Foreign Investors in Local-Currency Bond Markets: Implications for Bond Yields and Exchange Rates*

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Abstract

When foreign investors acquire local-currency bonds, they must also exchange foreign for local currency. In a model with intermediation frictions, foreign inflows thus generate correlated movements in intermediaries' bond and currency positions, and, in turn, in term and currency premia. Using data from Colombia's bond and foreign exchange markets, we show that this mechanism accounts for key empirical patterns in intermediaries' positions, bond yields, and exchange rates—including during inflow episodes, and in response to asset purchase policies. Consistent with the model, countries with more prevalent unhedged foreign investor flows exhibit stronger positive comovement between bond and currency returns.

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There is increasing recognition that financial intermediaries play a central role in determining bond yields and exchange rates (Gabaix and Maggiori, 2015; Bruno and Shin, 2015; Kekre et al., 2024; Greenwood et al., 2023; Gourinchas et al., 2025; Kekre and Lenel, 2025b). In the presence of intermediation frictions, these prices respond to shifts in investors' demand for assets across maturities and currencies, which intermediaries must absorb. This paper shows that there are important differences in the bond demand of domestic and foreign investors, because they induce intrinsically different changes in intermediaries' currency positions. As a result, the share of foreign investors in local-currency bond markets, as well as their propensity to hedge currency risk, affects the joint dynamics of bond yields and exchange rates and, in turn, the transmission of asset purchase policies by central banks.

We begin by showing that foreign investors—a significant presence in many local-currency government bond markets—induce correlated flows across a country's long-term bond and currency markets. Using unique transaction-level data from Colombia's bond and foreign exchange markets, we show that trades by foreign investors in local-currency bonds are accompanied by tightly linked transactions in currency markets, while this is not the case for domestic investors' trades. These patterns arise naturally from differences in the funding currency of domestic and foreign investors. Because foreign investors fund their purchases in foreign currency, acquiring local-currency bonds requires a simultaneous acquisition of local for foreign currency. As long as foreign investors don't fully hedge their currency exposures (as the data indicate), their long-term bond purchases generate correlated movements in intermediaries' holdings long-term bond and currency positions.

In the presence of intermediation frictions, foreign investors' bond purchases induce correlated revisions in term premia and currency premia. We formalize this mechanism in an equilibrium model of bond yields and exchange rates with frictions in financial intermediation. Our framework builds on Greenwood et al. (2023) but incorporates a distinction between domestic and foreign investors. When foreign investors demand local-currency bonds, intermediaries' exposure to long-term bond price risk and currency risk contemporaneously declines. As a result, they require lower term premia and lower currency premia, leading to a decline in bond yields and an exchange rate appreciation.

The mechanism conveyed by our model accounts for the effects of an episode of foreign inflows into Colombia's local-currency bond market. In March 2014, J.P. Morgan announced that Colombian long-term government bonds would be included in one of its flagship global bond indexes, triggering large bond purchases by benchmark-tracking foreign investors adjusting their portfolios to the new index. We show that these purchases were matched

almost one-for-one by foreign investors' acquisitions of Colombian pesos in the spot market. During this episode, domestic intermediaries absorbed foreign investors' demand, offloading long-term bonds and currencies from their portfolios. Alongside, in line with the mechanism described above, bond prices increased and the exchange rate appreciated.

Furthermore, we show that, on average, increases in Colombian intermediaries' portfolio holdings of long-term bonds or Colombian pesos relative to US dollars predict subsequent excess returns on these assets. In our framework, bond yields and exchange rates adjust to induce intermediaries to absorb fluctuations in the supply of bond price and currency risk, through term premia and currency premia. As a result, the model implies that intermediaries' positions indeed predict subsequent excess returns on average. These findings support the notion that intermediaries are the agents absorbing imbalances across maturities and currencies, and that they are compensated for doing so through jointly determined risk premia in bond and foreign exchange markets.

The composition of investors in local-currency bond markets affects the comovement between bond yields and exchange rates—an important empirical object in international finance (Lustig et al., 2019). In our model, this comovement primarily depends on the relative importance of two sets of shocks, those to short-term interest rates and those to foreign investors' unhedged bond flows. Short-term interest rate shocks affect bond and currency returns in opposite directions. An increase in the domestic short-term interest rate causes a decline in the price of long-term bonds, through an expectations hypothesis channel, while appreciating the domestic currency, through an uncovered interest parity channel. Interest rate risk thus induces a *negative* correlation in bond and currency returns. In contrast, because foreign investors induce correlated changes in intermediaries' positions, they naturally generate *positive* correlation in bond and currency returns, precisely because of the positively correlated revisions in term premia and currency risk premia. Thus, bond and currency risk can either offset or compound depending on the relative importance of foreign investors in local currency bond markets.

Existing models of frictional financial intermediation have largely emphasized short-term interest rate shocks, but assumed that investors' bond demand shocks absorbed by intermediaries are independent, effectively abstracting from the presence of foreign investors (Greenwood et al., 2023; Gourinchas et al., 2025). In other words, shifts in bond demand in these models affect the net supply of domestic bonds without directly changing intermediaries' currency positions. As a result, in these models the comovement in term premia and currency premia is negative, as it exclusively reflects bond and currency returns' exposure to interest

rate shocks. By contrast, our model can generate any covariance between bond and currency returns.

We show that countries in which unhedged foreign investor flows are more prevalent exhibit more positive comovement between bond and currency returns. In the model, the importance of unhedged foreign investor flows is governed by two forces. First, the relative volatility of bond purchases by foreign versus domestic investors. When a larger fraction of the variation in bond demand reflects foreign investors, changes in intermediaries' bond and currency positions are more correlated. Second, the extent of currency hedging by foreign investors. A higher tendency of foreign investors to hedge currency spot purchases, through currency forwards, naturally dampens the correlation in intermediaries' bond and currency positions.

Using cross-country data on local-currency bond holdings (Arslanalp and Tsuda, 2012, 2014) and estimates of foreign investors' hedging ratios (Cheema-Fox and Greenwood, 2024; Chen and Zhou, 2025), we document substantial heterogeneity in the incidence of foreign investors' flows in local bond markets and in their currency hedging behavior. Most importantly, countries where foreign investors drive a larger share of bond flows, or hedge less, display more positive comovement between bond and currency returns. Thus, foreign investor participation in local currency bonds appears to explain a portion of the observed cross-country differences in the comovement of bond yields and exchange rates.

Our analysis also speaks to the transmission of asset purchase policies, such as foreign exchange interventions, to bond yields and exchange rates. In our framework, intermediaries operate simultaneously in bond and currency markets, which are exposed to correlated risks. Consequently, a change in the net supply of one asset affects intermediaries' required premia in both markets. Whether foreign exchange interventions raise or lower bond prices depends on the sign of the covariance between bond and currency returns. This covariance, in turn, reflects the relative importance of unhedged foreign investor flows and short-term interest rate shocks.[1]

To examine the predictions for foreign exchange interventions, we use evidence from central bank auctions to purchase US dollars conducted in Colombia between 2012 and 2014. We exploit the auction cutoff price to compare dealers that barely won with those that barely lost. We find that dealers that sell dollars to the central bank subsequently trade US dollars at higher prices *and* local-currency bonds at lower prices than dealers that barely lost. Both

[1] Analogously, the covariance between bond and currency returns determines whether purchases of long-term bonds appreciate or depreciate the currency.

price changes are in the same direction, consistent with winners simultaneously demanding higher currency and term premia. More broadly, these results show that currency and term premia comove positively in response to a shift in the net supply of a single asset. This finding is consistent with intermediaries perceiving bond and currency returns as exposed to positively correlated risks.

Related literature Models of frictional financial intermediation have gained prominence in international macroeconomics and finance (Gabaix and Maggiori, 2015; Itskhoki and Mukhin, 2021; Kekre and Lenel, 2024; Chahrour et al., 2024; Gourinchas et al., 2025; Greenwood et al., 2023; Kekre and Lenel, 2025b). Moreover, there is mounting evidence that shocks to bond and currency demand cause movements in bond yields and exchange rates (Pandolfi and Williams, 2019; Ray et al., 2024; Hau et al., 2010; Beltran and He, 2024). We contribute to this literature by empirically grounding a mechanism that links foreign investors' bond flows to the portfolios of financial intermediaries, and that speaks to the cross-country differences in the comovement between bond yields and exchange rates (Lustig et al., 2019; Lloyd and Marin, 2024; Kekre and Lenel, 2024; Rebucci et al., 2025), and to the effects of foreign exchange interventions (Kuersteiner et al., 2018; Fratzscher et al., 2019).

Our proposed mechanism is related to, yet distinct from, several recent contributions. Some studies propose mechanisms whereby fluctuations in the US dollar affect risk premia by revaluing the wealth of constrained intermediaries (Carstens and Shin, 2019; Bruno and Shin, 2015; Hofmann et al., 2022; Bertaut et al., 2024; Kekre and Lenel, 2025b). In contrast, we emphasize the role of foreign investors' financial flows in shaping intermediaries' positions across bond and currency markets. That is, we emphasize a channel that operates through changes in intermediaries' positions (a "portfolio balance" channel), rather than through changes in intermediaries' price of risk. Our proposed mechanism is thus closely related to studies of the joint determination of capital flows, exchange rates, and equity prices (Hau and Rey, 2006; Camanho et al., 2022; Rey and Stavrakeva, 2024).[2] Hau and Rey (2006) and Camanho et al. (2022) document that net equity flows into foreign markets are associated with currency appreciations, which echoes our empirical findings for Colombia's local currency bond markets. Our paper relies on an analogous mechanism, but it focuses on government bond markets. In addition, our paper highlights the relationship between foreign investors and bond–currency return comovement, and its implications for the transmission of asset

[2]Koijen and Yogo (2020) estimates a demand system to study exchange rates jointly with short-term rates, long-term yields, and equity prices.

purchase policies, both theoretically and empirically. In this context, we note that it is the relative volatility of foreign investors' bond flows, rather than their average bond holdings, that matters for the comovement between bond and currency returns. Our paper is thus related to recent work emphasizing the differential volatility between foreign and domestic investors' financial flows, and in their sensitivities to global financial conditions (Zhou, 2024; Fu, 2023). While these papers investigate the sources of differences in investors' volatilities, we take the relative volatility of foreign investors as given, and highlight how it shapes the comovement between bond yields and exchange rates through their effects on intermediaries' portfolios.[3,4]

This paper also contributes to the literature on the transmission of asset purchase policies. In models of frictional financial intermediation, the effects of these policies, such as quantitative easing, depend on the equilibrium covariance between bond and currency returns (Gourinchas et al., 2025; Greenwood et al., 2023; Kekre and Lenel, 2025b). Empirical tests of these predictions often rely on high-frequency responses of asset prices to announced or implemented quantitative easing programs or dollar swap lines (Bauer and Neely, 2014; Neely, 2015; Swanson, 2021; Christensen and Zhang, 2025; Bhattarai and Neely, 2022; Rebucci et al., 2022; Arslan et al., 2020; Toraman, 2025; Kekre and Lenel, 2025a,b).

Our contribution to this literature is twofold. First, we extend this insight to interventions in currency markets and highlight the role of investor composition which shapes the transmission as it partly determines the equilibrium covariance between bond and currency returns. Second, we provide evidence based on central bank auctions for US dollar purchases, which shift the net supply of currency that intermediaries must absorb. Under plausible identifying assumptions, we argue that the trading behavior of intermediaries whose balance sheets are differentially affected by these interventions reveals the underlying transmission channel. We discuss how these intermediary-level responses inform us about the relevant elasticities of interest, and emphasize that our intermediary-level identification approach separates the balance-sheet channel from information effects that are inherent to high-frequency aggregate responses.

[3]Other papers, instead, study the determinants and dynamics of sovereign debt currency composition (Ottonello and Perez, 2019; Du and Schreger, 2022; Engel and Park, 2022; Lee, 2024).

[4]Other papers study how exposure to foreign investors influences the dynamics of short-term market rates (De Leo et al., 2024a), deviations from covered interest parity (De Leo et al., 2024b), deviations from uncovered interest parity (Kalemli-Ozcan, 2019; di Giovanni et al., 2021; Cormun and De Leo, 2026), sovereign and firm borrowing costs (Fang et al., 2025; Morelli et al., 2022; Moretti et al., 2024; Morais et al., 2019; Xu, 2024), the spillovers of external shocks (Faia et al., 2025; Chari et al., 2022), and the patterns of capital flows (Avdjiev et al., 2022).

1 Foreign investors in local-currency bond markets

Local-currency government bond markets universally feature both domestic and foreign investors (Arslanalp and Tsuda, 2012, 2014). In this section, we show that differences in these investors' funding currencies give rise to distinct correlations of financial flows across bond and currency markets. To this end, we use transaction-level data from Colombia's long-term local-currency bond market and foreign exchange market (both spot and forward). Our sample spans January 2013 through December 2020, unless otherwise noted. Colombia is a representative small open economy, with foreign investor participation in its government bond market at levels comparable to those observed in other small open economies.

1.1 Institutional details of Colombia's bond and currency markets

Government bonds market Since the 2000s, most of Colombia's sovereign debt is denominated in its domestic currency, the Colombian peso (COP). By 2020, total fiscal debt is USD 177 billion, representing around 65% of GDP. Of this total, two-thirds was denominated in COP, with 20% issued as inflation-linked bonds and 46% as standard peso-denominated instruments.

The Ministry of Finance designates financial institutions to participate in the "primary dealers" (PD) program for government bonds (*Títulos de Tesorería*, TES). Membership in this program is limited to a select group of institutions that meet the Ministry's eligibility criteria. On average, the primary market issues approximately COP 300 billion (less than USD 100 million) worth of TES bonds daily. In contrast, the secondary market for TES, described below, experiences a substantially higher daily turnover of around COP 2 trillion (USD 500 million).

Foreign exchange markets The COP–USD spot and forward interdealer market in Colombia is highly centralized. A single electronic trading platform, *SET–ICAP FX*, accounts for approximately 95% of total market volume. Offshore trading is restricted by regulatory measures.

Transactions in foreign exchange markets are restricted to authorized dealers (*Intermediarios del Mercado Cambiario*, IMC). Consequently, all market participants must conduct transactions through one of these 50 authorized dealers. These intermediaries include banking institutions, financial corporations, financial cooperatives, and stock brokerage firms. The average daily turnover for the spot market is USD 1.5 billion, while the forward market sees an average

daily turnover of USD 4 billion.[5]

Data sources Our analysis uses several datasets. Transactions involving purchases and sales of bonds in the secondary market take place on two trading platforms: (i) the Colombian Electronic Market (MEC), operated by the Colombian Stock Exchange, and (ii) the Electronic Trading System (SEN), managed by the central bank. All trades executed on these platforms are registered in the Central Securities Depository (DCV), overseen by the central bank. We rely on the DCV, which records counterparties, to observe all transactions occurring in the secondary market. To identify trades involving foreign investors, we use data from the "Declarations of Foreign Exchange Transactions" (*Declaraciones de Cambio*), which records all transactions involving foreign exchange and is compiled by the Technical and Economic Information Department of the central bank. To analyze FX Spot, Next-Day, and Forward markets in the interdealer market, we use data from the *SET-ICAP FX* platforms.[6]

1.2 Bond purchases by foreign and domestic investors

Foreign investors use foreign currency, typically the US dollar, to fund their local-currency bond purchases, whereas domestic investors fund themselves in domestic currency, that is, COP. This simple observation implies that bond purchases by foreign and domestic investors generate fundamentally different financial flows in foreign exchange markets.

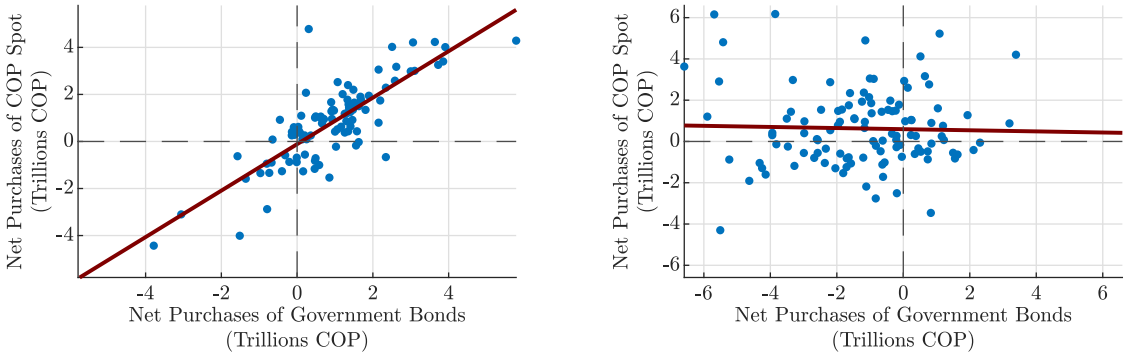
Figure 1a plots foreign investors' monthly net purchases of local-currency bonds (TES) in the secondary government bond market (x-axis) against their net purchases of domestic currency (COP) in the spot foreign exchange market (y-axis).[7] The data lie tightly along the 45-degree line. A regression of COP purchases on TES purchases for foreign investors yields a slope statistically indistinguishable from 1, with an R^2 of around 65%. A large share of foreign investors' net spot FX transactions is thus directly tied to their government bond market activity.

[5]These institutions are subject to FX mismatch limits overseen by the central bank, *Banco de la República*. The two main measures, expressed as a percentage of equity, are the *Posición Propia de Contado* (PPC), which measures net spot FX exposure (foreign-currency assets minus liabilities, excluding derivatives), and the *Posición Propia* (PP), which measures overall net FX exposure including derivatives. During our sample, the regulatory bounds were $[0, 50]$ percent for the PPC and $[-5, 20]$ percent for the PP. These limits have been far from binding: since 2010, the banking system's PPC has ranged from 0.8 to 12.2 percent of equity, while its PP has ranged from -0.3 to 3.1 percent.

[6]While bond trades can be directly attributed to individual foreign investors, foreign exchange transactions may be conducted either directly by these investors or through foreign intermediaries, obscuring the identity of the ultimate buyer. Consequently, it is not possible to establish a precise link between bond and foreign exchange transactions trades at the individual transaction level.

[7]During this period, total outstanding TES debt was around COP 250 trillion, of which foreign investors held roughly one-quarter.

Figure 1
Investors' flows in bond and currency markets



(a) By foreign investors (b) By domestic investors

Note: The figure plots monthly net purchases of government bonds (x-axis) against net purchases of COP in the spot market (y-axis). Panel 1a displays net purchases by foreign investors; Panel 1b displays net purchases by domestic investors. The fitted OLS regression line is shown in each panel.

By contrast, domestic investors' net bond purchases are not systematically correlated with their transactions in the spot FX market (Figure 1b). A regression of COP purchases on TES purchases for domestic investors yields a slope indistinguishable from zero, with an R^2 close to zero.

