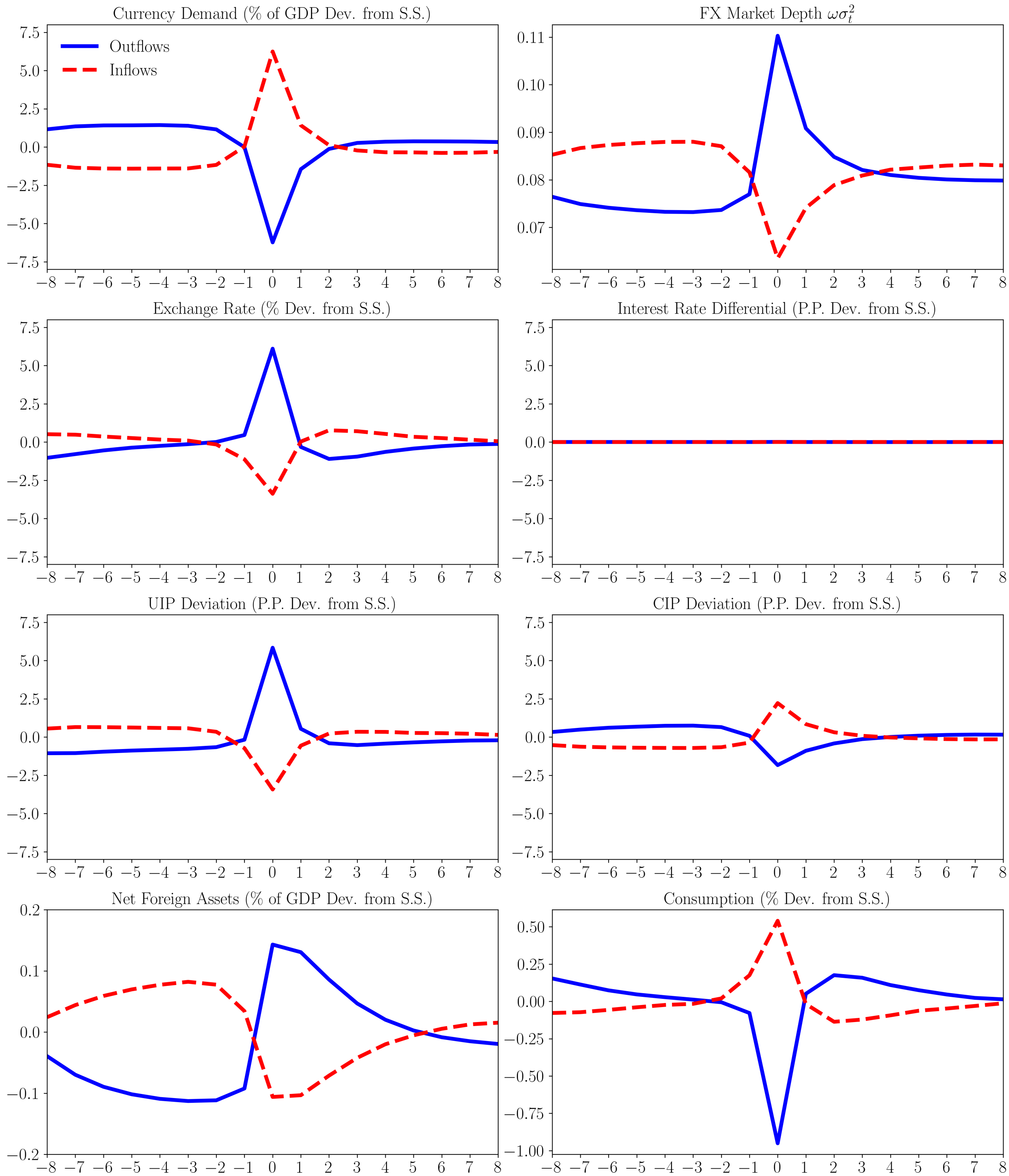



Figure 7: Model Response to Currency Demand Shocks

Notes: The figure depicts the average paths of selected variables during currency demand outflows (blue solid line) and inflows (red dashed line). One period corresponds to one quarter and period 0 coincides with the peak of the currency demand shock. The steady state (S.S.) of the shown variables is defined as their respective average in the simulation period.

Figure 8 shows how well the model replicates the empirical results from a quantitative perspective. The rescaled granular IV estimates with their 95% confidence intervals are displayed for the baseline, high- and low-volatility states, as well as for outflow and inflow episodes. These values correspond to the scaled coefficient $\Gamma$ reported in Table 5. Correspondingly, the vertical axis measures the effect of a 1% of GDP currency flow on the nominal exchange rate. To assess the model's quantitative fit, regressions analogous to those in the empirical analysis are run using the stochastic simulations, with the key difference that currency demand flows are directly observable in the model.[20] Two model variants are considered: one featuring both UIP and CIP deviations as described above (represented by diamonds in the figure) and one with only UIP deviations (triangles), obtained by removing the financiers' balance sheet constraint $\underline{B}^*$. Both models are calibrated to match the empirical baseline exchange rate response. While each reproduces the state dependence observed across volatility regimes and flow directions, the presence of CIP deviations makes this state dependence considerably more pronounced—especially along the volatility dimension—bringing all model-implied estimates within the empirical 95% confidence intervals of the GIV estimates.