These patterns arise naturally from differences in funding currency. A COP-funded investor purchasing X COP of a local-currency bond operates entirely within the bond market. The intermediary on the other side of the trade delivers X COP worth of bonds from inventory in exchange for COP cash, with no foreign exchange transaction. A US dollar-funded investor, by contrast, must first convert USD into COP at the spot rate Q to acquire the same bond. The intermediary then delivers the bond from inventory while receiving X/Q USD in exchange, as a result of the combined foreign investor FX and bond transaction. From the intermediary's perspective, the transaction thus generates both a COP bond outflow and a USD inflow.

Foreign and domestic investors' bond flows thus affect intermediary balance sheet risk in qualitatively different ways. In particular, foreign investor activity induces a correlated change in bond and currency positions for the intermediaries that absorb these flows.

We next formalize these insights in a model of bond and currency markets that features frictional financial intermediation. The main purpose of the model is to derive the asset price implications arising from differences in investor composition. In the model, we also consider the role of currency hedging by foreign investors (which nevertheless appears limited in our Colombian data). Following Greenwood et al. (2023), we model foreign and domestic investors' bond demand as exogenous and inelastic, and assume that they hedge an exogenous

constant fraction of their bond purchases through forward market. Although investor behavior is undoubtedly more complex in practice, the patterns documented in Figure 1 are driven by a fundamental difference in funding currency and would arise even in environments with endogenous portfolio choice.[8]

2 Implications for bond yields and exchange rates

Following Greenwood et al. (2023) and Gourinchas et al. (2025), we present a model in which government bond and foreign exchange markets, including spot and forward markets, are integrated with one another but segmented from other financial markets. A group of (domestic) intermediaries trades in all of these markets, conducting both the "yield-curve trade"—the trade that borrows short-term and lends long-term in domestic currency—and the "UIP trade"—the trade that borrows short-term in foreign currency and lends short-term in domestic currency. These two distinct trades are exposed to two distinct, yet possibly correlated, risks: bond price risk and currency risk.

In the model, the structure of the shocks determines the equilibrium properties of returns on the yield-curve and UIP trades. We consider shocks to short-term interest rates, shocks to domestic and foreign investors' demand for bonds and currencies, and additional asset-specific shocks that generate independent movements in bond and currency returns. As emphasized by Greenwood et al. (2023) and Gourinchas et al. (2025), shocks to short-term interest rates affect the returns to holding bonds of different maturities and currencies through the expectations hypothesis and uncovered interest parity channels, while demand shocks alter intermediaries' balance-sheet exposures. We emphasize that the origin of these demand shocks—whether from foreign or domestic investors—affects intermediary balance sheets in distinct ways, which is key to determining the equilibrium properties of returns on the yield-curve and UIP trades. At the end of this section, we discuss the role of the additional asset-specific shocks.

2.1 Baseline Model

The discrete-time model includes domestic short- and long-term bonds, as well as foreign short-term bonds, denominated in their respective currency. There are two types of agents: domestic and foreign bond investors, and intermediaries. Foreign and domestic bond investors have a preference—resulting in inelastic demand—for assets of specific currencies and maturities.

[8]Studies incorporating endogenous portfolio choice by foreign investors include Morelli et al. (2022); Akinci et al. (2022); Kekre et al. (2024); Kekre and Lenel (2025b); Bruno and Shin (2015); Hofmann et al. (2022).

Intermediaries, on the other hand, are specialized investors who absorb the net supply of domestic long-term bonds and foreign exchange resulting from exogenous demand shocks.

We follow Greenwood et al. (2023) and assume that asset prices (or yields) and expected returns are linear functions of a vector of state variables. To model fixed income assets, we (i) substitute log returns for simple returns throughout and (ii) use Campbell and Shiller (1988) linearizations of log returns.

Short-term bonds Short-term bonds in both currencies are supplied perfectly elastically, and short-term interest rates are determined exogenously according to AR(1) processes:

$$i_{t+1} = \bar{\imath} + \phi_i(i_t - \bar{\imath}) + \varepsilon_{i_{t+1}}; \tag{1}$$

$$i^\star_{t+1} = \bar{\imath} + \phi_i(i^\star_t - \bar{\imath}) + \varepsilon_{i^\star_{t+1}}, \tag{2}$$

where $\bar{\imath} > 0$, $\phi_i \in (0,1)$, $\text{var}(\varepsilon_{i_{t+1}}) = \text{var}(\varepsilon_{i^\star_{t+1}}) = \sigma_i^2 > 0$, and $\text{corr}(\varepsilon_{i_{t+1}}, \varepsilon_{i^\star_{t+1}}) = \rho \in [0,1]$. That is, we allow interest rate shocks to be correlated.

Long-term bonds Long-term bonds are perpetuities whose payments decline geometrically subject to time-varying cash flow shocks. The domestic currency return on long-term domestic bonds from t to $t+1$ is

$$r^y_{t+1} = y_t - \frac{\delta}{1-\delta}(y_{t+1} - y_t) - g_t, \tag{3}$$

where y_t is the log yield-to-maturity on domestic long-term bonds, and parameter $\delta \in (0,1)$ is the bond's payment decline rate (see Appendix A.1). Equation (3) expresses the bond's return as consisting of three components: (i) a carry component, (ii) a capital gain component, and (iii) time-varying cash flow shocks akin to time-varying default rates, respectively. The last term introduces a time-varying wedge in the price of domestic long-term bonds without directly influencing the fundamental value of the exchange rate. It follows an AR(1) process:

$$g_t = \phi_g g_{t-1} + \varepsilon_{g_t}, \tag{4}$$

where $\phi_g \in [0,1)$, and $\text{var}(\varepsilon_{g_t}) = \sigma_g^2 \geq 0$.

Let rx^y_{t+1} denote the excess return on domestic bonds, that is the return on the "yield-curve trade"—the trade that borrows short-term and lends long-term in domestic currency. Iterating equation (3) forward and taking expectations, one obtains:

$$y_t = (1-\delta)\sum_{j=0}^{\infty} \delta^j \, \text{E}_t[i_{t+j} + rx^y_{t+j+1} + g_{t+j}], \tag{5}$$

which indicates that the domestic long-term yield can be decomposed into the standard

expectations hypothesis and term premium components, as well as a term that accounts for all current and future expected shocks to cash flow of long-term bonds. The excess return on domestic bonds rx^y_{t+1} is determined in equilibrium, as described below.

Foreign exchange Let q_t denote the log nominal exchange rate, expressed as units of home currency per unit of foreign currency, in the spot market. The log excess return on the "UIP trade," the trade that borrows short-term in foreign currency and lends short-term in domestic currency, is:

$$rx^q_{t+1} = (i_t - i^\star_t) - (q_{t+1} - q_t). \tag{6}$$

Iterating this expression forward and taking expectations yields:

$$q_t = \sum_{j=0}^{\infty} \mathrm{E}_t[(i^\star_{t+j} - i_{t+j}) + rx^q_{t+j+1}] + \lim_{k\to\infty} \mathrm{E}_t\, q_{t+k}. \tag{7}$$

Equation (7) expresses the spot exchange rate as the sum of three components: (i) the expected future sum of interest rate differentials, i.e., the UIP component; (ii) a foreign exchange risk premium; and (iii) the expected long-run nominal exchange rate. We assume that the long-term nominal exchange rate, $\bar{q}_t \equiv \lim_{k\to\infty} \mathrm{E}_t\, q_{t+k}$, is time-varying and follows a random walk. That is:

$$\bar{q}_t = \bar{q}_{t-1} + \varepsilon_{q_t}, \tag{8}$$

where $\mathrm{var}(\varepsilon_{q_t}) = \sigma^2_q \geq 0$. Time variation in the long-term value of the nominal exchange rate introduces an additional, yet independent, source of risk for the UIP trade. While it is unmodeled here, time variation in the value of the long-term nominal spot exchange rate arises naturally in open-economy macroeconomic models with cross-country differences in inflation rates, while maintaining real exchange rate stationarity.

Intermediaries A subset of agents can trade all assets and enforce no arbitrage. Anticipating our empirical findings in Section 3, we refer to these agents as "intermediaries" or "domestic intermediaries." These agents maximize their next-period wealth through mean-variance preferences with a risk tolerance parameter τ. Let d^y_t denote the market value of the intermediary' holdings of long-term domestic bonds and d^q_t denote the value of the net intermediary's position in the borrow-foreign and lend-domestic UIP trade, all denominated in domestic currency. Defining $\mathbf{d}_t \equiv [d^y_t, d^q_t]'$ and $\mathbf{rx}_{t+1} \equiv [rx^y_{t+1}, rx^q_{t+1}]'$, intermediaries solve:

$$\max_{\mathbf{d}_t} \left\{ \mathbf{d}'_t\, \mathrm{E}_t[\mathbf{rx}_{t+1}] - \frac{1}{2\tau} \mathbf{d}'_t\, \mathrm{var}_t[\mathbf{rx}_{t+1}] \mathbf{d}_t \right\}, \tag{9}$$

Taking first-order condition yields the optimality condition faced by intermediaries:

$$\mathrm{E}_t[\mathbf{rx}_{t+1}] = \tau^{-1}\,\mathrm{var}_t[\mathbf{rx}_{t+1}]\mathbf{d}_t. \tag{10}$$

Equation (10) links the intermediaries' expected excess returns on different assets to their asset holdings. The variance–covariance matrix of excess returns governs the equilibrium relationship between intermediaries' positions and excess returns across the yield-curve trade and the UIP trade.[9]

Domestic and foreign investors' bond and currency demand In each period, domestic long-term bonds are available in a given net supply, denoted as s_t^y, which is equal to their gross issuance minus the demand from bond investors. The net supply of domestic long-term bonds follow AR(1) process:

$$s_{t+1}^y = \phi_{s^y}\, s_t^y + \varepsilon_{s_{t+1}^y}, \tag{11}$$

where $\phi_{s^y} \in [0,1)$, $\varepsilon_{s_{t+1}^y} = \eta_{t+1} + \eta_{t+1}^\star$, $\mathrm{var}(\varepsilon_{s_{t+1}^y}) = \sigma_\eta^2 + \sigma_{\eta^\star}^2 \geq 0$. We distinguish here between demand shocks coming from domestic investors (fluctuations in η_{t+1}) and foreign investors (fluctuations in $\eta_{t+1}^\star$) and we allow them to have different stochastic properties.

Let the net supply of home currency in the spot market (that is, net of the demand from domestic and foreign investors), denominated in units of domestic currency, follow a stochastic process such that

$$s_{t+1}^x = \phi_{s^q}\, s_t^x + \varepsilon_{s_{t+1}^x}, \tag{12}$$

where $\phi_{s^q} \in [0,1)$, $\varepsilon_{s_{t+1}^x} = \gamma_{t+1} + \gamma_{t+1}^\star$, and $\mathrm{var}(\varepsilon_{s_{t+1}^x}) = \sigma_\gamma^2 + \sigma_{\gamma^\star}^2 \geq 0$, distinguishing between demand shocks coming from domestic investors, γ_{t+1}, and foreign investors, $\gamma_{t+1}^\star$.

Without loss of generality, we assume throughout that, within each investor group, bond and currency demand volatilities are identical:

$$\phi_{s^y} = \phi_{s^q} \in [0,1); \qquad \sigma_\eta^2 = \sigma_\gamma^2 \geq 0; \qquad \sigma_{\eta^\star}^2 = \sigma_{\gamma^\star}^2 \geq 0. \tag{13}$$

Departing from the framework of Greenwood et al. (2023), and in line with the evidence of Section 1, we assume that any purchase of domestic long-term bonds $\eta_{t+1}^\star$ by foreign investors is accompanied by a simultaneous purchase of home currency in the spot market $\gamma_{t+1}^\star$ of same local-currency amount. That is:

$$\mathrm{cov}(\eta_{t+1}^\star, \gamma_{t+1}^\star) = \sigma_{\eta^\star}^2 = \sigma_{\gamma^\star}^2 \geq 0; \qquad \mathrm{corr}(\eta_{t+1}^\star, \gamma_{t+1}^\star) = 1. \tag{14}$$

[9] In Appendix A.2, we show that d_t^q consists of the sum of long spot and long forward positions, and thus indeed represents the net position of the intermediaries on the UIP trade.

This correlation arises naturally, as we argued in Section 1, as foreign investors intending to purchase domestic long-term bonds must inevitably acquire a corresponding amount of the home currency.

To the contrary, bond and currency demand of domestic investors are uncorrelated:

$$\text{cov}(\eta_{t+1}, \gamma_{t+1}) = 0; \qquad \text{corr}(\eta_{t+1}, \gamma_{t+1}) = 0. \tag{15}$$

Currency hedging We assume that a constant fraction $\alpha \in [0, 1]$ of foreign investor bond purchases are hedged via forward contracts. Specifically, foreign investors always purchase the full amount of domestic currency in the spot market to acquire local-currency bonds, and hedge a share α of this position by selling domestic currency in the forward market.

Let the net supply of home currency in the forward market (net of the demand from foreign investors), denominated in units of domestic currency, follow

$$s^f_{t+1} = \phi_{s^q} s^f_t + \varepsilon_{s^f_{t+1}} \tag{16}$$

where $\varepsilon_{s^f_{t+1}} = -\alpha\gamma^\star_{t+1}$ and thus $\text{var}(\varepsilon_{s^f_{t+1}}) = \alpha^2\sigma^2_{\gamma^\star}$. Intermediaries absorb flows both in the spot and forward FX markets. Taken together, the overall net supply of home currency (net of the demand from domestic and foreign investors), denominated in units of domestic currency, is

$$s^q_{t+1} = s^x_{t+1} + s^f_{t+1} = \phi_{s^q} s^q_t + \varepsilon^q_{t+1} \tag{17}$$

where $\varepsilon^q_{t+1} = \gamma_{t+1} + (1-\alpha)\gamma^\star_{t+1}$, and $\text{var}(\varepsilon_{s^q_{t+1}}) = \sigma^2_\gamma + (1-\alpha)^2\sigma^2_{\gamma^\star}$.

Market clearing The market clearing condition ensures that intermediaries absorb demand across bond and currency markets. That is:

$$\mathbf{s}_t = \mathbf{d}_t, \tag{18}$$

where $\mathbf{s}_t = [s^y_t, s^q_t]'$ denotes the vector of net supplies.

Correlated positions A key observation is that foreign investors' local-currency bond demand induces correlated changes in intermediaries' bond and currency positions (i.e., exposures to bond and currency risk). Formally, the correlation in intermediaries' positions is:

$$\Omega \equiv \text{corr}(d^y_t, d^q_t) = \frac{\text{cov}(s^y_t, s^q_t)}{\sqrt{\text{var}(s^y_t)}\sqrt{\text{var}(s^q_t)}} = \frac{(1-\alpha)\sigma^2_{\eta^\star}}{\sqrt{(\sigma^2_\eta + \sigma^2_{\eta^\star})}\sqrt{(\sigma^2_\eta + (1-\alpha)^2\sigma^2_{\eta^\star})}}, \tag{19}$$

which can be derived from equations (11)–(18).

The correlation in intermediaries' positions, labeled Ω, depends upon the relative importance of unhedged foreign investors' local-currency bond demand. As highlighted by equation (19), both the relative volatility of foreign investors' demand (rather than their average portfolio share), and their propensity to hedge currency risk matter for this relationship. When foreign investors play a relatively greater role in aggregate flow volatility, the correlation in flows across markets, and thus in intermediaries' positions, is higher. The extent of hedging by foreign investors also shapes this correlation. Comovement is strongest when foreign investors do not hedge their FX positions ($\alpha = 0$). Conversely, when foreign investors fully hedge their exposure to currency risk ($\alpha = 1$) their bond purchases generate no net currency pressure, eliminating any correlation in intermediaries' exposures to bond and currency risks.

Equilibrium Equilibrium expected excess returns must satisfy the intermediaries' optimality condition (10) as well as the market clearing condition (18), implying:

$$\mathrm{E}_t[\mathbf{rx}_{t+1}] = \tau^{-1} \operatorname{var}_t[\mathbf{rx}_{t+1}]\mathbf{s}_t. \tag{20}$$

To pin down equilibrium bond yields and exchange rates, y_t and q_t, we follow Greenwood et al. (2023) and conjecture that prices are linear functions of the state vector $\mathbf{z}_t$, which contains all stochastic processes, $\mathbf{z}_t = [i_t - \bar{\iota}, i_t^\star - \bar{\iota}, g_t, \bar{q}_t, s_t^y, s_t^q]'$. Appendix A.3 contains the full mathematical solution, provides a characterization of equilibrium bond yield and exchange rate, as well as a discussion on equilibrium multiplicity and selection.

Observations Three related but distinct points are worth emphasizing. First, in frameworks of frictional financial intermediation á la Greenwood et al. (2023) and Gourinchas et al. (2025), stochastic bond or currency supplies are not independent risk factors: absent interest rate risk, bond returns are fully predictable, so risk-averse intermediaries are unaffected by variation in the quantity of bonds or currency they must absorb, and supply shocks carry no risk premium. Supply risk is priced only insofar as variation in short-term rates generates uncertainty in asset returns. We formalize this observation in Appendix A.4.

Second, when short-term interest rate risk is the only independently priced risk factor, no arbitrary correlation structure imposed on supply shocks, whether exogenous or endogenous, can overturn the negative comovement in bond and currency returns due to interest rate risk. Because supply shocks are not themselves independently priced, the sign of the correlation between bond and currency returns is determined by the interest rate risk. We formalize this observation in Appendix A.4.

Third, our model breaks this logic by introducing two additional independently priced risk factors—affecting the cash flow of long-term bonds and the long-run value of the exchange rate—each of which generates return variation on its own, independently of interest rate risk. Unlike interest rate risk, these additional shocks do not, alone, generate any comovements in asset returns. However, once factors with these properties are present, the correlation structure of supply shocks can determine the sign of the correlation in bond and currency returns. We formalize this observation, central to our mechanism, in our analysis below.

3 Investors' flows and intermediaries' positions

We now outline several model predictions, and confront them with evidence from Colombia's bond and foreign exchange markets. Section 3.1 explores position and price dynamics during a period of foreign investor inflows into the Colombian local-currency sovereign bond market. Among several findings, this episode supports the view that intermediaries absorb imbalances across both markets, and prices adjust accordingly. To further substantiate this interpretation, Section 3.2 show that changes in intermediaries' positions predict, on average, higher subsequent excess returns on these positions. Throughout, "intermediaries" are the Colombian intermediaries that are designated dealers in bond and currency markets, "foreign investors" are investors domiciled outside of Colombia, and "domestic investors" are the domestic financial market participants other than intermediaries.

The key friction in the model is intermediaries' limited risk-bearing capacity. This links intermediaries' positions to expected returns. For tractability, we derive our main analytical results under a simplified version of the model. In particular, we abstract from interest-rate shocks ($\sigma_i = 0$) to isolate the effects of correlated foreign-investor flows. We abstract from currency risk hedging ($\alpha = 0$), so foreign investors' purchases of local-currency bonds translate fully into simultaneous flows in the currency market. These special cases, summarized Assumption 1, allow for sharp closed-form characterizations.

Assumption 1. *Short-term interest rates are deterministic ($\sigma_i = 0$), foreign investors do not hedge currency risk ($\alpha = 0$), asset-specific shocks are transitory ($\phi_g = 0$) and share the same volatility ($\sigma_g = \sigma_q$), and net-supply shocks are transitory ($\phi_{s_y} = \phi_{s_q} = 0$). In addition, long-term bonds are assumed to have near-infinite duration ($\delta \to 1$), and agents are sufficiently risk-tolerant (i.e., τ is large enough).*

3.1 The effects of foreign investors' bond purchases

We characterize the effects of a sudden increase in foreign investors' bond purchases.

Proposition 1. *Under Assumption 1, foreign investors' purchases of local-currency bonds cause*

(a) a simultaneous acquisition of domestic currency and domestic bonds by foreign investors;

(b) a decline in intermediaries' bond and currency positions;

(c) an increase in long-term bond prices and home currency appreciation.

Proof. See Appendix A.5. □

This proposition embodies a key mechanism of the model. When foreign investors buy local-currency bonds, they exchange short-term dollars for long-term pesos (they obtain short-term pesos and immediately use them to purchase long-term peso bonds). As intermediaries sell these bonds for dollars, they now have a shorter position on both the yield-curve trade, and on the UIP trade. Consequently, they require a downward shift in the premium on long-term bonds relative to short-term bonds, and on pesos relative to dollars. In equilibrium, long-term bond yields fall and the home currency appreciates.[10,11]

We confront these predictions against a major episode of foreign investor inflows into Colombia's local-currency government bond market (TES). In March 2014, J.P. Morgan announced the inclusion of five TES bonds in its flagship emerging-market local-currency index. The announcement triggered large index-driven purchases by foreign investors: by the time inclusion was completed in October 2014, foreign investors had acquired nearly 10% of outstanding TES bonds.[12] These purchases were mirrored almost one-for-one by foreign acquisitions of Colombian pesos (COP) in the spot FX market (Figure 2a). Consistent with Proposition 1, although the shock originates in the bond market, it simultaneously generates flows in the FX market because it is funded in US dollars.

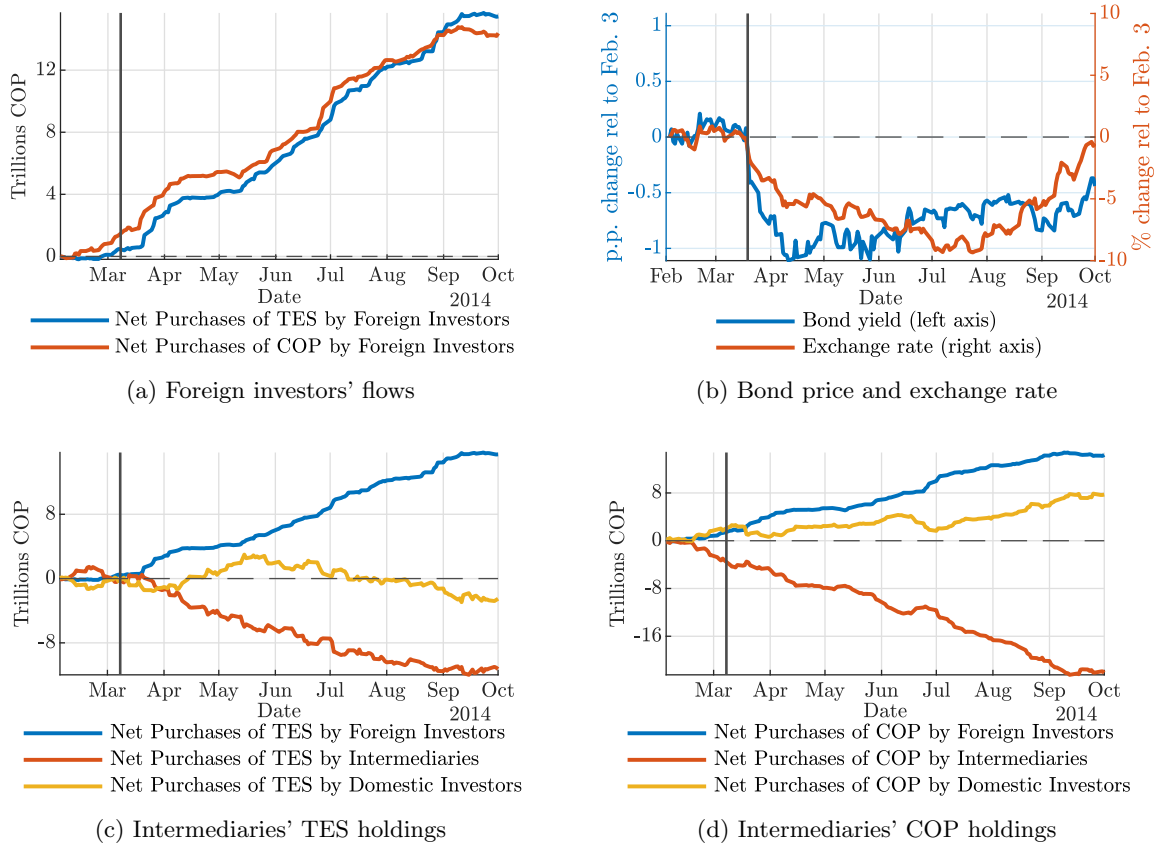
During this episode, Colombian intermediaries largely absorbed the resulting imbalances in both the bond and spot exchange markets (Figure 2c, Figure 2d); a similar pattern appears

[10] Note that a foreign investor's purchase of a long-term Colombian bond from a domestic intermediary leaves the financial account unchanged in this model. The transaction in fact involves exchanging a Colombian bond for a short-term foreign bond.

[11] Gabaix and Maggiori's (2015) model illustrates how capital flows into *short-term* local-currency bond markets can cause currency appreciations. We argue that these capital inflows occur primarily in the *long-term* local-currency bond markets, not only changing the net supply of different currencies, but also changing the net supply of local-currency bonds of different maturities.

[12] Williams (2018) uses Colombia's inclusion in J.P. Morgan's emerging markets debt index to study how increased foreign access to sovereign debt markets boosts private credit availability.

Figure 2
Positions and prices during J.P. Morgan Index Rebalancing



(a) Foreign investors' flows

(b) Bond price and exchange rate

(c) Intermediaries' TES holdings

(d) Intermediaries' COP holdings

Note: Figure 2a displays the evolution of the daily accumulated foreign purchases of TES bonds as well as with the daily accumulated foreign purchases of COP in the spot market during 2014. Figure 2c and Figure 2d display the evolution of the daily accumulated purchases of TES bonds and COP in the spot market, respectively, during 2014 for different investor groups (described in Section 1 and Section 3). The black vertical line denotes March 19, 2014, the day the rebalancing was announced.

when considering net spot purchases minus forward sales (Appendix Figure C.1). Thus, the foreign investors' purchases significantly changed intermediaries' bond and currency positions.

Price dynamics also align with the model's mechanism. Figure 2b reveals that, following the announcement, long-term bond prices increased (bond yields fell) and the peso appreciated. These patterns are consistent with the notion that intermediaries required lower future returns on both yield-curve and UIP trades as their exposures to these trading strategies' underlying risk have declined.

3.2 Intermediaries: positions and returns

We now examine whether intermediaries' positions predict subsequent bond and currency returns, as implied by their role as the marginal investors that absorb imbalances in these markets.

A key feature of models with frictional financial intermediation is that intermediaries

require compensation for bearing risk in the form of expected excess returns. In our model, this principle implies that intermediaries' positions predict their respective excess returns, as well as excess returns in the other market when bond and currency risks are correlated.

Proposition 2. *Under Assumption 1, intermediaries earn positive expected excess returns on both their bond and currency positions. Thus, on average, intermediaries' positions predict their respective excess returns:*

$$\mathbb{E}(\Delta d_t^y rx_{t+1}^y) \geq 0 \qquad \textit{and} \qquad \mathbb{E}(\Delta d_t^q rx_{t+1}^q) \geq 0,$$

where rx_{t+1}^y and rx_{t+1}^q denote, respectively, the one-period excess returns on bond and currency positions. Moreover, when positions are positively correlated across markets, as in our model with $\Omega \geq 0$, positions in one market also predict returns in the other:

$$\mathbb{E}(\Delta d_t^q rx_{t+1}^y) \geq 0 \qquad \textit{and} \qquad \mathbb{E}(\Delta d_t^y rx_{t+1}^q) \geq 0.$$

Proof. See Appendix A.5. □

More generally, a key implication of models of frictional financial intermediation is that intermediaries' risk exposures predict subsequent returns (see, e.g., Haddad and Sraer (2020)). In our setting, greater exposure to bond risk therefore predicts higher subsequent bond returns and, when bond and currency risks are correlated, also higher currency returns. The same logic applies to currency risk exposure.

We test this prediction using intermediaries' positions, measured in domestic currency. We focus on intermediaries' spot FX exposures rather than their combined spot and forward positions. This choice is motivated by the limited role of the forward market during the 2014 capital inflow episode (see Appendix Figure C.1) and, more generally, by the fact that foreign investors' forward FX transactions appear largely uncorrelated with their spot FX transactions (see Appendix Figure C.2).[13] We scale intermediaries' bond and FX positions by total TES outstanding and by M1, respectively.[14]

We then examine whether intermediaries' positions predict subsequent bond and currency returns. Specifically, for horizons $h = 1, 3, 6, 12$ months, we consider the unconditional

[13] Appendix Figure C.2 also implies that any correlation between intermediaries' spot and forward transactions does not stem from interactions with foreign investors. Thus, if intermediaries systematically offloaded currency risk through the forward market—something not observed during the 2014 episode (Appendix Figure C.1)—that risk would be absorbed by other domestic entities. The bond and currency exposures of the relevant "marginal" domestic portfolios would nevertheless remain correlated because of foreign investor participation.

[14] TES holdings are measured as a share of total TES outstanding. COP holdings are constructed by taking total liquid assets in the financial system at the beginning of our sample, accumulating monthly FX spot purchases, and normalizing by Colombia's M1 money supply.

Table 1
Intermediaries Portfolios' and UIP and Yield-Curve Trade Returns

Horizon (h)	1M	3M	6M	12M
$\mathrm{E}(\Delta d_t^q \times rx_{t+h}^q)$	2.5	10.6	31.4***	64.8***
	(2.3)	(6.8)	(10.6)	(19.0)
Observations	95	93	90	84
$\mathrm{E}(\Delta d_t^y \times rx_{t+h}^y)$	2.9	10.6*	17.5**	35.6***
	(4.9)	(5.8)	(6.7)	(9.3)
Observations	132	132	132	132
$\mathrm{E}(\Delta d_t^y \times rx_{t+h}^q)$	5.9	12.6	53.9***	67.6**
	(6.7)	(11.3)	(18.6)	(30.3)
Observations	131	129	126	120
$\mathrm{E}(\Delta d_t^q \times rx_{t+h}^y)$	0.4	4.0	6.0**	5.8
	(1.8)	(3.0)	(2.4)	(3.6)
Observations	96	96	96	96

Note: This table reports results from mean t-tests of the product of UIP and yield-curve trade returns with different positions of intermediaries. The 1M, 3M, 6M, and 12M columns denote test for average returns with holding periods of 1, 3, 6, and 12-month, respectively. The null hypothesis is that average returns are equal to zero. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively.

expectations of the four position-return products

$$\left\{\Delta d_t^q rx_{t+h}^q,\ \Delta d_t^y rx_{t+h}^y,\ \Delta d_t^y rx_{t+h}^q,\ \Delta d_t^q rx_{t+h}^y\right\}.$$

Here, Δd_t^q denotes a change in intermediaries' position associated with selling USD to buy COP, measured in USD; Δd_t^y denotes a change in intermediaries' position toward long-term domestic government bonds; rx_{t+h}^q denotes excess currency returns over an h-month holding period; and rx_{t+h}^y denotes the corresponding excess bond returns. We focus on the 10-year local-currency government bond and measure returns in domestic currency. Table 1 reports mean t-tests of whether these unconditional expectations differ from zero.

The results in Table 1 are consistent with Proposition 2. Intermediaries' bond and currency positions predict both bond and currency returns, with estimates that are noisier at the one-month horizon but statistically significant at the 3-, 6-, and 12-month horizons. Appendix Table C.1 shows that the corresponding positive association is not present for domestic or foreign investors. Taken together, the evidence is consistent with intermediaries—both

primary dealers and FX market intermediaries—being the agents that enforce no-arbitrage conditions and require compensation for bearing the associated risks.

4 Bond yields and exchange rates, and asset purchase policies

We now characterize the equilibrium relationship between bond yields and exchange rates, focusing on the correlation between excess bond returns and excess currency returns, and quantify the role of unhedged foreign investor demand for bonds in shaping this correlation in Colombia's data (Section 4.1). We then derive the implications for the transmission of asset purchase policies and confront these predictions with evidence on the effects of central bank dollar purchases (Section 4.2).

4.1 Equilibrium bond and currency returns

Our mechanism implies a tight connection between the presence of unhedged foreign investor flows and the correlation in bond and currency returns.

Proposition 3. *Under Assumption 1,* $\text{corr}_t(rx^y_{t+1}, rx^q_{t+1}) > 0$ *if and only if* $\Omega > 0$.

Proof. See Appendix A.5. □

Absent interest rate risk, the correlation between excess bond and currency returns is positive whenever unhedged foreign investors operate in the local-currency bond market, and thus risk exposures are positively correlated. Absent interest rate shocks, the two independently priced risk factors are the shocks to cash flow of long-term bonds and the shocks to the long-run value of the exchange rate. These shocks are asset specific, and thus, if demand fluctuations were independent, term premia and currency premia would also be uncorrelated. However, when demand shocks are correlated, as it is the case in the presence of unhedged foreign investors, their comovement is reflected in the joint distribution of premia. Correlated positions thus beget correlated returns as they directly link the net supply in bond and currency markets that intermediaries must absorb, and, as a result, the premia they require. (Note that this effect emerges even if intermediaries absorbing the demand for bonds and currency were distinct entities.)

We now turn to examine the determinants of the bond-currency return comovement in the general version of the baseline model calibrated on Colombian data, which includes short-term interest rate risk.

Calibration Our calibration approach does not target directly the empirical comovement in excess bond and currency returns. Instead, it relies on the time series properties of short-term interest rates and net supply volumes, as well as the standard deviations of excess bond returns and excess currency returns. The model is calibrated on Colombian data at a quarterly frequency. Table B.1 reports the values of the baseline parameters. We use 3-month interbank rates from Colombia and the United States to discipline the processes of short-term interest rates (ϕ_i, σ_i, ρ). We construct quarterly bond positions of market participants to discipline the persistence of the net supply shocks ($\phi_{s^y} = \phi_{s^q}$) and the volatility of domestic and foreign investors' bond demand shocks ($\sigma_\eta = \sigma_\gamma$ and $\sigma_{\eta^\star} = \sigma_{\gamma^\star}$).[15] The symmetric calibration of net supply processes across bond and currency markets (following eq. (13)) appears a reasonable approximation of the data. We set the risk aversion of intermediaries ($1/\tau$) to 0.03, in line with the range of calibrated values in Gourinchas et al. (2025). We calibrate the unobservable asset-specific shocks (σ_g, σ_q) to match the standard deviation of excess 10-year Colombian bond returns and excess currency returns.

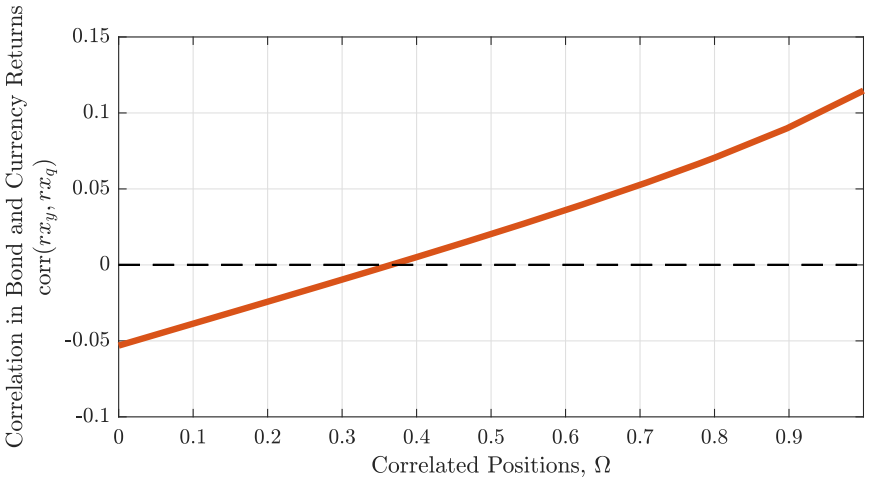
In this baseline calibration we set the currency-risk hedge ratio, α, to 0. We argue that this is a valid approximation of the Colombian data: Appendix Figure C.2 documents that there is no consistent relationship between foreign investors net purchases of COP in the spot market and their net sales of COP in the forward market, indicating that foreign investors do not systematically hedge their COP-denominated bond positions.

Quantifying the role of correlated positions To quantify the contribution of correlated intermediaries' positions to the comovement of bond and currency excess returns, we compare two models that differ in the degree of correlated positions (that is, Ω in (19)). The first calibration corresponds to the empirically relevant level of correlated net supply fluctuations for Colombia, $\Omega = 0.46$. The second is a counterfactual economy in which foreign investors' flows are uncorrelated across markets, implying $\Omega = 0$, while holding all other parameters fixed (that is, leaving the overall volatility of demand shocks unchanged).

Figure 3 depicts the correlation in bond and currency returns for different levels of correlation in intermediaries' portfolios' exposure. In the counterfactual economy without correlated exposures, the model implies a negative correlation between excess bond and currency returns (around -6%). In this case, as in Greenwood et al. (2023), short-term interest rate shocks are the only set of shocks that induce correlated risk, and yield-curve

[15]The TES (COP) holdings are computed as a fraction of the total value of TES outstanding bonds (M1 money aggregate).

Figure 3
Asset positions and asset returns



Note: The figure depicts the equilibrium correlation in bond and currency excess returns for different levels of correlation in net supplies, $\Omega \equiv \text{corr}(s_t^y, s_t^q)$ (achieved by different relative importance of foreign to home standard deviations of supply shocks, see eq. (19)). Table B.1 reports the baseline calibration.

and UIP trades load on these shocks with opposite signs. An increase in domestic short-term rates results in lower domestic long-term bond prices, which is detrimental to the yield-curve trade, but it simultaneously appreciates the domestic currency, benefiting the UIP trade.[16] By contrast, in the baseline model with $\Omega = 0.46$, correlated net supply fluctuations introduce a source of risk that moves term premia and currency premia in the same direction (the correlation is around 2%), overturning the negative comovement generated by interest rate risk alone.

Thus, the difference in correlations between these two calibrations of the model ($\Omega = 0$ and $\Omega = 0.46$) isolates the portion of bond-currency comovement attributable to unhedged foreign investors flows and correlated exposures. Quantitatively, moving from the counterfactual to the baseline raises the bond-currency return correlation by about 8%, accounting for approximately half of the empirical counterpart (which is around 14%).