[20]The regression specification used to obtain the model-implied estimates is:

$$\log(\mathcal{E}_t/\mathcal{E}_{t-1}) = \beta \left(N_t^* - N_{t-1}^*\right) / \overline{GDP^*} + \theta \log\left(Y_{T,t}/Y_{T,t-1}\right) + \psi \log\left(Y_{NT,t}/Y_{NT,t-1}\right) + \varepsilon_t$$

where $\overline{GDP^*} = 4(\overline{Y_T} + \overline{Y}_{NT}/\overline{\mathcal{E}})$ denotes annualized steady-state GDP, and $\beta$ is the coefficient of interest. The distinction between high and low volatility states and inflows and outflows mirrors the empirical specification, where the measure of conditional exchange rate volatility in the model is $\sigma_t^2$ and flows are captured by $N_t^*$.

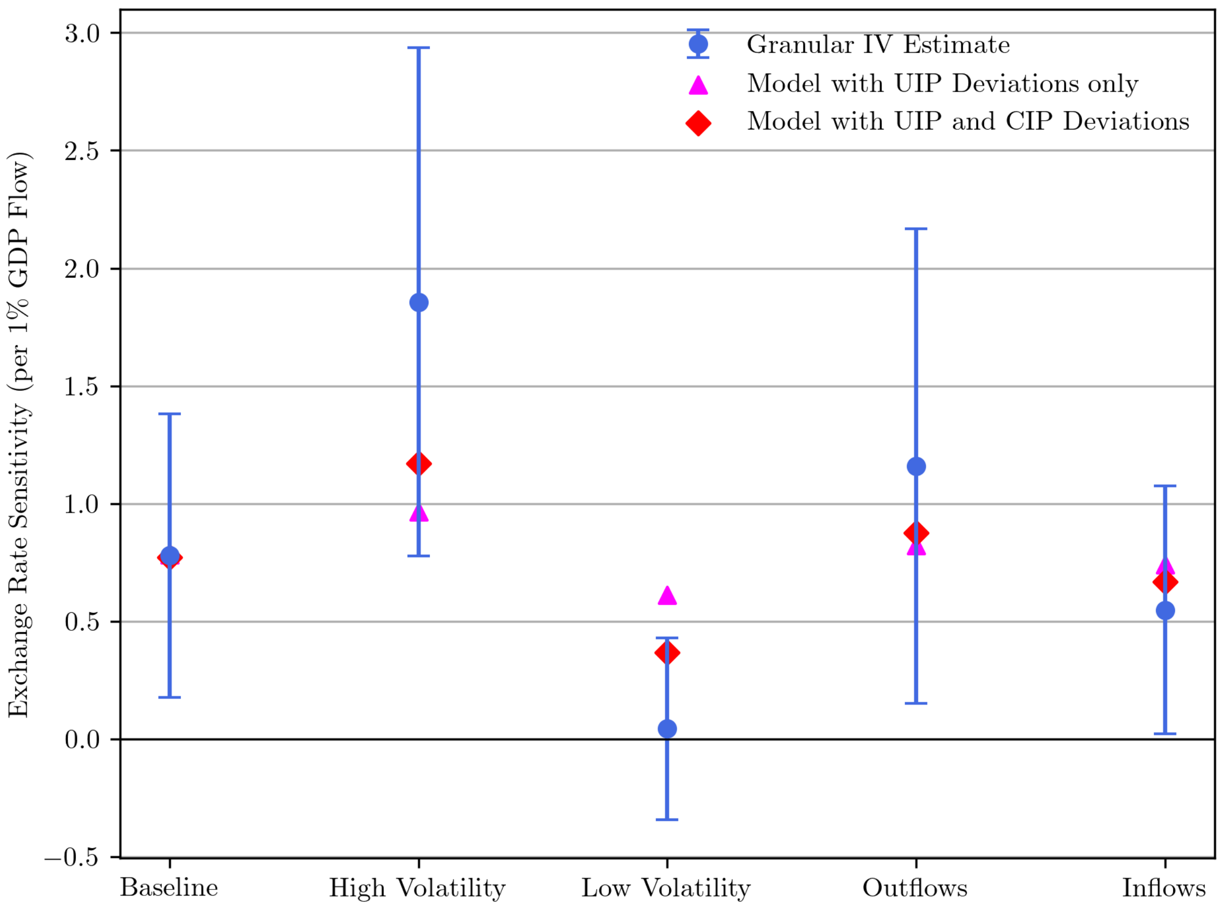



Figure 8: Model Comparison

Notes: The vertical axis shows the effect of a 1% of GDP currency flow on the nominal exchange rate. The GIV Estimate reports the rescaled point estimate and its 95% confidence interval from the empirical analysis in Table 5. Analogous model-implied estimates are obtained from a model with only UIP deviations (triangle) and from a model with both UIP and CIP deviations (diamond). These model-based estimates are computed using the stochastic simulations by regressing the log change in the exchange rate on rescaled currency demand flows.

# 6 Conclusions

This paper provides causal evidence that FX markets are shallow and highly state dependent. Mutual fund rebalancing flows generate significant exchange rate movements, with elasticities an order of magnitude lower in EM currencies compared to AEs. The results show that market depth is not constant but varies systematically with conditions: it declines during periods of elevated volatility and becomes weaker during episodes of mutual fund outflows. For EM currencies, both volatility and the direction of flows strongly shape the exchange rate response, while for AEs, volatility is the dominant factor. Finally, a quantitative small open economy model with limited risk-bearing capacity and balance sheet constraints in FX markets helps rationalize these findings, reproducing the qualitative state dependence and matching the quantitative magnitudes observed in the data.

These findings have broader implications for both theory and policy. They offer micro-based evidence of a portfolio balance channel, helping to discipline its strength and underlying transmission mechanisms in open-economy models. Regarding the design of FX interventions, a policy-induced form of currency demand, the evidence suggests that they are most effective when implemented during periods of heightened uncertainty, precisely when markets are shallowest. Moreover, the findings soften the conventional view that interventions are ineffective in AEs because of market depth. During volatile episodes, even AE currencies exhibit limited depth, suggesting that the boundaries of when interventions matter may be broader than often recognized.

An important avenue for future research is to complement the asset-side perspective taken here with an empirical analysis of FX intermediaries. Since the frictions underlying shallow FX markets stem from intermediaries' characteristics, incorporating data on their positions and constraints would help connect the demand-side evidence presented in this paper to the forces shaping liquidity and pricing in FX markets, yielding a more complete picture of how flows translate into price movements.

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# Appendix

## A Sample Construction

**Sample Selection** The security holdings data from open-end funds are obtained from Morningstar Direct using the Morningstar Data Package in Python.[21] Four filters are applied to construct the sample. First, only funds with holdings in at least two currencies, each with a minimum weight of 2%, are retained to ensure coverage of globally invested funds. Second, funds with assets under management (AUM) below USD 1 million are excluded, as very small funds contribute little to aggregate currency demand but can add disproportionate noise. Third, obsolete funds are removed from the sample to avoid discontinued reporting and ensure a consistent time series. Finally, the time coverage begins in 2005:Q4. Earlier observations are discarded due to substantially lower coverage in prior periods.

**Rebalancing Measure Construction** The computation of the rebalancing measure (6) requires several restrictions on the underlying securities. First, FX forward positions are excluded, since the reporting of FX forwards is inconsistent and does not allow a systematic identification of currency pairs and contract direction as mentioned in the main text. Second, securities with negative market value are excluded, as these rare observations introduce potential noise into the measure. Third, positions with missing market value or security identifiers are removed, because the absence of these variables prevents tracking of securities over time.

**Control Variables Construction** Bloomberg data (see Table A.1) are obtained at a daily frequency and converted to quarterly observations using end-of-month values. Since Bloomberg quotes forward exchange rates in pips, the (log) forward premium is computed as

$$Forward\_Premium_t = \log\left(Spot\_Rate_t + Forward\_Pips_t/10000\right) - \log\left(Spot\_Rate_t\right).$$

In addition, 3-month implied bilateral exchange rate volatility and risk reversals are not available for all currency pairs. In these cases, the average of each currency's volatility and risk reversal against the U.S. dollar is used.Finally, for each currency pair $c_A/c_B$, the first five principal components $\{u^{PC1}_{c_A/c_B,t}, \cdots, u^{PC5}_{c_A/c_B,t}\}$ are extracted from the residuals $u_{i,c_A/c_B,t}\ \forall\, i \in \mathcal{I}_{c_A}$ in (11), whenever feasible.

[21]See https://pypi.org/project/morningstar-data/.

Table A.1: Overview of Data Sources

| Data | Description | Source |
|---|---|---|
| Mutual fund security holdings | Security-level positions of open-end funds | Morningstar Direct |
| Mutual fund characteristics | Fund-level characteristics of open-end funds | Morningstar Direct |
| Exchange rates | Bilateral nominal exchange rates | Bloomberg |
| Forward exchange rates | 3-month bilateral forward exchange rates | Bloomberg |
| Interest rates | 3-month, 1-year, 5-year, and 10-year government bond yields | Bloomberg |
| Expected exchange rate volatilities | 3-month implied bilateral exchange rate volatilities | Bloomberg |
| Exchange rate risk reversals | 3-month implied bilateral exchange rate risk reversals | Bloomberg |
| Exchange rate classifications | Coarse exchange rate classification | Ilzetzki et al. (2019); Reinhart & Rogoff (2004) |
| Nominal GDP | Yearly gross domestic product (GDP) in current USD | World Development Indicators, World Bank |