4.2 Asset purchase policies, bond yields and exchange rates

The equilibrium variance–covariance matrix of bond and currency returns shapes the effects of asset purchases—policies that alter intermediaries' positions in either bond or currency markets, such as foreign exchange interventions. Asset purchase programs have become increasingly prevalent in both advanced and emerging economies. The following proposition formalizes these effects in the case of central bank foreign currency purchases, which is the

[16] Short-rate risk only influences the correlation in returns if short-rate fluctuations are not perfectly correlated across countries. Correlated short-rate fluctuations limit the variation in the short-rate *differential*, thereby reducing the impact of interest rate risk on the UIP trade.

focus of our empirical analysis.

Proposition 4. *In the baseline model of Section 2, a domestic central bank's purchase of foreign currency, modeled as an increase in γ_t in equation (17), leads to a depreciation of the home currency. In addition, it causes a decline in the price of long-term bonds if and only if* $\text{cov}_t(rx^y_{t+1}, rx^q_{t+1}) > 0$.

Proof. See Appendix A.5. □

Even if the central bank's purchases of foreign currency are confined to a single market—the foreign exchange market—they affect not only the exchange rate but also the price of long-term bonds. This "cross-market" effect arises from two central features of our model and is shaped by the structure of shocks.

First, intermediaries operate in both the bond and currency markets, which are exposed to correlated risks. As a result, a shift in the net supply of one asset effectively induces revisions in both term premia and currency premia, as it alters the intermediaries' exposure to correlated bond and currency risks. Second, the magnitude and direction of these effects depend on the stochastic properties of bond and currency returns, captured by their covariance. As discussed in Section 4.1, this covariance reflects, at least in part, the relative importance of unhedged foreign investor flow shocks versus short-term interest rate shocks. In economies where unhedged foreign investor flows are dominant, the risks associated with the UIP trade and the yield-curve trade are positively correlated, and so is the response of bond yields and exchange rates to asset purchases/sales.[17] We now turn to the empirical evidence on these predictions.

Empirical setting We confront these predictions with evidence from a program of foreign exchange auctions conducted by the central bank in Colombia. As we describe below, these auctions alter the net supply of dollars that intermediaries must absorb, allowing us to trace the effects of these interventions on the exchange rates and bond prices at which these intermediaries trade.

Institutional background The central bank conducted foreign exchange auctions as part of a program of daily, pre-announced dollar purchases aimed at accumulating international reserves. Although such operations were conducted between 2008 and 2014, we focus on the

[17] In this model, asset purchases should be interpreted as government interventions carried out under the full variance-covariance structure implied by all exogenous processes, rather than in a counterfactual setting where these interventions are the sole source of variation.

2012–2014 period, when auctions became effectively daily and when detailed secondary-market transaction data are available, allowing us to link auction outcomes to market prices.[18]

We analyze proprietary data covering 650 multi-unit, uniform-price foreign exchange auctions conducted by the central bank. Prior to each auction, the central bank announced a purchase quota for US dollars, exactly two minutes before the auction began. This announcement was largely operational, as it implemented a stable purchase pace maintained over extended periods and already anticipated by market participants, rather than reflecting a discretionary day-by-day choice. At the same time, it conveyed the timing of the operation within the day. Realized purchases could fall short of the announced quota if dealers submitted insufficient dollar offers. In practice, however, this constraint was rarely binding: the central bank purchased, on average, 99.2 percent of the announced quota across auction dates. Auctions were conducted over a three-minute window, during which authorized financial institutions could submit and revise bids specifying both a price (COP/USD) and a quantity of dollars offered. Each participant was allowed to submit a single bid. At the close of the auction, bids were ranked in ascending order of price, and allocations were made sequentially starting from the lowest-priced offers until the preannounced purchase amount was exhausted. All accepted bids were settled at a common clearing price, defined as the highest accepted ask price (the cutoff price), consistent with a uniform-price auction mechanism.

On average, each auction involved around eight participating financial institutions, primarily private commercial banks drawn from the set of authorized dealers. The central bank purchased an average of USD 23 million per day, with purchases occasionally reaching USD 50 million. For context, during the same period the average daily turnover in the COP/USD spot market was approximately USD 950 million, with an average individual transaction size of about USD 0.785 million (see Table 2 for additional descriptive statistics on central bank auctions).

Identification approach We examine the effects of the auction by comparing the subsequent trading behavior of dealers that barely won to those that barely lost, in both the foreign exchange and the bond markets. The identifying assumption in this comparison is that bidders close to the threshold, those who barely win and those who barely lose, are ex ante similar. Marginal bidders, whose bids fall just above or below the cutoff, cannot precisely anticipate their final status, so that winning is as good as random in a neighborhood of the

[18] Auctions were intermittent prior to 2012 (June 24–October 6, 2008; March 3–June 30, 2010; January 3–September 30, 2011). Continuous daily operations begin in 2012, coinciding with the availability of secondary market data.

Table 2
US Dollar Auctions and Outcome Variables: Summary Statistics

	Mean	Std. Dev.	Min	P25	Median	P75	Max
Panel A: US Dollar Auctions (650 auctions, March 2012–December 2014)							
Number of Participants	8.14	2.58	2.0	6.0	8.0	10.0	15.0
Winning Participants	4.91	2.10	1.0	3.0	5.0	6.0	11.0
Losing Participants	3.23	2.20	0.0	2.0	3.0	5.0	10.0
Bids per Auction	8.14	2.58	2.0	6.0	8.0	10.0	15.0
Winning Bids per Auction	4.91	2.10	1.0	3.0	5.0	6.0	11.0
Losing Bids per Auction	3.23	2.20	0.0	2.0	3.0	5.0	10.0
Cutoff Price	1,885	93.9	1,756	1,804	1,882	1,932	2,372
Bid Range per Auction	1.71	1.40	0.10	0.90	1.30	2.00	9.18
USD Purchase by Marginal Winning bid$^{(a)}$	4.69	4.53	0.10	1.50	3.00	6.60	32.00
Panel B: Outcome Variables							
TES Sec. Market Prices	−2.37	6.14	−20.4	−6.43	−3.41	0.41	21.1
USD Sec. Market Prices	−0.002	0.06	−0.49	−0.02	−0.00	0.02	1.3

Note: This table presents summary statistics for all 650 US Dollar auctions in our sample. $^{(a)}$ Amounts are expressed in millions of US dollars. Panel A shows the summary statistics for the US dollar Auctions. Panel B shows the summary statistics for the outcome variables.

cutoff. Under this identifying assumption, differences in secondary-market asset prices within a narrow window around the cutoff are attributable to the differential impact of the auction on winners' and losers' balance sheets.[19]

We provide suggestive evidence on the composition of marginal bidders. Table C.2 shows that barely winning and barely losing observations are spread across many institutions, even though dealers differ in their overall participation rates and in their frequency of being close to the cutoff. Thus, the identifying variation is not driven exclusively by a small set of dealers. Table C.3 further documents limited persistence in auction outcomes, which is consistent with limited scope for systematic sorting around the cutoff. Appendix Figures C.3 and C.4 provide direct evidence on the comparability of marginal winners and losers across various dimensions: dealers' pre-auction positions, total assets, and total liabilities all evolve continuously through the cutoff, with discontinuities that are statistically indistinguishable from zero.

We center each dealer's bid on the auction cutoff and define the running variable as the signed distance from the cutoff,

$$z_{i,t} = -\left(a_{i,t} - a_t^c\right),$$

where $a_{i,t}$ is the price submitted by dealer i on auction day t and a_t^c is the cutoff price. Because the central bank ranks bids in ascending order and accepts the lowest-priced offers,

[19]The institutional implementation of liquidity management further supports this interpretation. Sterilization through TES was relatively uncommon during this period, as day-to-day liquidity management relied primarily on repos and remunerated deposits, and FX purchases could often be accommodated through lower repo provision. Moreover, the FX purchases in our sample were small relative to routine liquidity operations. When TES operations were used for liquidity management, they were spread over time and across maturities to minimize effects on individual bond prices. Such operations therefore affected market-wide liquidity conditions rather than the relative exposure of marginal winners and losers within a given auction.

our sign convention implies that accepted bids lie weakly above zero and rejected bids lie below zero. That is, winners satisfy $z_{i,t} \geq 0$, while losers satisfy $z_{i,t} < 0$, and the cutoff is centered at zero. The treatment indicator is

$$T_{i,t} = \mathbb{1}\{z_{i,t} \geq 0\},$$

which equals one for accepted bids.

We consider two complementary estimators: a *sharp* design that measures the effect of winning the auction, and a *fuzzy* design that scales this discontinuity by the awarded volume.

The sharp design uses a local linear regression within a data-driven bandwidth to estimate the discontinuity in a secondary-market outcome $y_{i,t}$ at the cutoff:

$$y_{i,t} = \beta_{RD}\, T_{i,t} + \beta_1\, z_{i,t} + \beta_2\, z_{i,t} \times T_{i,t} + \varepsilon_{i,t}, \tag{21}$$

where $y_{i,t}$ denotes either bond or dollar prices in their respective secondary markets, measured after the auction but during the same trading day, and expressed as a % deviation from the median spot price of the corresponding day (to avoid issues related to unit scaling over time). The coefficient of interest is β_{RD}, the reduced-form effect of *winning* the auction on the secondary-market outcome; unlike the fuzzy design below, it is not scaled by the allocated quantity. Estimation uses the data-driven bandwidth of Calonico et al. (2014) with a uniform kernel, and standard errors clustered at each value of the running variable (Lee and Card, 2008).

The fuzzy design uses two-stage least squares, instrumenting awarded volume $x^s_{i,t}$ with the winning indicator $T^s_{i,t}$. The logic behind the identification strategy is that, within a narrow neighborhood of the auction cutoff, bids just above and just below the cutoff are locally comparable, while crossing the cutoff generates a discontinuous increase in awarded volume. Thus, under the standard RD continuity, no-manipulation, exclusion, and monotonicity assumptions, the cutoff indicator provides a valid local instrument for awarded volume. The two-stage least squares is as follows:

$$x^s_{i,t} = \pi\, T^s_{i,t} + \gamma_1\, z^s_{i,t} + \gamma_2\, z^s_{i,t} \times T^s_{i,t} + \alpha_t + u_{i,t}, \tag{22}$$

$$y_{i,t} = \beta_{FRD}\, \widehat{x}^s_{i,t} + \delta_1\, z^s_{i,t} + \delta_2\, z^s_{i,t} \times T^s_{i,t} + \alpha_t + \varepsilon_{i,t}. \tag{23}$$

The fuzzy (Wald) estimator $\hat{\beta}_{FRD}$ is the ratio of the jump in the outcome to the jump in awarded volume at the cutoff. It recovers the effect of a one million US dollars of awarded

volume. That is,

$$\beta_{FRD} = \frac{\lim_{\epsilon \downarrow 0} E\left[y_{i,t} | z^s_{i,t} = \epsilon\right] - \lim_{\epsilon \uparrow 0} E\left[y_{i,t} | z^s_{i,t} = \epsilon\right]}{\lim_{\epsilon \downarrow 0} E\left[x^s_{i,t} | z^s_{i,t} = \epsilon\right] - \lim_{\epsilon \uparrow 0} E\left[x^s_{i,t} | z^s_{i,t} = \epsilon\right]}. \tag{24}$$

Interpretation This empirical framework uses cross-intermediary variation to identify the effects of asset purchases on bond yields and exchange rate. To illustrate how this evidence speaks to the the effects of Proposition 4, Appendix A.6 extends the baseline model with a simple decentralized trading protocol among intermediaries that generates temporary price dispersion around the aggregate equilibrium. Within the extended framework, idiosyncratic net supply shocks, such as those arising from marginally winning or losing central bank auctions, generate cross-sectional differences in subsequent intermediary transaction prices. In particular, an intermediary that receives an idiosyncratic shock that leaves it with a larger peso inventory and a smaller dollar inventory trades at a higher dollar price (i.e., a more depreciated exchange rate) and requires a higher yield to hold local-currency bonds than an intermediary that does not face such an inventory imbalance. Importantly, the effect on bond yields arises only when the equilibrium covariance between bond and currency returns is positive, and its magnitude is increasing in this covariance, all else equal.[20]

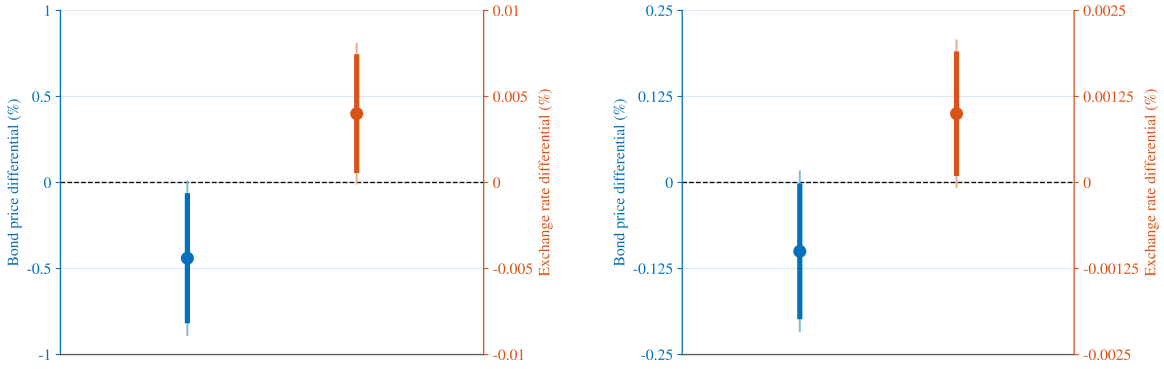
Asset price effects of asset purchases We document that central bank purchases of US dollars affect both the exchange rate and bond prices in a manner consistent with Proposition 4. Figure 4 reports sharp and fuzzy estimates of the effect of winning the US dollar auction on both secondary markets, while Appendix Table C.4 reports the full set of estimated coefficients. Under the sharp design, dollar auction winners, the dealers that sell US dollars to the central bank, subsequently trade FX at prices 0.004 percentage points higher and bonds at prices 0.44 percentage points lower than auction losers, with both effects significant at the 10% level. These magnitudes are economically meaningful: the exchange rate effect is about 7% of the standard deviation of the USD secondary-market outcome (0.06), and the bond price effect about 7% of the standard deviation of the TES secondary-market outcome (6.14; see Table 2).[21] Appendix Figure C.5 presents the corresponding binned RD plots.

These effects are consistent with the prediction in Proposition 4. A central bank purchase

[20] Moreover, we emphasize that a cross-sectional approach also mitigates concerns related to the information effects of central bank interventions—such as those discussed and documented in Candian et al. (2023)—which would inevitably be present in high-frequency asset price responses around the intervention.

[21] The marginal winners sell on average USD 4.69 million to the central bank (see Table 2), equivalent to roughly 0.5% of average daily FX turnover.

Figure 4
The responses of bond prices and exchange rates to central banks' US dollar purchases



(a) Sharp Design (b) Fuzzy Design

Note: This figure reports the effect of winning the US dollar auction on bond and exchange rate secondary-market prices, along with 90% (darker) and 95% (lighter) confidence intervals constructed using standard errors clustered at each value of the running variable. Panel (a) reports the sharp estimate β_{RD} in equation (21); panel (b) reports the fuzzy estimate β_{FRD} in equation (22). All specifications use a uniform kernel and the data-driven bandwidth of Calonico et al. (2014). Appendix Table C.4 reports the full set of estimates.

of foreign currency depreciates the peso (that is, it increases the price of US dollars), and, because bond and currency returns are positively correlated, the greater exposure to Colombian peso risk induced by winning the dollar auction also leads intermediaries to demand a higher term premium, lowering long-term bond prices. The joint sign pattern, a weaker peso together with lower bond prices, therefore implies a positive perceived covariance $\text{cov}_t(rx^y_{t+1}, rx^q_{t+1}) > 0$.

While the sharp design measures the effect of winning per se, the fuzzy design isolates the effect per unit of awarded volume, instrumenting the realized change in the dealer's dollar inventory with the winning indicator. The first stage is strong: barely winning raises a dealer's awarded volume by about USD 4.5 million at the cutoff, highly significant in both samples (Appendix Table C.5) and in line with the average marginal allocation reported in Table 2. The fuzzy coefficients therefore admit a direct economic reading: they measure the price impact, in each secondary market, of one million additional US dollars of inventory that the marginal intermediary must absorb. Per one additional million dollars of awarded volume, winning the auction lowers the TES secondary price by 0.10 percentage points and raises the USD spot price by 0.001 percentage points, both significant at the 10% level and signed exactly as in the sharp design. Evaluated at the mean awarded volume of the marginal winner (USD 4.69 million; Table 2), these per-unit effects amount to about 7.6% and 7.8% of the standard deviation of the TES and USD outcomes, respectively, closely matching the magnitudes in the sharp design. The joint pattern per dollar absorbed, a lower bond price together with a weaker peso, once more implies a positive perceived covariance

$\text{cov}_t(rx^y_{t+1}, rx^q_{t+1}) > 0$. Both designs thus deliver the same conclusion: a central bank dollar purchase weakens the peso and lowers long-term bond prices.

Discussion An identifying assumption across both sharp and fuzzy designs is that dealers cannot precisely manipulate their position relative to the cutoff. In a standard regression-discontinuity setting, such manipulation would typically appear as a discontinuity in the density of the running variable at zero. We therefore test for a density discontinuity following Cattaneo et al. (2020).

This diagnostic requires some care in the auction setting. In each auction, the cutoff is an equilibrium object that separates winning from losing bids, and at least one bid lie exactly at the clearing price. As a result, pooling auctions mechanically generates mass at zero even in the absence of manipulation. Such bunching reflects the auction-clearing rule rather than dealers' ability to sort precisely around the cutoff. For this reason, a density test in this setting is best interpreted as a conservative diagnostic: evidence of bunching at zero could overstate manipulation, while continuity of the estimated density provides reassuring support for the design.

Appendix Figure C.6 reports the test for the US dollar auctions. Despite the auction-specific concern that the clearing rule may mechanically create mass near the cutoff, the estimated density is continuous at zero. The test statistic is $T = 0.823$, with a p-value of 0.411, so we fail to reject the null of no density discontinuity. This result argues against the presence of precise manipulation around the cutoff and lends supports to our empirical design.

5 Foreign investors and asset returns across countries

Do countries with a higher prevalence of unhedged foreign investor flows exhibit a higher correlation between bond and currency returns? To answer this question, we construct a measure capturing the extent to which a country is exposed to unhedged foreign investor flows, and study whether cross-country variation in this measure is associated with differences in the joint behavior of bond yields and exchange rates.

5.1 Bond and currency returns across countries

We begin by extending the analysis of bond and currency returns in Lustig et al. (2019) to a larger panel of economies. We document that there is substantial amount of cross-country heterogeneity in correlation between excess bond returns and excess currency returns.

Definitions We denote $P_t^{(n)}$ as the price of a zero-coupon bond of maturity n in local-currency terms at time t, with the continuously compounding yield on this bond given by $y_t^{(n)} = -\frac{1}{n} \log P_t^{(n)}$. The short-term risk-free rate r_t^f is the yield on a one-period bond.

The local-currency bond excess return on the domestic zero-coupon bond in local currency $rx_{t+1}^{(n)}$ is defined as:

$$rx_{t+1}^{(n)} = -(n-1)y_{t+1}^{(n-1)} + ny_t^{(n)} - r_t^f.$$

It represents the excess return on the "yield-curve trade"—the trade that borrows short-term and lends long-term in domestic currency. It is the return from holding a long-term bond for one period, financed by borrowing at the short-term rate in domestic currency.

As in Section 2, Q_t is the nominal spot exchange rate in terms of domestic currency per US dollar, and $\Delta q_{t+1} = \log(Q_{t+1}/Q_t)$ is the rate of domestic currency depreciation.

The excess return on home currency, rx_{t+1}^q, is

$$rx_{t+1}^q = r_t^f - r_t^{f,US} - \Delta q_{t+1}.$$

It represents the return on the "UIP trade"—the trade that borrows short-term in foreign currency and lends short-term in domestic currency over one period.

Data We select all economies with bond benchmark indexes on *Datastream*. We use monthly data from January 2006 to December 2021.[22] The dataset includes spot exchange rates, 10-year government bond total return indexes, and 3-month deposit rates.[23] Our sample includes Australia, Canada, Colombia, India, Indonesia, Japan, Mexico, New Zealand, Poland, South Africa, South Korea, Sweden, Switzerland, Thailand, and the United Kingdom.

Analysis Consider the following country-j-specific regression of excess currency returns on excess bond returns:

$$rx_{j,t+3}^q = \alpha + \beta rx_{j,t+3}^{(10y)} + \epsilon_{j,t+3}. \tag{25}$$

Table 3 (Columns (1)-(2)) reports the estimates of β of equation (25) and the associated correlation coefficients for our panel of countries. There is vast heterogeneity across countries in the comovement between bond and currency returns. Across countries, regression and correlation coefficients are either significantly negative, significantly positive, or statistically

[22] While some countries' sample starts in December 1999, the data is sparse before 2006, and thus we start our analysis in 2006. We exclude data beyond December 2021 to avoid incorporating recent inflation dynamics.
[23] Although the above bond excess returns are defined for zero-coupon bonds, empirically, we compute them using monthly returns on 10-year government bond total return indexes, which may pertain to coupon government bonds. This approach is standard and follows Lustig et al. (2019).

Table 3
Bond and currency excess returns (3-month excess returns)

			Residualized excess returns	
Country	Regression coefficient	Correlation	Regression coefficient	Correlation
Australia	-0.88^{***}	-0.47	-0.68^{***}	-0.41
	(0.17)	$[-0.57, -0.35]$	(0.18)	$[-0.54, -0.26]$
Canada	-0.69^{***}	-0.44	-0.74^{***}	-0.51
	(0.11)	$[-0.55, -0.32]$	(0.13)	$[-0.62, -0.38]$
Colombia	0.13^{**}	0.14	0.18^{***}	0.12
	(0.06)	$[0.00, 0.28]$	(0.07)	$[-0.04, 0.28]$
India	0.02	0.02	0.07	-0.01
	(0.13)	$[-0.13, 0.17]$	(0.12)	$[-0.18, 0.16]$
Indonesia	0.56^{***}	0.62	0.57^{***}	0.21
	(0.08)	$[0.49, 0.72]$	(0.10)	$[0.02, 0.39]$
Japan	1.37^{***}	0.35	1.12^{***}	0.29
	(0.30)	$[0.21, 0.47]$	(0.38)	$[0.13, 0.43]$
Korea	-0.06	-0.04	-0.15	-0.02
	(0.16)	$[-0.22, 0.14]$	(0.18)	$[-0.21, 0.18]$
Mexico	0.29^{**}	0.20	0.36^{***}	0.17
	(0.11)	$[0.03, 0.35]$	(0.12)	$[-0.02, 0.34]$
New Zealand	-0.61^{***}	-0.34	-0.45^{**}	-0.27
	(0.16)	$[-0.46, -0.21]$	(0.18)	$[-0.42, -0.11]$
Poland	0.09	0.04	-0.01	0.11
	(0.14)	$[-0.10, 0.18]$	(0.13)	$[-0.06, 0.27]$
South Africa	0.61^{***}	0.30	0.74^{***}	0.24
	(0.16)	$[0.16, 0.42]$	(0.20)	$[0.07, 0.39]$
Sweden	-1.01^{***}	-0.53	-0.98^{***}	-0.55
	(0.14)	$[-0.63, -0.42]$	(0.14)	$[-0.66, -0.43]$
Switzerland	-0.31^{*}	-0.16	-0.23	-0.12
	(0.17)	$[-0.30, -0.02]$	(0.18)	$[-0.28, 0.04]$
Thailand	0.51^{**}	0.31	0.51^{**}	0.20
	(0.21)	$[0.00, 0.56]$	(0.21)	$[-0.11, 0.47]$
United Kingdom	-0.69^{***}	-0.45	-0.74^{***}	-0.51
	(0.12)	$[-0.56, -0.33]$	(0.15)	$[-0.63, -0.38]$

Note: Column (1) reports the estimated slope coefficient of regression equation (25). Column (2) reports the correlation between $rx^{q}_{j,t+3}$ and $rx^{(10y)}_{j,t+3}$. Columns (3)-(4) repeat the analysis using the excess returns residualized by current and lag probability of default in the 10-year sovereign bonds (as retrieved from *Refinitiv*), that is: $rx^{m}_{j,t+3} = \sum_{k=0}^{1} \phi_k(\text{Prob. default}_{j,t-k}) + \epsilon^{rx^m}_{j,t+3}$, where $m = \{10y, q\}$. Stars denote significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Values in parenthesis are standard errors, and values in square brackets are 95 percent confidence interval.

insignificant. These conclusions apply also when using 1-month excess returns, as documented in Appendix Table B.2.

In our interpretation of cash-flow shocks to long-term bonds developed in Appendix A.1, time-varying default risk affects bond returns independently of currency returns (the cash flow shocks). One could, however, consider richer models in which time-varying default risk by itself generates a positive comovement between bond and currency returns. We

provide evidence suggesting that this default risk is unlikely to explain the positive association between bond and currency excess returns. We proxy for default risk using probabilities of default on 10-year sovereign bonds from *Refinitiv*. We residualize both bond and currency excess returns with respect to contemporaneous and lagged default probabilities, and then regress residualized excess currency returns on residualized excess bond returns. Table 3 (Columns (3)–(4)) shows that the residualized returns exhibit comovement patterns very similar to those observed in the raw data (Columns (1)–(2)).

5.2 Foreign investors and currency hedging across countries

Our mechanism links the comovement of bond and currency returns to a country's exposure to unhedged foreign investor flows, and thus to the extent to which intermediaries' positions are positively correlated across bond and currency markets. This degree of correlated positions is governed by Ω in equation (19). We now turn to estimating Ω for each country in our sample.

We use the standard deviations of the shares of foreign and non-bank domestic investors, respectively, in local-currency government debt securities to proxy for the volatility of foreign and domestic investors' flows, $\sigma_{\eta^\star}$ and σ_η, in equation (19). These measures are based on data on quarterly investor holding shares of sovereign debt for the sample period 2006-2021 (Arslanalp and Tsuda, 2012, 2014). To do so, we assume that the total outstanding amount of local-currency bonds is constant, so as to use investor holding shares, rather than levels, to construct estimates of $\sigma_{\eta^\star}$ and σ_η.[24] We identify domestic banks as the relevant "intermediaries," a choice consistent with the analysis and evidence in Section 3.

To measure hedging ratios, α, we rely on estimates from the existing literature. For advanced economies, we use hedge ratios for global fixed-income investors from Cheema-Fox and Greenwood (2024). For emerging economies, we use the estimates of hedge ratios for US mutual funds documented in Chen and Zhou (2025). While the evidence on hedging ratios for emerging economies is based on US mutual funds, we note that these are main foreign investor type in Colombia's local currency government bond market (see Appendix B.1).[25]

Table 4 reports, for each country, the estimated importance of unhedged foreign investors' bond flows, labeled Ω, along with the estimated relative volatility in bond flows, $\sigma_{\eta^\star}/\sigma_\eta$, and estimated hedge ratios, α. We observe substantial cross-country heterogeneity in Ω, which ranges from close to zero in the United Kingdom to roughly 80 percent in Indonesia. These

[24] Non-bank domestic investors exclude domestic bank and central bank holdings. For emerging economies, we construct these shares using the share of non-bank domestic investors in total sovereign debt, as data disaggregated by currency denomination are not available.

[25] The hedging ratio estimates correspond to averages over 1998-2023 from Cheema-Fox and Greenwood (2024) and 2010–2023 from Chen and Zhou (2025).

Table 4
Correlated positions across countries

Country	Corr. Pos. Ω	Rel. Std. Dev. $\sigma_{\eta^\star}/\sigma_\eta$	Hedge Ratio α
Australia	0.09	0.66	0.75
Canada	0.08	0.64	0.76
Colombia	0.46	0.95	0.05
India	0.09	0.29	−0.20
Indonesia	0.81	2.00	−0.09
Japan	0.03	0.27	0.56
Korea	0.14	0.35	−0.33
Mexico	0.70	1.38	−0.24
New Zealand	0.20	1.07	0.74
Poland	0.59	1.04	−0.38
South Africa	0.70	1.58	0.09
Sweden	0.04	0.79	0.91
Switzerland	0.12	0.80	0.75
Thailand	0.63	1.14	−0.36
UK	0.001	0.10	0.93

Note: Column 1 reports our estimated measure of overall correlation in net supplies, based on eq. (19). Column 2 reports the relative standard deviation of holdings, computed as the ratio of the standard deviation of the share of local-currency sovereign debt securities held by foreign investors to that held by domestic non-bank investors, using data from Arslanalp and Tsuda (2012, 2014). Column 3 reports the hedging ratio for each country, following Cheema-Fox and Greenwood (2024) for advanced economies and Chen and Zhou (2025) for emerging economies.

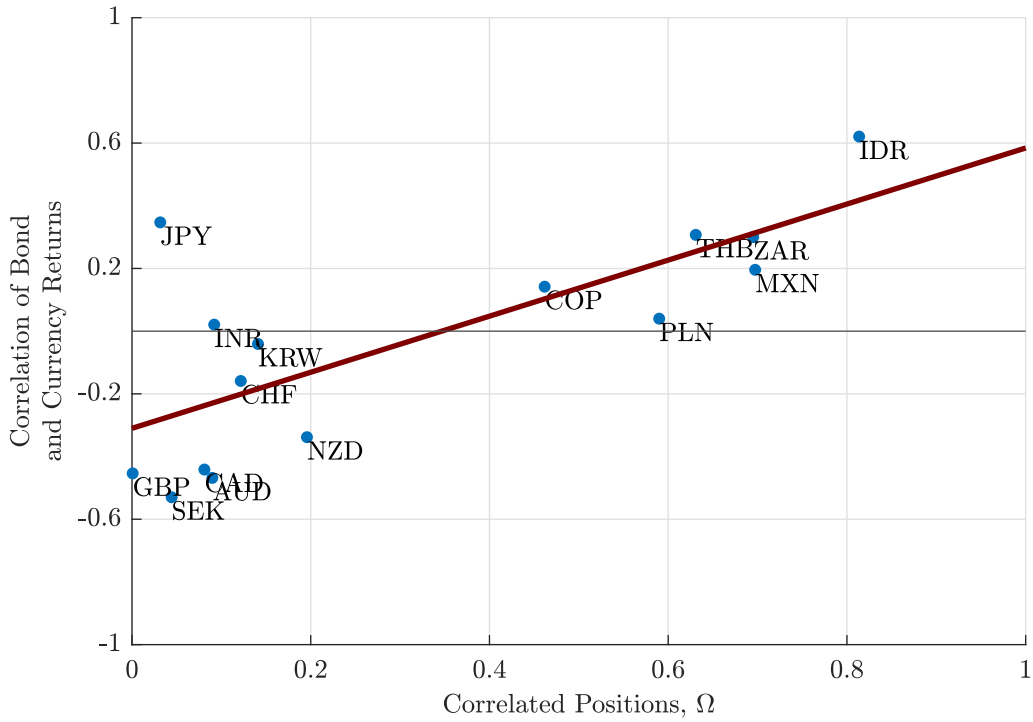
differences reflect variation across countries in both the relative importance of foreign versus domestic investor flows and in foreign investors' currency-hedging behavior.

It is worth noting that hedge ratios of US mutual funds investing in emerging economies are sometimes negative. This reflects the tendency of US mutual funds to further increase, rather than reduce, their exposure to emerging market currencies, and it is consistent with the models in De Leo et al. (2024b) and Chen and Zhou (2025), where forward demand partly reflects currency speculation. Our model can easily accommodate "negative hedging ratios," as α need not be restricted between 0 and 1. That said, in Appendix Figure B.2, we recompute Ω after truncating the distribution of hedge ratios so that $\alpha \geq 0$, and the substantive conclusions of this analysis remain unchanged.

5.3 Correlated positions and correlated bond–currency returns

We document that, in line with our model's mechanism, countries with a higher estimated correlation in intermediaries' positions exhibit, on average, a more positive comovement between bond and currency returns, as illustrated in Figure 5. Although our empirical measure of correlated positions, Ω, is admittedly simple, we view this evidence as indicative of a meaningful relationship between the relative importance of unhedged foreign flows in

Figure 5
Correlated Positions and Bond-Yield Comovement



Note: This figure displays the correlation of bond and currency excess returns (y-axis) and the Ω from eq. (19) (x-axis).

total flow volatility and the bond–currency return comovement. We note that both the differential presence of foreign investors' and the differential propensity to hedge currency risk independently contribute to cross-country variation in bond–currency return comovement (see Appendix Figure B.3).

Advanced vs. emerging economies Figure 5 highlights a distinction between advanced and emerging economies. With a few notable exceptions, emerging economies exhibit both high correlated positions and a positive comovement between bond and currency returns. As shown in Table 4, the large correlated positions observed in emerging economies can be attributed to the prominent role of foreign investors *and* their limited use of currency hedging.

Systematic differences in hedge ratios between emerging and advanced economies are not surprising. Foreign investors are typically attracted to emerging markets by substantially higher interest rate differentials relative to advanced economies. Hedging currency risk in such environments is costly, as it effectively requires giving up the interest rate differential (assuming covered interest parity approximately holds).[26] In addition, many emerging economies—both

[26] This consideration has led many investment advisors, such as Meketa Investment Group (2022), to recommend avoiding currency hedging for emerging market investments, while viewing hedging as more appropriate for advanced economies.

sovereigns and corporates—issue debt in US dollars, providing an alternative to investing in local-currency assets that require costly currency hedging, which may further contribute to the observed differences in hedging behavior across the two groups of countries.

6 Conclusion

Local-currency government bond markets around the world are populated by both domestic and foreign investors (Arslanalp and Tsuda, 2012, 2014). We argue that this basic feature has been largely overlooked in leading models with frictional financial intermediation, despite having first-order implications for asset price dynamics and for the transmission of central bank asset purchase programs. Our central insight is that differences in funding currencies imply that investor composition governs how flows are distributed across bond and currency markets, and, in turn, the adjustments in bond yields and exchange rates required for intermediaries to absorb these flows.

This mechanism captures several salient features of the data. It accounts for the joint behavior of bond prices and exchange rates during episodes of foreign inflows into Colombia's local-currency bond market. It rationalizes why changes in Colombia's intermediaries' positions forecast both term premia and currency premia, and it explains intermediaries' trading behavior following central bank interventions in the foreign exchange market. More broadly, the framework helps explain cross-country heterogeneity in the comovement between bond yields and exchange rates. Thus, the presence of foreign investors matters not only during episodes of large inflows, but more fundamentally because it shapes the comovement between bond and currency returns, and therefore the nature of risk faced by intermediaries.

From a policy perspective, our model highlights that the transmission of central bank policies to bond prices and exchange rates depends on the composition of investors in local-currency bond markets. In this sense, there are meaningful interactions between financial regulation policies—such as capital controls—and central bank balance sheet policies—such as quantitative easing or foreign exchange interventions. While assessing the welfare implications of these interactions is beyond the scope of this paper, our results suggest that policymakers should take them into account when designing these policy frameworks.

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Appendix

A Model Appendix

A.1 Return of a perpetuity: Campbell-Shiller approximation

This appendix derives equation (3), the domestic-currency return on long-term domestic bonds.

Bond cash flows absent default Long-term bonds are self-amortizing perpetuities with face value 1 at time t. Absent default, the bond pays a coupon C each period, together with a principal repayment $1-\kappa$, while a fraction $\kappa \in [0,1]$ of the remains outstanding into the next period. Let P_t^y denote the bond's price and Y_t its yield-to-maturity. The (default-free) gross return from t to $t+1$ is

$$1 + R_{t+1}^{y,*} = \frac{C + 1 - \kappa + \kappa P_{t+1}^y}{P_t^y}. \tag{A.1}$$

Discounting the geometrically declining coupon-and-principal stream at the constant yield Y_t gives the closed-form price

$$P_t^y = \sum_{j=1}^{\infty} \frac{\kappa^{j-1}(1-\kappa+C)}{(1+Y_t)^j} = \frac{1+C-\kappa}{1+Y_t-\kappa}. \tag{A.2}$$

Introducing time-varying default We now depart from the default-free case. Default follows a Poisson process, as in Duffie and Singleton (1999). Let ψ_t be the intensity of sovereign default. When default strikes a given bond, the government restructures it, writing down its coupon, principal, and continuation value by a common fraction $\ell \in [0,1]$. We model the stock of long-term debt as a continuum of individual perpetuity contracts of the type described above, each subject to *independent* Poisson default arrival with the common intensity ψ_t. After a given contract defaults, the government immediately reissues a replacement contract with identical terms (C, κ), restoring its place in the deterministic path of aggregate bond supply (similar to Costain et al. (2022)).

Two consequences follow immediately from this construction. First, because defaulted bonds are replaced one-for-one and on the same terms, the distribution of outstanding bonds is unaffected by the history of default events. Second, default timing is independent across the continuum of contracts, so by a law of large numbers the realized *fraction* of the bond stock defaulting between t and $t+1$ is deterministic, even though no single contract's default date is predictable. This fraction equals the intensity ψ_t.

The representative bond's payoff is thus haircut by the deterministic factor $(1-\ell\psi_t)$. The resulting gross return on the bond from t to $t+1$ is

$$1+R^y_{t+1}=\frac{(1-\ell\psi_t)\left(C+1-\kappa+\kappa P^y_{t+1}\right)}{P^y_t}, \tag{A.3}$$

where P^y_t is the bond's (equilibrium) price and Y_t, defined via

$$P^y_t=\frac{1+C-\kappa}{1+Y_t-\kappa}, \tag{A.4}$$

is its yield-to-maturity, exactly as in (A.2).

Log-linear approximation of the return Take the log-linear approximation of eq. (A.3) around the point where it is trading at par at $t+1$ and $\psi_t=0$:

$$r^y_{t+1}\approx\theta+\delta\, p^y_{t+1}-p^y_t-\ell\psi_t, \tag{A.5}$$

where $\theta\equiv\ln(1+C)$ and $\delta\equiv\kappa/(1+C)$, exactly as in the default-free case. Default risk enters (A.5) only through the additive term $-\ell\psi_t$; it does not affect the linearization coefficients θ,δ, since these come from the cash-flow structure (C,κ), which is unaffected by default given immediate re-issuance.