Table A.2: Currency Pairs

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Advanced Economy Currency Pairs | | | | | | | | | |
| AUD/CAD | AUD/CHF | AUD/DKK | AUD/EUR | AUD/GBP | AUD/HKD | AUD/ILS | AUD/JPY | AUD/NOK | AUD/NZD |
| AUD/SEK | AUD/SGD | AUD/USD | CAD/CHF | CAD/DKK | CAD/EUR | CAD/GBP | CAD/HKD | CAD/ILS | CAD/JPY |
| CAD/NOK | CAD/NZD | CAD/SEK | CAD/SGD | CAD/USD | CHF/DKK | CHF/EUR | CHF/GBP | CHF/HKD | CHF/ILS |
| CHF/JPY | CHF/NOK | CHF/NZD | CHF/SEK | CHF/SGD | CHF/USD | DKK/EUR | DKK/GBP | DKK/HKD | DKK/ILS |
| DKK/JPY | DKK/NOK | DKK/SEK | DKK/SGD | DKK/USD | EUR/GBP | EUR/HKD | EUR/ILS | EUR/JPY | EUR/NOK |
| EUR/NZD | EUR/SEK | EUR/SGD | EUR/USD | GBP/HKD | GBP/ILS | GBP/JPY | GBP/NOK | GBP/NZD | GBP/SEK |
| GBP/SGD | GBP/USD | HKD/ILS | HKD/NOK | HKD/NZD | HKD/SEK | HKD/SGD | HKD/USD | ILS/JPY | ILS/NOK |
| ILS/SEK | ILS/USD | JPY/NOK | JPY/NZD | JPY/SEK | JPY/SGD | JPY/USD | NOK/SEK | NOK/SGD | NOK/USD |
| NZD/SEK | NZD/USD | SEK/SGD | SEK/USD | SGD/USD | | | | | |
| Emerging Market Currency Pairs | | | | | | | | | |
| AUD/BRL | AUD/CLP | AUD/CNY | AUD/IDR | AUD/INR | AUD/KRW | AUD/MXN | AUD/MYR | AUD/THB | AUD/ZAR |
| BRL/CAD | BRL/CHF | BRL/CLP | BRL/EUR | BRL/GBP | BRL/ILS | BRL/JPY | BRL/KRW | BRL/NOK | BRL/USD |
| CAD/CNY | CAD/IDR | CAD/INR | CAD/KRW | CAD/MXN | CAD/MYR | CAD/PLN | CAD/RUB | CAD/THB | CAD/ZAR |
| CHF/CNY | CHF/KRW | CHF/MXN | CHF/MYR | CHF/PLN | CHF/THB | CHF/ZAR | CLP/EUR | CLP/GBP | CLP/MXN |
| CLP/USD | CNY/DKK | CNY/EUR | CNY/GBP | CNY/HKD | CNY/KRW | CNY/MYR | CNY/SEK | CNY/SGD | CNY/THB |
| CNY/USD | CZK/EUR | CZK/KRW | CZK/USD | DKK/IDR | DKK/INR | DKK/KRW | DKK/MXN | DKK/THB | DKK/ZAR |
| EUR/HUF | EUR/IDR | EUR/INR | EUR/KRW | EUR/MXN | EUR/MYR | EUR/PLN | EUR/RON | EUR/RUB | EUR/THB |
| EUR/TRY | EUR/ZAR | GBP/IDR | GBP/INR | GBP/KRW | GBP/MXN | GBP/MYR | GBP/PLN | GBP/RUB | GBP/THB |
| GBP/TRY | GBP/ZAR | HKD/INR | HKD/KRW | HKD/MXN | HKD/MYR | HKD/THB | HKD/ZAR | HUF/KRW | HUF/USD |
| IDR/KRW | IDR/MYR | IDR/SEK | IDR/SGD | IDR/THB | IDR/USD | ILS/MXN | ILS/TRY | ILS/ZAR | INR/KRW |
| INR/MYR | INR/SEK | INR/SGD | INR/USD | JPY/KRW | JPY/MXN | JPY/MYR | JPY/THB | JPY/ZAR | KRW/MXN |
| KRW/MYR | KRW/NOK | KRW/NZD | KRW/PLN | KRW/RUB | KRW/SEK | KRW/SGD | KRW/THB | KRW/TRY | KRW/USD |
| KRW/ZAR | MXN/NOK | MXN/SEK | MXN/USD | MYR/SGD | MYR/THB | MYR/USD | NOK/ZAR | PLN/USD | RON/USD |
| RUB/USD | SEK/THB | SEK/ZAR | SGD/THB | SGD/ZAR | THB/USD | TRY/USD | USD/ZAR | | |

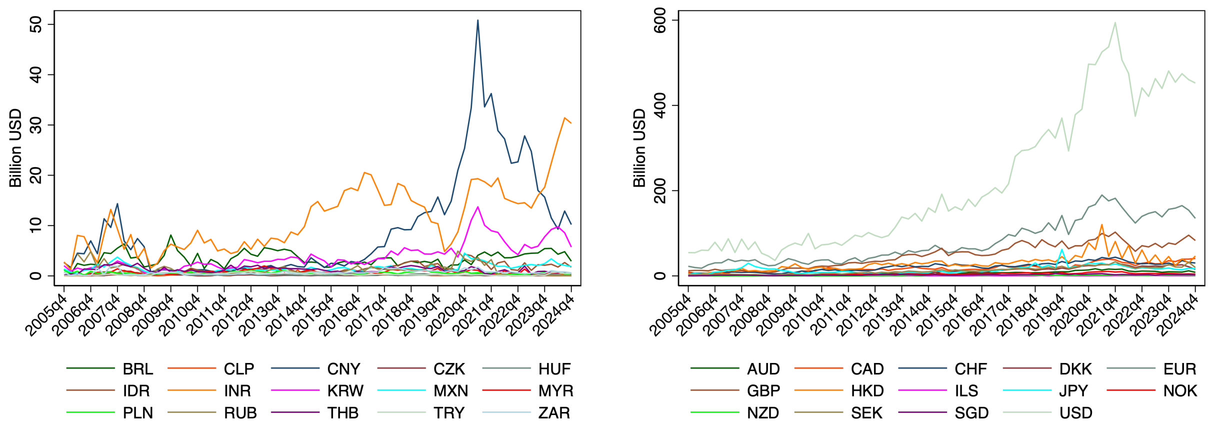
# B Additional Empirical Results and Details