Applying the same first-order approximation linking the log yield to the price as in the baseline case—i.e. log-linearizing (A.4) around par—collapses this to the static relation

$$p^y_t\approx\frac{1}{1-\delta}\theta-\frac{1}{1-\delta}y_t. \tag{A.6}$$

Substituting (A.6), evaluated at both t and $t+1$, into (A.5), the price terms cancel and we obtain

$$r^y_{t+1}\approx\frac{1}{1-\delta}y_t-\frac{\delta}{1-\delta}y_{t+1}-\ell\psi_t,$$

which we rewrite, adding and subtracting y_t, as

$$r^y_{t+1}\approx y_t-\frac{\delta}{1-\delta}(y_{t+1}-y_t)-\ell\psi_t. \tag{A.7}$$

Equation (A.7) is precisely (3) in the main text, with $g_t\equiv\ell\,\psi_t$. The return on the long-term bond decomposes into (i) a carry component y_t, (ii) a capital-gain component $-\frac{\delta}{1-\delta}(y_{t+1}-y_t)$ driven by revisions to the yield, and (iii) a default-risk wedge g_t equal to the haircut-weighted default intensity, which lowers the realized return independently of yield movements. Finally, letting the default intensity ψ_t vary over time and follow (after scaling by ℓ) an autoregressive process delivers (4).

A.2 Spot and forward exchange markets and Covered Interest Parity

Let d_t^x denote the intermediary's net positions in the borrow-foreign and lend-domestic FX trade in the spot market. Let d_t^f denote a long-domestic forward position of the intermediary. Both d_t^x and d_t^f are expressed in domestic currency units. The realized returns from these positions are given by:

$$d_t^x[i_t - i_t^\star - (q_{t+1} - q_t)] + d_t^f[f_t - q_{t+1}] \tag{A.8}$$

where f_t is the time-t forward log nominal exchange rate, measured in units of domestic currency per unit of foreign currency. Defining the total FX market position as $d_t^q \equiv d_t^x + d_t^f$, we rewrite the expression above as:

$$d_t^q[i_t - i_t^\star - (q_{t+1} - q_t)] - d_t^f[i_t - i_t^\star - (f_t - q_t)] \tag{A.9}$$

The first term is the realized return of the intermediary's net exposure to the UIP trade, combining long spot and forward FX positions. The second term is the return from a *covered* FX trade, which earns any covered interest parity (CIP) deviations CIP devs$_t \equiv i_t - i_t^\star - (f_t - q_t)$.

Defining $\mathbf{d}_t \equiv [d_t^y, d_t^q, d_t^f]'$ and $\mathbf{rx}_{t+1} \equiv [rx_{t+1}^y, rx_{t+1}^q, \text{CIP devs}_t]'$, intermediaries solve:

$$\max_{\mathbf{d}_t} \left\{ \mathbf{d}_t' \, \mathrm{E}_t[\mathbf{rx}_{t+1}] - \frac{1}{2\tau} \mathbf{d}_t' \, \mathrm{var}_t[\mathbf{rx}_{t+1}] \mathbf{d}_t \right\}, \tag{A.10}$$

Taking first-order condition yields the optimality condition faced by intermediaries:

$$\mathrm{E}_t[\mathbf{rx}_{t+1}] = \tau^{-1} \, \mathrm{var}_t[\mathbf{rx}_{t+1}] \mathbf{d}_t. \tag{A.11}$$

or:

$$\begin{bmatrix} \mathrm{E}_t[rx_{t+1}^y] \\ \mathrm{E}_t[rx_{t+1}^q] \\ \mathrm{E}_t[\text{CIP devs}_t] \end{bmatrix} = \tau^{-1} \begin{bmatrix} \mathrm{var}_t(rx_{t+1}^y) & \mathrm{cov}_t(rx_{t+1}^y, rx_{t+1}^q) & 0 \\ \mathrm{cov}_t(rx_{t+1}^q, rx_{t+1}^y) & \mathrm{var}_t(rx_{t+1}^q) & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} d_t^y \\ d_t^q \\ d_t^f \end{bmatrix}$$

and thus:

$$\text{CIP devs}_t = 0$$

CIP holds in this model, because any CIP deviations would create *riskless* arbitrage opportunities. Regardless of their risk tolerance, intermediaries would thus eliminate away any CIP deviations.

As a result, we can simplify the intermediary's optimization problem by recasting it in terms of their positions in the long-term domestic bond market (d_t^y) and in the combined FX

market ($d_t^q \equiv d_t^x + d_t^f$), which consolidates spot and forward FX exposures.

A.3 Solution of baseline model

In this subsection, we derive the system of equations necessary to solve the baseline model presented in Section 2.1. We follow Greenwood et al. (2023) by conjecturing that equilibrium prices are a linear function of a state vector of shocks and arrive at a system of two equations with two unknowns. The resulting equations can be studied to derive qualitative implications about the model. We close out Appendix A by proving the main propositions of the paper.

A.3.1 Equilibrium Conjecture and Properties

Equilibrium Conjecture We conjecture that the two prices that we need to pin down in equilibrium, y_t and q_t, are a linear function of a state vector of z_t

$$y_t = \alpha_0^y + \alpha_1^{y'} z_t;$$
$$q_t = \alpha_0^q + \alpha_1^{q'} z_t,$$

where the 6×1 state vector $\mathbf{z}_t = [i_t - \bar{\iota}, i_t^* - \bar{\iota}, g_t, \bar{q}_t, s_t^y, s_t^q]'$ follows a VAR(1) process $\mathbf{z}_{t+1} = \Phi \mathbf{z}_t + \varepsilon_{t+1}$, with $\text{var}_t[\varepsilon_{t+1}] = \Sigma$ and $\Phi = \text{diag}(\phi_i, \phi_i, \phi_g, 1, \phi_{s^y}, \phi_{s^q})$. In vector form the two prices yield $\mathbf{y}_t + \mathbf{a} + \mathbf{A}\mathbf{z}_t$, where $\mathbf{y}_t = [y_t, q_t]'$, $\mathbf{a} = [\alpha_0^y, \alpha_0^q]'$, and $\mathbf{A} = [\alpha_1^y, \alpha_1^q]'$.

Rational Expectations Equilibrium Let $f(\alpha_0)$ be an operator that gives the price-impact coefficients that clear the markets for long-term bonds and FX when agents conjecture that $\alpha = \alpha_0$, where $\alpha = vec(\text{A})$. We say that a rational expectations equilibrium in this model is a fixed point

$$\alpha^* = f(\alpha^*). \tag{A.13}$$

Within this context, intermediaries must form beliefs—specifically, price-impact coefficients—about how the net supplies of long-term bonds and foreign exchange, s_t^y and s_t^q, influence equilibrium asset prices, y_t and q_t. A rational expectations equilibrium is therefore a fixed point of a specific operator involving these price-impact coefficients.

Equilibrium Properties The presence of supply risk in this model makes the risk tolerance of investors τ a key variable. If agents are not risk-tolerant enough, then an equilibrium does not exist. However, for high levels of risk tolerance, stochastic supply shocks generate multiple equilibria. The different equilibria correspond to different self-fulfilling beliefs (price-impact coefficients) that investors might have about the risk of holding the different assets. For

example, if investors believe that supply shocks barely affect prices, they will perceive these assets as less risky. Consequently, investors will absorb large supply shocks and will not require large compensations through a fall in asset prices. However, if investors believe supply shocks will have greater impact on prices, they demand a large decline in prices as compensation for absorbing these shocks.

Despite multiple equilibria, there is always a unique stable equilibrium. Denoting by $\{\lambda_i\}$ the eigenvalues of the Jacobian $D_\alpha f(\alpha^*)$, we see that α^* is stable if $|\lambda_i| < 1$. The importance of a unique stable equilibrium lies in the fact that we can infer qualitative implications from our model. It also implies that comparative statics on our equilibrium price-impact coefficients α^* offer an easy and informative interpretation.

A.3.2 Equilibrium Solution

Recall the first-order condition of intermediaries:

$$\mathrm{E}_t[\mathbf{rx}_{t+1}] = \tau^{-1}\,\mathrm{var}_t[\mathbf{rx}_{t+1}]\mathbf{d}_t. \tag{A.14}$$

This equation, along with the market clearing condition ($\mathbf{d}_t = \mathbf{s}_t$), implies

$$\mathrm{E}_t[\mathbf{rx}_{t+1}] = \tau^{-1}\mathbf{V}\mathbf{s}_t, \tag{A.15}$$

where

$$\mathbf{V} = \mathrm{var}_t[\mathbf{rx}_{t+1}] = \begin{bmatrix} V_y & C_{y,q} \\ C_{y,q} & V_q \end{bmatrix}.$$

We can write out equation (A.14), yielding individual excess return equations:

$$\mathrm{E}_t\left[rx^y_{t+1}\right] = \frac{1}{\tau}\left[V_y \cdot s^y_t + C_{y,q} \cdot s^q_t\right]; \tag{A.16a}$$

$$\mathrm{E}_t\left[rx^q_{t+1}\right] = \frac{1}{\tau}\left[C_{y,q} \cdot s^y_t + V_q \cdot s^q_t\right], \tag{A.16b}$$

where $V_y \equiv \mathrm{var}_t[rx^y_{t+1}]$, $V_q \equiv \mathrm{var}_t[rx^q_{t+1}]$, and $C_{y,q} \equiv \mathrm{cov}_t[rx^y_{t+1}, rx^q_{t+1}]$. Note that $\mathbf{V}$ is constant in equilibrium and we hereafter drop the time subscripts.

Using these equilibrium excess return equations, along with asset prices equations (5) and (7), as well as the exogenous processes, we can characterize equilibrium bond yields and foreign exchange prices:

$$y_t = \left\{\bar{\iota} + \frac{1-\delta}{1-\delta\phi_i}\cdot(i_t - \bar{\iota})\right\} + \frac{1-\delta}{1-\delta\phi_g}g_t + \tau^{-1}\left\{\frac{1-\delta}{1-\delta\phi_{s^y}}V_y \cdot s^y_t + \frac{1-\delta}{1-\delta\phi_{s^q}}C_{y,q} \cdot s^q_t\right\}; \tag{A.17}$$

$$q_t = \left\{ \frac{1}{1-\phi_i} \cdot (i_t^\star - i_t) \right\} + \bar{q}_t + \tau^{-1} \left\{ \frac{1}{1-\phi_{s^y}} C_{y,q} \cdot s_t^y + \frac{1}{1-\phi_{s^q}} V_q \cdot s_t^q \right\}. \tag{A.18}$$

We now focus on the fixed-point problem. The vector of excess returns is

$$\mathbf{rx}_{t+1} \equiv \begin{bmatrix} rx_{t+1}^y \\ rx_{t+1}^q \end{bmatrix} = \begin{bmatrix} \frac{1}{1-\delta} y_t - \frac{\delta}{1-\delta} y_{t+1} - i_t - g_t \\ i_t - i_t^\star - (q_{t+1} - q_t) \end{bmatrix} = \mathbf{B}_0 \mathbf{y}_t + \mathbf{B}_1 \mathbf{y}_{t+1} + \mathbf{R}_1 \mathbf{z}_t + \mathbf{r}_0.$$

where we have used equations (1), (2), (3), (6), and the fact that $rx_{t+1}^y \equiv r_{t+1}^y - i_t$. Additionally,

$$\mathbf{B}_0 = \begin{bmatrix} \frac{1}{1-\delta} & 0 \\ 0 & 1 \end{bmatrix}, \ \mathbf{B}_1 = \begin{bmatrix} -\frac{\delta}{1-\delta} & 0 \\ 0 & -1 \end{bmatrix}, \ \mathbf{R}_1 = \begin{bmatrix} -1 & 0 & -1 & 0 & 0 & 0 \\ 1 & -1 & 0 & 0 & 0 & 0 \end{bmatrix}, \mathbf{r}_0 = \begin{bmatrix} -\bar{\iota} \\ 0 \end{bmatrix}.$$

Note that when conjecturing the equilibrium, we defined $\mathbf{y}_t = \mathbf{a} + \mathbf{A}\mathbf{z}_t$. Iterating this expression one period forward and using that $\mathbf{z}_{t+1} = \Phi \mathbf{z}_t + \varepsilon_{t+1}$, one can obtain that

$$\mathbf{y}_{t+1} = \mathbf{a} + \mathbf{A}\mathbf{z}_{t+1} = \mathbf{a} + \mathbf{A}\Phi \mathbf{z}_t + \mathbf{A}\varepsilon_{t+1}. \tag{A.19}$$

Recall that Φ is a diagonal matrix with the AR(1) coefficients of the 6 different exogenous processes. Going back to the equation for $\mathbf{rx}_{t+1}$ we just derived yields

$$\mathbf{rx}_{t+1} = [\mathbf{B}_0\mathbf{a} + \mathbf{B}_1\mathbf{a} + \mathbf{r}_0] + [\mathbf{B}_0\mathbf{A} + \mathbf{B}_1\mathbf{A}\Phi + \mathbf{R}_1]\mathbf{z}_t + [\mathbf{B}_1\mathbf{A}]\varepsilon_{t+1}, \tag{A.20}$$

which implies that

$$E_t[\mathbf{rx}_{t+1}] = [\mathbf{B}_0\mathbf{a} + \mathbf{B}_1\mathbf{a} + \mathbf{r}_0] + [\mathbf{B}_0\mathbf{A} + \mathbf{B}_1\mathbf{A}\Phi + \mathbf{R}_1]\mathbf{z}_t; \tag{A.21}$$

$$\mathbf{V} \equiv \text{var}_t[\mathbf{rx}_{t+1}] = \mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1'. \tag{A.22}$$

Going back to the market-clearing condition in equation (A.15), $\mathbf{s}_t = [s_t^y, s_t^q]'$ can be written as $\mathbf{s}_t = \mathbf{S}_1\mathbf{z}_t$, where

$$\mathbf{S}_1 \equiv \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

which allows us to write equation (A.15) as

$$[\mathbf{B}_0\mathbf{a} + \mathbf{B}_1\mathbf{a} + \mathbf{r}_0] + [\mathbf{B}_0\mathbf{A} + \mathbf{B}_1\mathbf{A}\Phi + \mathbf{R}_1]\mathbf{z}_t = \tau^{-1}(\mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1')(\mathbf{S}_1\mathbf{z}_t). \tag{A.23}$$

Equation (A.23) is the main equation which will be used to solve the fixed-point problem. We first separate the terms that contain $\mathbf{z}_t$ from the terms that do not. For the constant terms we find that

$$(\mathbf{B}_0 + \mathbf{B}_1)\mathbf{a} = -\mathbf{r}_0. \tag{A.24}$$

Based on the structure of $\mathbf{B}_0$ and $\mathbf{B}_1$, the last row of the $\mathbf{B}_0+\mathbf{B}_1$ only contains zeros. Therefore, the domestic long-term bond yield is pinned down in equilibrium—but the constant for the exchange rate is not.

For the terms containing $\mathbf{z}_t$, note that $\mathbf{B}_0, \mathbf{B}_1$, and Φ are diagonal, and thus it follows that

$$[\mathbf{B}_0 \mathrm{A} + \mathbf{B}_1 \mathrm{A}\Phi] = \mathbf{A} \circ [\mathbf{B}_0\mathbf{E} + \mathbf{B}_1\mathbf{E}\Phi], \tag{A.25}$$

where $\circ$ is the element-wise matrix multiplication and $\mathbf{E}$ is a 2×6 matrix of 1s. Thus, we get

$$[\mathbf{B}_0\mathbf{E} + \mathbf{B}_1\mathbf{E}\Phi] = \begin{bmatrix} \frac{1-\delta\phi_i}{1-\delta} & \frac{1-\delta\phi_i}{1-\delta} & \frac{1-\delta\phi_g}{1-\delta} & \frac{1}{1-\delta} & \frac{1-\delta\phi_{s^y}}{1-\delta} & \frac{1-\delta\phi_{s^q}}{1-\delta} \\ 1-\phi_i & 1-\phi_i & 1-\phi_g & 1 & 1-\phi_{s^y} & 1-\phi_{s^q} \end{bmatrix}.$$

Using this, the terms containing $\mathbf{z}_t$ have to equate on both sides. That is,

$$[\mathbf{A} \circ (\mathbf{B}_0\mathbf{E} + \mathbf{B}_1\mathbf{E}\Phi) + \mathbf{R}_1]\mathbf{z}_t = \tau^{-1}(\mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1')\mathbf{S}_1\mathbf{z}_t. \tag{A.26}$$

Solving for the $\mathbf{A}$ in the LHS yields

$$\mathbf{A} = [\tau^{-1}\mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1'\mathbf{S}_1 - \mathbf{R}_1] \oslash [\mathbf{B}_0\mathbf{E} + \mathbf{B}_1\mathbf{E}\Phi], \tag{A.27}$$

where $\oslash$ is element-wise matrix division. To further characterize the solution to the problem in (A.27), we can partition $\mathbf{z}_t$ as $\mathbf{z}_t = [\mathbf{z}_{1,t}', \mathbf{z}_{2,t}', \mathbf{z}_{3,t}']'$, where $\mathbf{z}_{1,t} = [i_t - \bar{\iota}, i_t^* - \bar{\iota}, g_t]'$, $\mathbf{z}_{2,t} = \bar{q}_t$, and $\mathbf{z}_{3,t} = [s_t^y, s_t^q]'$. Similarly, we partition $\mathbf{A} = [\mathbf{A}_1, \mathbf{A}_2, \mathbf{A}_3]$, where $\mathbf{A}_1$ is the 2×3 matrix of loadings on $\mathbf{z}_{1,t}$, $\mathbf{A}_2$ is the 2×1 matrix of loadings on $\mathbf{z}_{2,t}$, and $\mathbf{A}_3$ is the 2×2 matrix of loadings on $\mathbf{z}_{3,t}$.

For an arbitrary matrix $\mathbf{X}$, denote $\mathbf{X}^{[n-m]}$ for $n < m$ be the submatrix of $\mathbf{X}$ consisting of columns $n, n+1, ..., m-1, m$. Therefore, given the form of $\mathbf{R}_1$ and $\mathbf{S}_1$ ($\mathbf{S}_1^{[1-3]} = \mathbf{0}_{2\times 3}$) we can define submatrix $\mathbf{A}_1$ as

$$\mathbf{A}_1 = -\mathbf{R}_1^{[1-3]} \oslash [\mathbf{B}_0\mathbf{E} + \mathbf{B}_1\mathbf{E}\Phi]^{[1-3]} = \begin{bmatrix} \frac{1-\delta}{1-\delta\phi_i} & 0 & \frac{1-\delta}{1-\delta\phi_g} \\ -\frac{1}{1-\phi_i} & \frac{1}{1-\phi_i} & 0 \end{bmatrix}.$$

This matrix displays the price-impact coefficients of the domestic short-term rate (first column), the foreign short-term rate (second column), and the bond-specific shock (third column), on the domestic long-term yield (first row), and on FX (second row).

For $\mathbf{A}_2$, which contains the FX-specific shock, we can already see from the equilibrium price in equation (A.18) that $\mathbf{A}_2 = [0, 1]'$. In other words, the specific shock on the price of the exchange rate has no impact on the long-term bond price, while affecting the FX rate one-for-one.

Lastly, we now move to the supply shocks; that is, pinning down $\mathbf{A}_3$. Due to the

orthogonality of the different shocks, the variance-covariance matrix Σ can be partitioned as

$$\Sigma = \begin{bmatrix} \Sigma_1 & 0_{3\times1} & 0_{3\times2} \\ 0_{1\times3} & \Sigma_2 & 0_{1\times2} \\ 0_{2\times3} & 0_{2\times1} & \Sigma_3 \end{bmatrix} \quad \text{where} \quad \Sigma_1 = \begin{bmatrix} \sigma_i^2 & \rho\sigma_i^2 & 0 \\ \rho\sigma_i^2 & \sigma_i^2 & 0 \\ 0 & 0 & \sigma_g^2 \end{bmatrix}, \quad \Sigma_3 = \begin{bmatrix} \sigma_{s^y}^2 & \sigma_{\eta^*}\sigma_{\gamma^*} \\ \sigma_{\eta^*}\sigma_{\gamma^*} & \sigma_{s^q}^2 \end{bmatrix},$$

and $\Sigma_2 = \sigma_q^2$. The variance-covariance matrix of excess returns ($\mathbf{V} \equiv \text{var}_t[\mathbf{rx}_{t+1}]$) becomes

$$\mathbf{V} = (\mathbf{B}_1\mathbf{A}_1\Sigma_1\mathbf{A}_1'\mathbf{B}_1') + (\mathbf{B}_1\mathbf{A}_2\Sigma_2\mathbf{A}_2'\mathbf{B}_1') + (\mathbf{B}_1\mathbf{A}_3\Sigma_3\mathbf{A}_3'\mathbf{B}_1'). \tag{A.28}$$

Making use of the form $\mathbf{S}_1$ and $\mathbf{R}_1$ ($\mathbf{R}_1^{[5-6]} = \mathbf{0}_{2\times2}$), the following fixed-point problem involving $\mathbf{A}_3$ is obtained

$$\mathbf{A}_3 = \mathbf{F}_3(\mathbf{A}_3) \equiv \tau^{-1}[(\mathbf{B}_1\mathbf{A}_1\Sigma_1\mathbf{A}_1'\mathbf{B}_1')+(\mathbf{B}_1\mathbf{A}_2\Sigma_2\mathbf{A}_2'\mathbf{B}_1')+(\mathbf{B}_1\mathbf{A}_3\Sigma_3\mathbf{A}_3'\mathbf{B}_1')]\oslash[\mathbf{B}_0\mathbf{E}+\mathbf{B}_1\mathbf{E}\Phi]^{[5-6]}. \tag{A.29}$$

The operator $\mathbf{F}_3(\mathbf{A}_3)$ gives the price function $\mathbf{y}_t = \text{g}(\mathbf{A}_3) + \mathbf{A}_1\mathbf{z}_{1,t} + \mathbf{A}_2\mathbf{z}_{2,t} + \mathbf{F}_3(\mathbf{A}_3)\mathbf{z}_{3,t}$ that will clear the markets for long-term bonds and FX when agents conjecture that the risk of holding of assets is determined by the price function $\mathbf{y}_{t+1} = \mathbf{a}_0+\mathbf{A}_1\mathbf{z}_{1,t+1}+\mathbf{A}_2\mathbf{z}_{2,t+1}+\mathbf{A}_3\mathbf{z}_{3,t+1}$.

From equation (A.29), and using $\mathbf{V}$ in its matrix form, the equilibrium price-impact coefficients must satisfy

$$\begin{bmatrix} \alpha_{s^y}^y & \alpha_{s^q}^y \\ \alpha_{s^y}^q & \alpha_{s^q}^q \end{bmatrix} = \tau^{-1} \begin{bmatrix} \frac{1-\delta}{1-\delta\phi_{s^y}} V_y & \frac{1-\delta}{1-\delta\phi_{s^q}} C_{y,q} \\ \frac{1}{1-\phi_{s^y}} C_{q,y} & \frac{1}{1-\phi_{s^q}} V_q \end{bmatrix}. \tag{A.30}$$

The var.-cov. matrix in the absence of supply risk is $[(\mathbf{B}_1\mathbf{A}_1\Sigma_1\mathbf{A}_1'\mathbf{B}_1') + (\mathbf{B}_1\mathbf{A}_2\Sigma_2\mathbf{A}_2'\mathbf{B}_1')] =$

$$\begin{bmatrix} \left(\frac{\delta}{1-\delta\phi_i}\right)^2 \sigma_i^2 + \left(\frac{\delta}{1-\delta\phi_g}\right)^2 \sigma_g^2 & -\frac{\delta}{1-\delta\phi_i}\frac{1}{1-\phi_i}\sigma_i^2(1-\rho) \\ -\frac{\delta}{1-\delta\phi_i}\frac{1}{1-\phi_i}\sigma_i^2(1-\rho) & \left(\frac{1}{1-\phi_i}\right)^2 2\sigma_i^2(1-\rho) + \sigma_q^2 \end{bmatrix}. \tag{A.31}$$

Solving for the contribution of supply risk to the variance-covariance matrix, one can additionally find $\mathbf{B}_1\mathbf{A}_3\Sigma_3\mathbf{A}_3'\mathbf{B}_1'$. Note that one can recast the fixed-point problem in terms of the variance-covariance matrix, instead of using the 2×2 matrix $\mathbf{A}_3$. This is convenient because $\mathbf{V}$ is symmetric, effectively reducing the fixed-point problem to one involving three unknowns instead of four. One needs to find a fixed point in the form $\mathbf{V} = \mathbf{G}(\mathbf{V})$. Plugging the α's of equation (A.30) in the contribution of supply risk to the variance-covariance matrix, and using this and (A.31) in (A.28), along with denoting the constants

$$g_y \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{s^y}}\sigma_\eta, \quad g_y^* \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{s^y}}\sigma_{\eta^*}, \quad g_q \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{s^q}}\sigma_\gamma, \quad g_q^* \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{s^q}}\sigma_{\gamma^*}, \tag{A.32}$$

$$h_y \equiv \tau^{-1}\frac{1}{1-\phi_{s^y}}\sigma_\eta,\;\; h_y^* \equiv \tau^{-1}\frac{1}{1-\phi_{s^y}}\sigma_{\eta^*},\;\; h_q \equiv \tau^{-1}\frac{1}{1-\phi_{s^q}}\sigma_\gamma,\;\; h_q^* \equiv \tau^{-1}\frac{1}{1-\phi_{s^q}}\sigma_{\gamma^*}.$$

we get that $\mathbf{V}$ must satisfy the following system of three equations in three unknowns:

$$V_y = \left(\frac{\delta}{1-\delta\phi_i}\right)^2\sigma_i^2 + \left(\frac{\delta}{1-\delta\phi_g}\right)^2\sigma_g^2 + (V_y)^2(g_y^2+g_{y^*}^2) + (C_{y,q})^2(g_q^2+g_{q^*}^2) + 2g_{y^*}g_{q^*}V_yC_{y,q}; \tag{A.33a}$$

$$V_q = \left(\frac{1}{1-\phi_i}\right)^2 2\sigma_i^2(1-\rho) + \sigma_q^2 + (C_{y,q})^2(h_y^2+h_{y^*}^2) + (V_q)^2(h_q^2+h_{q^*}^2) + 2h_{y^*}h_{q^*}V_qC_{y,q}; \tag{A.33b}$$

$$\begin{aligned} C_{y,q} = &-\frac{\delta}{1-\delta\phi_i}\frac{1}{1-\phi_i}\sigma_i^2(1-\rho) + V_yC_{y,q}(g_yh_y + g_{y^*}h_{y^*}) + V_qC_{y,q}(g_qh_q + g_{q^*}h_{q^*}) \\ &+ (C_{y,q})^2g_{q^*}h_{y^*} + V_yV_qg_{y^*}h_{q^*}. \end{aligned} \tag{A.33c}$$

where $C_{y,q} = C_{q,y}$ and

$$\mathbf{V} = \mathrm{var}_t[\mathbf{rx}_{t+1}] = \begin{bmatrix} V_y & C_{y,q} \\ C_{y,q} & V_q \end{bmatrix}.$$

which completes the full write-down of the solution method.

A.4 Observations on Risk Factors and Asset Returns

Lemma 1 conveys that, in frameworks of frictional financial intermediation á la Greenwood et al. (2023) and Gourinchas et al. (2025), stochastic supply is not an independently priced risk factor.

Lemma 1. *Suppose all shocks other than supply shocks are absent, i.e., $\sigma_i = \sigma_g = \sigma_q = 0$. Then $V_y = V_q = C_{y,q} = 0$.*

Proof. Setting $\sigma_i = \sigma_g = \sigma_q = 0$ in equations (A.33a) and (A.33c) yields a three-equation system whose unique, stable solution is $V_y = V_q = C_{y,q} = 0$. □

Lemma 2 shows that when short-term interest rate risk is the only independently priced risk factor, no arbitrary correlation structure imposed on supply shocks—whether exogenous or endogenous—can overturn the negative comovement in bond and currency returns implied by interest rate risk.

Lemma 2. *Suppose all shocks other than interest rate shocks and supply shocks are absent, i.e., $\sigma_g = \sigma_q = 0$. Then, regardless of the prevalence of foreign investors, the covariance between bond and currency returns is weakly negative: $C_{y,q} \leq 0$.*

Proof. Setting $\sigma_g = \sigma_q = 0$ in equations (A.33a) and (A.33c) yields a three-equation system whose unique, stable solution satisfies $V_y \geq 0$, $V_q \geq 0$, and $C_{y,q} \leq 0$. □

A.5 Proofs

Proof of Proposition 1. Consider a purchase of local-currency denominated long-term bonds by foreign investors, i.e., a decline in $\eta^\star$. From equation (14), foreign demand for home bonds is positively associated with foreign demand for the home currency. Hence, a fall in $\eta^\star$ implies a simultaneous fall in $\gamma^\star$, corresponding to a purchase of domestic currency by foreign investors. Using equations (11) and (12), the joint decline in $\eta^\star$ and $\gamma^\star$ reduces the amount of bond and currency risk intermediaries must absorb in equilibrium. Finally, the equilibrium pricing conditions (A.17) and (A.18) imply that lower intermediary risk exposure compresses the required risk premia. As a result, the local-currency denominated long-term bond yield declines and the home currency appreciates. □

Proof of Proposition 2. Let's begin by observing that

$$\mathbb{E}(\Delta d^y_t rx^y_{t+1}) = \mathbb{E}(d^y_t rx^y_{t+1}) - \mathbb{E}(d^y_{t-1} rx^y_{t+1}). \tag{A.34}$$

We can use the law of iterated expectations on the second term in the right-hand side of (A.34) to obtain:

$$\mathbb{E}(d^y_{t-1} rx^y_{t+1}) = \mathbb{E}\left(\mathrm{E}_t(d^y_{t-1} rx^y_{t+1})\right) = \mathbb{E}(d^y_{t-1}\, \mathrm{E}_t\, rx^y_{t+1}), \tag{A.35}$$

Using the intermediaries' optimality condition, (10), this can be written as:

$$\mathbb{E}(d^y_{t-1} rx^y_{t+1}) = \tau^{-1}\, \mathrm{var}_t(rx^y_{t+1})\mathbb{E}(d^y_{t-1} d^y_t) + \tau^{-1}\, \mathrm{cov}_t(rx^y_{t+1}, rx^q_{t+1})\mathbb{E}(d^y_{t-1} d^q_t). \tag{A.36}$$

Assumption 1 implies that $\phi_{s^y} = \phi_{s^q} = 0$, therefore, by equations (11) and (17):

$$\mathbb{E}(d^y_{t-1} d^y_t) = \mathbb{E}(d^y_{t-1} d^q_t) = 0. \tag{A.37}$$

This equation, along with (A.34), implies that:

$$\mathbb{E}(\Delta d^y_t rx^y_{t+1}) = \mathbb{E}(d^y_t rx^y_{t+1}). \tag{A.38}$$

Analogously, we can show that $\mathbb{E}(\Delta d^q_t rx^q_{t+1}) = \mathbb{E}(d^q_t rx^q_{t+1})$. Next, using equation (10), one can show that

$$\mathbb{E}(d^y_t rx^y_{t+1}) = \tau^{-1}\left[\mathrm{var}_t(rx^y_{t+1})\mathbb{E}\left((d^y_t)^2\right) + \mathrm{cov}_t(rx^y_{t+1}, rx^q_{t+1})\mathbb{E}\left(d^q_t d^y_t\right)\right]; \tag{A.39}$$

$$\mathbb{E}\left(d^q_t rx^q_{t+1}\right) = \tau^{-1}\left[\mathrm{var}_t(rx^q_{t+1})\mathbb{E}\left((d^q_t)^2\right) + \mathrm{cov}_t(rx^y_{t+1}, rx^q_{t+1})\mathbb{E}\left(d^y_t d^q_t\right)\right]. \tag{A.40}$$

Using the market clearing condition (18), the processes of net supplies, (11) and (7), the properties of foreign and home investors' flows, (14) and (15), as well as Proposition 3, one can show that $\mathbb{E}(d_t^y rx_{t+1}^y) \geq 0$ and $\mathbb{E}(d_t^q rx_{t+1}^q) \geq 0$. □

Proof of Proposition 3. Assumption 1 implies that $V_y = V_q$, which simplifies our system of equations (A.33a)–(A.33c) as follows:

$$V_y = \sigma_g^2 + (V_y)^2\tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2) + (C_{y,q})^2\tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2) + 2V_yC_{y,q}\tau^{-2}\sigma_{\eta^*}^2; \tag{A.41a}$$

$$C_{y,q} = 2V_yC_{y,q}\tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2) + (C_{y,q})^2\tau^{-2}\sigma_{\eta^*}^2 + (V_y)^2\tau^{-2}\sigma_{\eta^*}^2. \tag{A.41b}$$

We can use equation (19) to rewrite this system as

$$V_y = \sigma_g^2 + \tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2)\left[(V_y)^2 + (C_{y,q})^2 + 2\Omega V_yC_{y,q}\right]; \tag{A.42a}$$

$$C_{y,q} = \tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2)\left[2V_yC_{y,q} + (C_{y,q})^2\Omega + (V_y)^2\Omega\right]. \tag{A.42b}$$

First, setting $\Omega = 0$, it can be readily seen from equations (A.42a)-(A.42b) that the only real solution implies $C_{y,q} = 0$. Second, dividing both sides of (A.42b) by V_y and rearranging, we obtain

$$\frac{C_{y,q}}{V_y}\left(1 - 2V_y\tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^\star}^2)\right) = \Omega\, V_y\, \tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^\star}^2)\left(1 + \left(\frac{C_{y,q}}{V_y}\right)^2\right). \tag{A.43}$$

Since $V_y > 0$ and $\tau > 0$, we therefore get that

$$\text{sign}(C_{y,q}) = \text{sign}(\Omega), \tag{A.44}$$

as long as agents are risk-tolerant enough. That is, for τ sufficiently large, we get that

$$1 - 2V_y\tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^\star}^2) > 0. \tag{A.45}$$

□

Proof of Proposition 4. Consider a unit increase in γ_t in equation (17), which implies an increase in home currency net supply s_q without a corresponding movement in bond net supply (i.e. $s_y = 0$). By the equilibrium solution of the bond yield, eq. (A.17) derived in Appendix A.3, such impulse causes an increase in long-term bond yields, or a decline in the price of long-term bonds, if and only if $\text{cov}_t(rx_{t+1}^y, rx_{t+1}^q) > 0$. □

A.6 Decentralized Trading and the Effects of Asset Purchases

This appendix presents a simple decentralized trading protocol among intermediaries that generates temporary price dispersion around the aggregate equilibrium. Within this

framework, idiosyncratic net supply shocks, such as those arising from marginally winning or losing central bank auctions, generate cross-sectional differences in subsequent intermediary transaction prices. In particular, an intermediary that receives an idiosyncratic shock that leaves it with a larger peso inventory and a smaller dollar inventory trades at a higher dollar price (i.e., a more depreciated exchange rate) and requires a higher yield to hold local-currency bonds than an intermediary that does not face such an inventory imbalance. Importantly, the effect on bond yields arises only when the equilibrium covariance between bond and currency returns is positive, and its magnitude is increasing in this covariance, all else equal.

Setup There is a continuum of intermediaries indexed over $i \in [0, 1]$, that are ex-ante identical at the beginning of each period. Following shocks to aggregate bond and currency supply, intermediary i holds inventory[27]

$$\mathbf{d}_{i,t} = \mathbf{s}_t + \mathbf{e}_{i,t},$$

where $\mathbf{e}_{i,t}$ is an idiosyncratic net supply shock that alter its balance sheet, such as such as those arising from marginally winning and losing central bank auctions:

$$\mathbf{e}_{i,t} \equiv \begin{bmatrix} e^y_{i,t} \\ e^q_{i,t} \end{bmatrix} \sim \mathcal{N}(\mathbf{0}, \Sigma_e).$$

Following the problem in equation (9), each intermediary chooses its position according to:[28]

$$\mathrm{E}_t[\mathbf{rx}_{i,t+1}] = \tau^{-1} \operatorname{var}_t(\mathbf{rx}_{t+1})\mathbf{d}_{i,t}. \tag{A.46}$$

Differences in inventories therefore translate into differences in reservation values:

$$\mathrm{E}_t[\mathbf{rx}_{i,t+1}] - \mathrm{E}_t[\mathbf{rx}_{j,t+1}] = \tau^{-1} \operatorname{var}_t(\mathbf{rx}_{t+1})(\mathbf{d}_{i,t} - \mathbf{d}_{j,t}),$$

and thus heterogeneous reservation prices across intermediaries:

$$\mathrm{E}_t[rx^y_{i,t+1}] - \mathrm{E}_t[rx^y_{j,t+1}] = \frac{1}{1-\delta}(y_{i,t} - y_{j,t}); \qquad \mathrm{E}_t[rx^q_{i,t+1}] - \mathrm{E}_t[rx^q_{j,t+1}] = q_{i,t} - q_{j,t}.$$

Search in decentralized markets Suppose that intermediaries i and j are randomly matched in the decentralized market. Let $\mathbf{x}_t = [x^y_t, x^q_t]$ denote the vector of assets transferred from intermediary i to intermediary j. Following the trade, intermediaries positions become $\mathbf{d}'_{i,t} = \mathbf{d}_{i,t} - \mathbf{x}_t$ and $\mathbf{d}'_{j,t} = \mathbf{d}_{j,t} + \mathbf{x}_t$. Each intermediary's position determines its reservation prices through equation (A.46), whereby intermediaries with different inventories have different

[27] Aggregate market clearing implies: $\int_0^1 \mathbf{d}_{i,t}\, \mathrm{d}i = \mathbf{s}_t$.
[28] All intermediaries face the same aggregate uncertainty, and thus the same covariance matrix, $\operatorname{var}_t(\mathbf{rx}_{t+1})$.

reservation prices.