**State-Dependent Local Projections** The state-dependent specification is given by

$$\Delta e_{c_A/c_B,t+h} = S_{c_A/c_B,t}\left[\beta_h(1)\widehat{m}_{c_A/c_B,t+h} + \alpha_{c_A/c_B,h}(1) + \gamma_{t,h} + \mathbf{X}'_{c_A/c_B,t-2}\Phi(1) + \sum_{s=2}^{4}\psi_s(1)\Delta e_{c_A/c_B,t-s}\right]$$

$$+(1 - S_{c_A/c_B,t})\left[\beta_h(0)\widehat{m}_{c_A/c_B,t+h} + \alpha_{c_A/c_B,h}(0) + \gamma_{t,h} + \mathbf{X}'_{c_A/c_B,t-2}\Phi(0) + \sum_{s=2}^{4}\psi_s(0)\Delta e_{c_A/c_B,t-s}\right] + \varepsilon_{c_A/c_B,t,h},$$

where $S_{c_A/c_B,t} \in \{0, 1\}$ denotes the regime indicator that determines the relevant state.




(a) EM Currencies

(b) AE Currencies

Notes: The two panels decompose external assets by emerging market currencies (panel B.1a) and advanced economy currencies (panel B.1b) in the sample. External assets are defined as all assets that are not denominated in the funds' portfolio currency.

Figure B.1: External Assets by Currencies

Table B.1: Granular IV – Principal Components Sensitivity

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.334*** | 0.443*** | 0.453** | 0.348** | 0.311** | 0.272** |
| | [0.117] | [0.166] | [0.181] | [0.139] | [0.134] | [0.133] |
| Observations | 10148 | 10148 | 10148 | 10148 | 10067 | 10017 |
| Adjusted $R^2$ | 0.046 | 0.034 | 0.033 | 0.045 | 0.048 | 0.052 |
| Scaled Coefficient $\Gamma$ | 0.163 | 0.216 | 0.220 | 0.169 | 0.150 | 0.131 |
| Montiel–Pflueger $F$-stat. | 50.544 | 33.174 | 39.514 | 37.439 | 36.225 | 24.254 |
| PC Controls | 0 | 1 | 3 | 5 | 7 | 10 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable. PC Controls lists the number of principal components extracted from the rebalancing residual as explained in Section 3.3.

Table B.2: Unhedged Mutual Fund Characteristics

| | N | Mean | SD | Min | p25 | p50 | p75 | Max |
|---|---|---|---|---|---|---|---|---|
| AUM (Mil USD) | 192826 | 346.23 | 1308.07 | 1.00 | 19.42 | 66.13 | 239.50 | 149359.70 |
| Currencies held | 192826 | 3.27 | 1.73 | 2.00 | 2.00 | 3.00 | 4.00 | 18.00 |
| Home Currency Share | 192826 | 56.96 | 34.36 | 0.00 | 25.07 | 66.20 | 88.68 | 98.00 |
| Equity Share | 192826 | 56.22 | 46.37 | 0.00 | 0.00 | 88.65 | 100.00 | 100.00 |
| Fixed Income Share | 192826 | 16.06 | 32.93 | 0.00 | 0.00 | 0.00 | 5.02 | 100.00 |
| Cash Share | 192826 | 0.42 | 2.98 | 0.00 | 0.00 | 0.00 | 0.00 | 97.92 |
| Fund of Funds Share | 192826 | 26.77 | 41.27 | 0.00 | 0.00 | 0.00 | 62.93 | 100.00 |
| Other Investments Share | 192826 | 0.53 | 4.28 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |

Notes: Observations are at the fund–quarter level. AUM stands for (total) assets under management and the shares are expressed in percent. The Home Currency Share is computed as the share of assets denominated in the funds' respective portfolio currencies. Other Investments primarily include alternatives and commodities.

Table B.3: Granular IV – Excluding NBER-dated Recessions

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.313*** | 0.319** | 0.301** | 0.686*** | 0.050 | 0.414*** | 0.238* |
| | [0.115] | [0.152] | [0.150] | [0.239] | [0.075] | [0.154] | [0.121] |
| Observations | 9978 | 5478 | 4500 | 4345 | 5618 | 5674 | 4275 |
| Adjusted $R^2$ | 0.057 | 0.077 | 0.026 | 0.049 | 0.117 | 0.074 | 0.065 |
| Scaled Coefficient $\Gamma$ | 0.165 | 0.683 | 0.083 | 0.340 | 0.028 | 0.225 | 0.119 |
| Montiel–Pflueger $F$-stat. | 35.095 | 21.176 | 20.336 | 18.270 | 34.511 | 56.609 | 32.177 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable.

Table B.4: Granular IV – 1-Year Interest Rate Differentials and UIP Deviations

(a) Effects on 1-Year Interest Rate Differentials

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.000 | 0.002 | -0.005 | 0.022 | -0.010 | 0.001 | -0.011 |
| | [0.011] | [0.014] | [0.013] | [0.019] | [0.012] | [0.019] | [0.016] |
| Observations | 11062 | 5965 | 5097 | 5176 | 5872 | 6369 | 4667 |
| Adjusted $R^2$ | 0.963 | 0.966 | 0.925 | 0.957 | 0.973 | 0.961 | 0.969 |
| Montiel–Pflueger $F$-stat. | 51.665 | 34.293 | 22.607 | 37.608 | 35.247 | 49.071 | 50.902 |

(b) Effects on 1-Year UIP Deviations

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.330*** | 0.349** | 0.286* | 0.657*** | 0.056 | 0.398** | 0.307** |
| | [0.123] | [0.159] | [0.151] | [0.203] | [0.088] | [0.173] | [0.122] |
| Observations | 11062 | 5965 | 5097 | 5176 | 5872 | 6369 | 4667 |
| Adjusted $R^2$ | 0.255 | 0.323 | 0.082 | 0.166 | 0.414 | 0.276 | 0.245 |
| Montiel–Pflueger $F$-stat. | 52.110 | 34.272 | 22.859 | 37.935 | 35.468 | 49.615 | 50.359 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variables are the interest rate differential at a 1-year maturity $\Delta i_{c_A/c_B,1Y,t} = i_{c_B,1Y,t} - i_{c_A,1Y,t}$ and the corresponding ex-post UIP deviation $UIP_{c_A/c_B,1Y,t} = \Delta e_{c_A/c_B,t} + \Delta i_{c_A/c_B,1Y,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls (excluding interest rate differentials) and four lags of the dependent variable.

Table B.5: Granular IV – 2-Year Interest Rate Differentials and UIP Deviations

(a) Effects on 2-Year Interest Rate Differentials

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.000 | 0.001 | -0.003 | 0.026 | -0.014 | 0.001 | -0.010 |
| | [0.010] | [0.013] | [0.014] | [0.017] | [0.013] | [0.018] | [0.016] |
| Observations | 11062 | 5965 | 5097 | 5176 | 5872 | 6369 | 4667 |
| Adjusted $R^2$ | 0.965 | 0.968 | 0.924 | 0.959 | 0.975 | 0.964 | 0.970 |
| Montiel–Pflueger $F$-stat. | 51.724 | 34.321 | 22.652 | 37.768 | 35.293 | 49.192 | 51.032 |

(b) Effects on 2-Year UIP Deviations

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.335*** | 0.353** | 0.291* | 0.670*** | 0.054 | 0.407** | 0.306** |
| | [0.123] | [0.160] | [0.153] | [0.202] | [0.088] | [0.175] | [0.119] |
| Observations | 11062 | 5965 | 5097 | 5176 | 5872 | 6369 | 4667 |
| Adjusted $R^2$ | 0.265 | 0.336 | 0.081 | 0.172 | 0.425 | 0.287 | 0.252 |
| Montiel–Pflueger $F$-stat. | 52.139 | 34.284 | 22.864 | 37.917 | 35.482 | 49.668 | 50.364 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variables are the interest rate differential at a 2-year maturity $\Delta i_{c_A/c_B,2Y,t} = i_{c_B,2Y,t} - i_{c_A,2Y,t}$ and the corresponding ex-post UIP deviation $UIP_{c_A/c_B,2Y,t} = \Delta e_{c_A/c_B,t} + \Delta i_{c_A/c_B,2Y,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls (excluding interest rate differentials) and four lags of the dependent variable.

Table B.6: Granular IV – 3-Year Interest Rate Differentials and UIP Deviations

(a) Effects on 3-Year Interest Rate Differentials

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | -0.002 | -0.002 | -0.001 | 0.023 | -0.015 | -0.002 | -0.009 |
| | [0.010] | [0.012] | [0.014] | [0.016] | [0.012] | [0.018] | [0.014] |
| Observations | 11062 | 5965 | 5097 | 5176 | 5872 | 6369 | 4667 |
| Adjusted $R^2$ | 0.968 | 0.971 | 0.924 | 0.962 | 0.977 | 0.967 | 0.972 |
| Montiel–Pflueger $F$-stat. | 51.683 | 34.260 | 22.645 | 37.702 | 35.265 | 49.182 | 51.072 |

(b) Effects on 3-Year UIP Deviations

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.335*** | 0.350** | 0.292* | 0.670*** | 0.052 | 0.408** | 0.302** |
| | [0.123] | [0.159] | [0.154] | [0.202] | [0.087] | [0.175] | [0.118] |
| Observations | 11062 | 5965 | 5097 | 5176 | 5872 | 6369 | 4667 |
| Adjusted $R^2$ | 0.272 | 0.346 | 0.083 | 0.176 | 0.433 | 0.295 | 0.258 |
| Montiel–Pflueger $F$-stat. | 52.109 | 34.259 | 22.852 | 37.874 | 35.470 | 49.665 | 50.343 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variables are the interest rate differential at a 3-year maturity $\Delta i_{c_A/c_B,3Y,t} = i_{c_B,3Y,t} - i_{c_A,3Y,t}$ and the corresponding ex-post UIP deviation $UIP_{c_A/c_B,3Y,t} = \Delta e_{c_A/c_B,t} + \Delta i_{c_A/c_B,3Y,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls (excluding interest rate differentials) and four lags of the dependent variable.

Table B.7: Granular IV – 5-Year Interest Rate Differentials and UIP Deviations

(a) Effects on 5-Year Interest Rate Differentials

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | -0.005 | -0.009 | 0.003 | 0.020 | -0.017 | -0.005 | -0.011 |
| | [0.010] | [0.012] | [0.014] | [0.014] | [0.012] | [0.017] | [0.013] |
| Observations | 11062 | 5965 | 5097 | 5176 | 5872 | 6369 | 4667 |
| Adjusted $R^2$ | 0.972 | 0.974 | 0.931 | 0.966 | 0.980 | 0.971 | 0.975 |
| Montiel–Pflueger $F$-stat. | 51.720 | 34.240 | 22.576 | 37.632 | 35.261 | 49.142 | 51.277 |

(b) Effects on 5-Year UIP Deviations

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.330*** | 0.338** | 0.296* | 0.661*** | 0.049 | 0.403** | 0.290** |
| | [0.121] | [0.156] | [0.155] | [0.200] | [0.085] | [0.174] | [0.115] |
| Observations | 11062 | 5965 | 5097 | 5176 | 5872 | 6369 | 4667 |
| Adjusted $R^2$ | 0.279 | 0.355 | 0.086 | 0.180 | 0.441 | 0.301 | 0.265 |
| Montiel–Pflueger $F$-stat. | 52.050 | 34.201 | 22.841 | 37.808 | 35.451 | 49.621 | 50.346 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variables are the interest rate differential at a 5-year maturity $\Delta i_{c_A/c_B,5Y,t} = i_{c_B,5Y,t} - i_{c_A,5Y,t}$ and the corresponding ex-post UIP deviation $UIP_{c_A/c_B,5Y,t} = \Delta e_{c_A/c_B,t} + \Delta i_{c_A/c_B,5Y,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls (excluding interest rate differentials) and four lags of the dependent variable.

Table B.8: Granular IV – 7-Year Interest Rate Differentials and UIP Deviations

(a) Effects on 7-Year Interest Rate Differentials

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | -0.007 | -0.013 | 0.003 | 0.015 | -0.019 | -0.004 | -0.015 |
| | [0.010] | [0.012] | [0.013] | [0.014] | [0.012] | [0.017] | [0.013] |
| Observations | 11053 | 5956 | 5097 | 5175 | 5864 | 6360 | 4667 |
| Adjusted $R^2$ | 0.974 | 0.977 | 0.933 | 0.968 | 0.982 | 0.974 | 0.976 |
| Montiel–Pflueger $F$-stat. | 51.799 | 34.268 | 22.549 | 37.579 | 35.413 | 49.118 | 51.458 |

(b) Effects on 7-Year UIP Deviations

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.323*** | 0.326** | 0.298* | 0.654*** | 0.045 | 0.398** | 0.280** |
| | [0.119] | [0.153] | [0.155] | [0.200] | [0.084] | [0.172] | [0.113] |
| Observations | 11053 | 5956 | 5097 | 5175 | 5864 | 6360 | 4667 |
| Adjusted $R^2$ | 0.281 | 0.357 | 0.090 | 0.181 | 0.443 | 0.302 | 0.269 |
| Montiel–Pflueger $F$-stat. | 52.062 | 34.198 | 22.831 | 37.750 | 35.566 | 49.654 | 50.348 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variables are the interest rate differential at a 7-year maturity $\Delta i_{c_A/c_B,7Y,t} = i_{c_B,7Y,t} - i_{c_A,7Y,t}$ and the corresponding ex-post UIP deviation $UIP_{c_A/c_B,7Y,t} = \Delta e_{c_A/c_B,t} + \Delta i_{c_A/c_B,7Y,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls (excluding interest rate differentials) and four lags of the dependent variable.

Table B.9: Granular IV – 10-Year Interest Rate Differentials and UIP Deviations

(a) Effects on 10-Year Interest Rate Differentials

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | -0.012 | -0.021 | 0.004 | 0.009 | -0.023** | -0.010 | -0.016 |
| | [0.009] | [0.013] | [0.012] | [0.013] | [0.011] | [0.016] | [0.012] |
| Observations | 11038 | 5941 | 5097 | 5168 | 5856 | 6353 | 4660 |
| Adjusted $R^2$ | 0.975 | 0.978 | 0.935 | 0.970 | 0.983 | 0.975 | 0.978 |
| Montiel–Pflueger $F$-stat. | 51.961 | 34.356 | 22.404 | 37.640 | 35.639 | 49.083 | 51.689 |

(b) Effects on 10-Year UIP Deviations

| | (1) All | (2) EM | (3) AE | (4) High Vol | (5) Low Vol | (6) Outflows | (7) Inflows |
|---|---|---|---|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.317*** | 0.313** | 0.301* | 0.645*** | 0.039 | 0.389** | 0.276** |
| | [0.118] | [0.150] | [0.154] | [0.199] | [0.082] | [0.170] | [0.112] |
| Observations | 11038 | 5941 | 5097 | 5168 | 5856 | 6353 | 4660 |
| Adjusted $R^2$ | 0.279 | 0.354 | 0.091 | 0.177 | 0.443 | 0.297 | 0.271 |
| Montiel–Pflueger $F$-stat. | 52.087 | 34.196 | 22.822 | 37.754 | 35.661 | 49.714 | 50.474 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variables are the interest rate differential at a 10-year maturity $\Delta i_{c_A/c_B,10Y,t} = i_{c_B,10Y,t} - i_{c_A,10Y,t}$ and the corresponding ex-post UIP deviation $UIP_{c_A/c_B,10Y,t} = \Delta e_{c_A/c_B,t} + \Delta i_{c_A/c_B,10Y,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls (excluding interest rate differentials) and four lags of the dependent variable.

Table B.10: Granular IV – Hedging-Adjusted Fund Categories

| | (1) All | (2) Equity | (3) Fixed Income |
|---|---|---|---|
| Rebalancing $m_{c_A/c_B,t}$ | 0.202** | 0.138* | 0.059* |
| | [0.078] | [0.080] | [0.033] |
| Observations | 10140 | 9830 | 6427 |
| Adjusted $R^2$ | 0.039 | 0.044 | 0.059 |
| Scaled Coefficient $\Gamma$ | 0.098 | 0.087 | 0.147 |
| Montiel–Pflueger $F$-stat. | 41.644 | 65.576 | 42.798 |
| Rebalancing SD | 2.57 | 2.81 | 4.99 |
| Hedge Ratio | 4.10 | 1.84 | 15.57 |

Notes: Standard errors clustered by currency pair and time in brackets * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the quarterly log difference in the spot exchange rate $\Delta e_{c_A/c_B,t}$. All regressions control for currency pair and time fixed effects, include macro-financial controls and four lags of the dependent variable. Mutual fund currency-demand flows are adjusted for hedging to the extent that they account for estimated hedging ratios. Hedging ratios at the fund–currency-pair–time level are computed from observed FX forward positions under the assumption that funds hedge their foreign-currency exposures, since the direction of the FX forward positions is not always observable in the data.

# C Model Details

**Definition 1** (Competitive Equilibrium)**.** Given exogenous process $\{Y_{T,t}, Y_{N,t}, N_t^*\}_{t=0}^{\infty}$ and initial condition $B_{-1}^*$, a competitive equilibrium is a sequence of prices $\{\mathcal{E}_t, R_t, \lambda_t\}_{t=0}^{\infty}$ and implied conditional exchange rate volatility $\{\sigma_t^2\}_{t=0}^{\infty}$, allocations $\{C_{T,t}, C_{N,t}\}_{t=0}^{\infty}$ and bond positions $\{B_t^*, D_t^*\}_{t=0}^{\infty}$ such that:

1. Households and financiers optimize, implying (19), (20), (21) and (22)
2. Goods and bond markets clear, implying (23), (24) and (25)
3. The transversality condition on net foreign assets holds

$$\lim_{T\to\infty} \frac{B_T^*}{(R^*)^T} = 0.$$

**Derivation of the Domestic Interest Rate** Use the Euler equation (19) to write the inverse of the domestic interest rate as

$$\mathbb{E}_t\left[\beta \frac{u_1(C_{T,t+1}, C_{NT,t+1})}{u_1(C_{T,t}, C_{NT,t})} \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}}\right] = \frac{1}{R_t}.$$

Next, insert the expenditure switching condition (20) to obtain

$$\mathbb{E}_t\left[\beta \frac{u_2(C_{T,t+1}, C_{NT,t+1})}{u_2(C_{T,t}, C_{NT,t})}\right] = \frac{1}{R_t},$$

which clarifies that the domestic interest rate is simply driven by changes in the marginal utility with respect to non-tradable consumption, since the price level of non-tradables is constant by assumption ($P_{NT,t} = 1\ \forall\ t$). In addition, note that the calibration choice $\sigma = 2$ and $\xi = 0.5$ implies that the marginal utility with respect to non-tradable consumption depends only on non-tradable consumption:

$$\mathbb{E}_t\left[\beta \left(\frac{C_{t+1}}{C_t}\right)^{\frac{1-\sigma\xi}{\xi}} \left(\frac{C_{NT,t+1}}{C_{NT,t}}\right)^{-\frac{1}{\xi}}\right] = \mathbb{E}_t\left[\beta \left(\frac{C_{NT,t+1}}{C_{NT,t}}\right)^{-\frac{1}{\xi}}\right] = \frac{1}{R_t}.$$

Since non-tradable consumption is equal to non-tradable endowment according to market clearing (24), the domestic interest rate is driven by shocks to the non-tradable endowment

$$\mathbb{E}_t\left[\beta \left(\frac{Y_{NT,t+1}}{Y_{NT,t}}\right)^{-\frac{1}{\xi}}\right] = \frac{1}{R_t},$$

and is unaffected by currency demand shocks to the extent that they are uncorrelated with non-tradable endowment shocks.