The transaction prices are determined through Nash bargaining. Let $(\tilde{q}_{ij,t}, \tilde{y}_{ij,t})$ denote the negotiated transaction prices between intermediaries i and j. Following the over-the-counter search literature (Duffie et al., 2005), we assume that bilateral bargaining determines the traded quantities so as to maximize the match surplus. This implies that post-trade marginal valuations are equalized,

$$\mathrm{E}_t[\mathbf{rx}'_{i,t+1}] = \mathrm{E}_t[\mathbf{rx}'_{j,t+1}].$$

Based on (A.46), this implies that the post-trade quantities are also equalized:

$$\mathbf{d}'_{i,t} = \mathbf{d}_{i,t} - \mathbf{x}_t = \mathbf{d}_{j,t} + \mathbf{x}_t = \mathbf{d}'_{j,t},$$

which implies the equilibrium trade quantity

$$\mathbf{x}_t = \frac{1}{2}\left(\mathbf{d}_{i,t} - \mathbf{d}_{j,t}\right).$$

Finally, assuming symmetric Nash bargaining, the negotiated transaction prices are given by

$$\tilde{q}_{ij,t} = \frac{1}{2}(q_{i,t} + q_{j,t}), \qquad \tilde{y}_{ij,t} = \frac{1}{2}(y_{i,t} + y_{j,t}), \tag{A.47}$$

where $(q_{i,t}, y_{i,t})$ and $(q_{j,t}, y_{j,t})$ denote the reservation prices implied by the intermediaries' optimality conditions.

Average transaction price conditional on $\mathbf{e}_{i,t}$ The reservation prices are

$$q_{i,t} = q_t + \tau^{-1}\left(C_{yq}e^y_{i,t} + V_q e^q_{i,t}\right),$$

and

$$y_{i,t} = y_t + (1-\delta)\tau^{-1}\left(V_y e^y_{i,t} + C_{yq}e^q_{i,t}\right).$$

Under symmetric Nash bargaining, when i is randomly matched with a counterparty j, the negotiated transaction price for the exchange rate and bond yields are given by equation (A.47), so that

$$E_t[\tilde{q}_{ij,t} \mid \mathbf{e}_{i,t}] = q_t + \frac{1}{2\tau}\left(C_{yq}e^y_{i,t} + V_q e^q_{i,t}\right),$$

and

$$E_t[\tilde{y}_{ij,t} \mid \mathbf{e}_{i,t}] = y_t + \frac{1-\delta}{2\tau}\left(V_y e^y_{i,t} + C_{yq}e^q_{i,t}\right).$$

Interpreting the estimates of Section 4.2 The effects of central bank purchases of US dollars, when allocated randomly across intermediaries as per our identification approach,

are akin to the following:

$$E_t[\tilde{q}_{ij,t} \mid e^q_{i,t} > 0] - E_t[\tilde{q}_{ij,t} \mid e^q_{i,t} = 0] = \frac{1}{2\tau} V_q e^q_{i,t}, \tag{A.48}$$

and

$$E_t[\tilde{y}_{ij,t} \mid e^q_{i,t} > 0] - E_t[\tilde{y}_{ij,t} \mid e^q_{i,t} = 0] = \frac{1-\delta}{2\tau} C_{yq} e^q_{i,t}.$$

or, using equation (A.6), we can find the response of the bond price differential:

$$E_t[\tilde{p}^y_{ij,t} \mid e^q_{i,t} > 0] - E_t[\tilde{p}^y_{ij,t} \mid e^q_{i,t} = 0] = -\frac{1}{2\tau} C_{yq} e^q_{i,t}. \tag{A.49}$$

We can draw several implications from equations (A.48) and (A.49). First, an intermediary that receives an idiosyncratic shock that leaves it with a longer-peso–shorter-dollar position trades at a higher dollar price (i.e., a more depreciated exchange rate). Second, this intermediary trades long-term bonds at a lower price (i.e., a higher yield) if and only if $\text{cov}_t(rx^y_{t+1}, rx^q_{t+1}) > 0$, analogously to Proposition 4. Third, the magnitude of the bond yield effect is increasing in the equilibrium covariance between bond and currency returns, all else equal. Equation (A.49) shows that the relevant elasticity is scaled by a factor of one-half, which follows from our assumption of symmetric Nash bargaining.

While alternative assumptions about how prices and quantities are determined in decentralized markets may affect the mapping from cross-sectional elasticities to aggregate effects, we view the overarching message that the equilibrium covariance determines the qualitative cross-market implications of asset purchases as a natural and intuitive feature of this class of models. That is, the same covariance structure that governs intermediaries' portfolio choices and reservation prices at the micro level also shapes the aggregate effects of asset purchases.

B Foreign investor type and hedging in fixed income

B.1 Foreign investor type in Colombia

Our evidence from Colombia suggests that foreigners tend to produce correlated demand in bond and currency markets. Additionally, the extent of currency hedging from foreigners that purchase local-currency government bonds seems negligible. In this section, we explore the type of foreign investor present in Colombia's sovereign bond market.

As shown in Figure B.1a, foreign participation in Colombia's bond market was limited before 2012 but increased significantly thereafter. This growth was partly driven by regulatory reforms implemented between 2010 and 2013, which facilitated investment through local managers and simplified tax reporting for fixed-income securities. Furthermore, a 2012 tax reform reduced income tax on TES for non-resident investors from 33% to 14%. The country's investment-grade credit rating, awarded in 2011 by credit rating agencies such as *S&P*, *Moody's*, and *Fitch Ratings*, and its increased weight in *J.P. Morgan*'s emerging market debt indices in 2014, also played a key role in attracting international capital.

Figure B.1b shows the share of bond holding across foreign investors. Before 2014 foreign banks held the largest share of sovereign bonds among foreign investors, although their overall market participation was relatively low. Since 2014, mutual funds have become the dominant investors, followed by international pension funds and monetary authorities, collectively holding about 80% of the foreign investor base, which is now more significant relative to the total outstanding debt.

B.2 Additional Cross-Country Evidence on Comovement and Ω

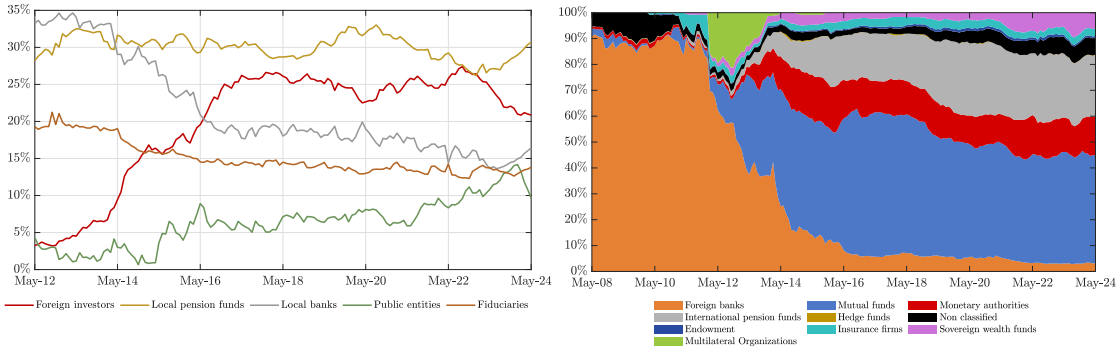
In Figure B.2 we reproduce Figure 5, but replacing $\alpha = 0$ for emerging economies that we estimated have $\alpha < 0$ using the data from Chen and Zhou (2025).

In Figure B.3 we re-compute Ω under two different assumptions. First, we assign the median hedge ratio across countries to all countries (Panel a). Second, we assign the median standard deviation for foreign investors and other domestic investors to all countries (Panel b). In this way, we can keep fixed one of the two reasons why Ω might vary. We observe that both the hedge ratios and the relative volatility of foreign to non-bank domestic investors are relevant to explain the comovement between bond and currency returns across countries.

Table B.1
Baseline calibration

Parameter	Interpretation	Value
$1/\tau$	Risk-tolerance	0.03
δ	Maturity of long-term bonds	0.90
ϕ_i	Persistence of short-term rates	0.965
ρ	Correlation of short-term rates	0.69
ϕ_g	Persistence of bond-specific shocks	0
ϕ_{s^y}; ϕ_{s^q}	Persistence of net supply shocks	0.85
$\sigma_\eta; \sigma_\gamma$	Std. dev. of domestic investors demand	0.0248
$\sigma_{\eta^\star}; \sigma_{\gamma^\star}$	Std. dev. of foreign investors demand	0.0233
σ_i	Std. dev. of interest rate shocks	0.0015
σ_g	Std. dev. of bond-specific shocks	0.05
σ_q	Std. dev. of long-term q shocks	0.05
α	Currency hedge ratio	0

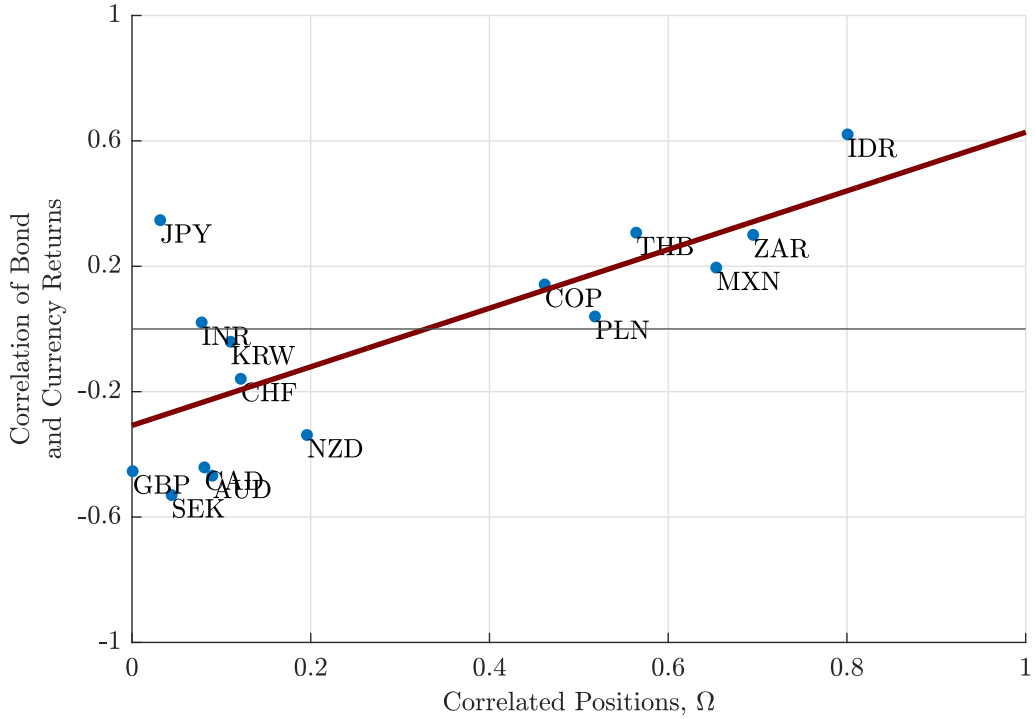
Figure B.1
Participation in the Colombian TES market



(a) Total bond holdings by entity (b) Bond holdings across foreign investors

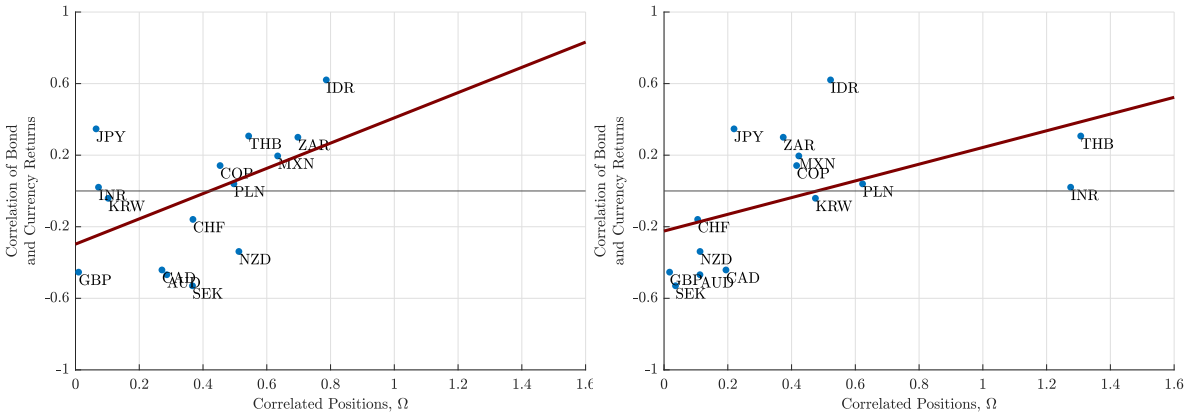
Note: The data presented correspond to all trades registered with the Central Securities Depository (DCV), which operates under the supervision of the Central Bank of Colombia. Panel A shows the TES participation (percentage of total outstanding TES volume) across major entities, while Panel B focuses specifically on the share held by foreign investors, detailing the distribution among different types of foreign investors within the total foreign share.

Figure B.2
Comovement in Excess Returns and Ω



Note: This figure displays the correlation of bond and currency excess returns (y-axis) and the Estimated Ω from equation (19) (x-axis). In the computation for Estimated Ω we restrict $\alpha \geq 0$.

Figure B.3
Comovement in Excess Returns and Ω



(a) Ω with median hedge ratios

(b) Ω with median volatilities

Note: This figure displays the correlation of bond and currency excess returns (y-axis) and the Estimated Ω from eq. (19) (x-axis). In the computation for Estimated Ω in Panel (a) we restrict α to be the median hedge ratio for all countries. In Panel (b) we restrict the standard deviation for foreign and other domestics investors to the median across countries. Countries in red (blue) are part of the emerging (advanced) economies sample.

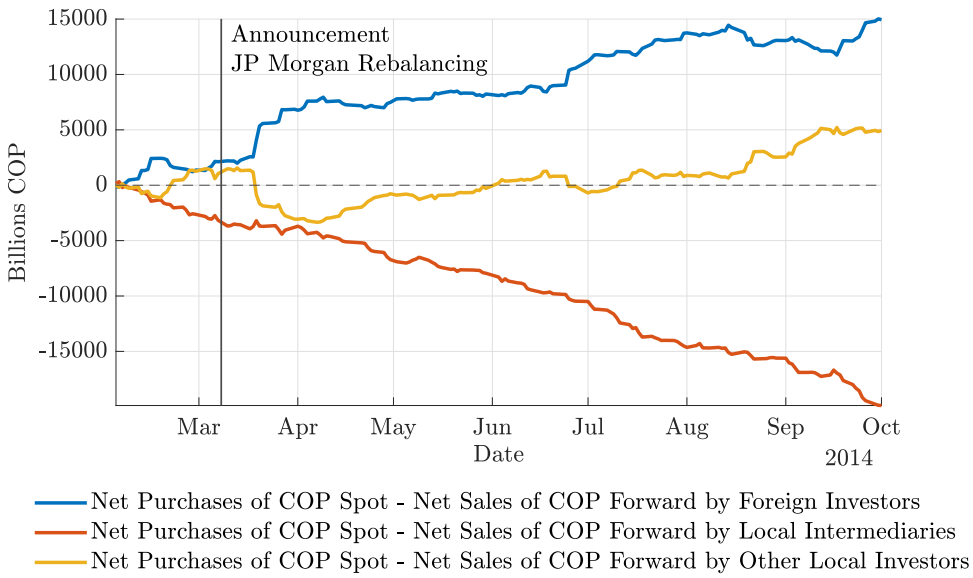
Table B.2
Summary of FX and bond excess returns (1-month excess returns)

			Residualized excess returns	
Country	Regression coefficient	Correlation	Regression coefficient	Correlation
Australia	-0.70^{***}	-0.35	-0.78^{***}	-0.39
	(0.15)	$[-0.47, -0.22]$	(0.17)	$[-0.52, -0.24]$
Canada	-0.65^{***}	-0.39	-0.81^{***}	-0.47
	(0.12)	$[-0.50, -0.26]$	(0.13)	$[-0.59, -0.33]$
Colombia	0.25^{***}	0.27	0.34^{**}	0.34
	(0.09)	[0.13, 0.40]	(0.15)	[0.19, 0.48]
India	0.10	0.09	-0.06	-0.05
	(0.10)	$[-0.06, 0.23]$	(0.12)	$[-0.22, 0.12]$
Indonesia	0.57^{***}	0.59	0.64^{***}	0.60
	(0.11)	[0.46, 0.70]	(0.13)	[0.46, 0.71]
Japan	1.32^{***}	0.37	1.43^{***}	0.39
	(0.26)	[0.24, 0.49]	(0.34)	[0.24, 0.52]
Korea	-0.12	-0.07	-0.22	-0.12
	(0.15)	$[-0.25, 0.11]$	(0.18)	$[-0.31, 0.07]$
Mexico	0.65^{***}	0.40	0.69^{***}	0.39
	(0.17)	[0.25, 0.53]	(0.21)	[0.22, 0.54]
New Zealand	-0.55^{***}	-0.25	-0.52^{**}	-0.24
	(0.19)	$[-0.38, -0.11]$	(0.22)	$[-0.39, -0.08]$
Poland	0.43^{**}	0.21	0.50^{**}	0.25
	(0.17)	[0.07, 0.34]	(0.21)	[0.09, 0.40]
South Africa	0.96^{***}	0.53	1.11^{***}	0.58
	(0.11)	[0.42, 0.62]	(0.13)	[0.46, 0.68]
Sweden	-0.79^{***}	-0.41	-0.95^{***}	-0.47
	(0.15)	$[-0.52, -0.29]$	(0.17)	$[-0.59, -0.33]$
Switzerland	-0.17	-0.08	-0.07	-0.03
	(0.18)	$[-0.22, 0.06]$	(0.21)	$[-0.20, 0.13]$
Thailand	0.39^{*}	0.25	0.39^{*}	0.25
	(0.23)	$[-0.05, 0.51]$	(0.23)	$[-0.05, 0.51]$
United Kingdom	-0.57^{***}	-0.40	-0.58^{***}	-0.41
	(0.12)	$[-0.51, -0.27]$	(0.15)	$[-0.54, -0.26]$

Note: Column (1) of the table reports the estimated slope coefficient for the following baseline regression $rx^{q}_{j,t+1} = \alpha + \beta rx^{(10y)}_{j,t+1} + \epsilon_{j,t+1}$. Column (2) reports the correlation between $rx^{q}_{j,t+1}$ and $rx^{(10y)}_{j,t+1}$. Column (3) reports the estimated slope coefficient of a regression of the residualized component of $rx^{q}_{j,t+1}$ on the residualized component of $rx^{(10y)}_{j,t+1}$. We residualize local-currency bond and FX excess returns according to the following regression $rx^{m}_{j,t+1} = \sum_{k=0}^{1} \phi_k (\text{Prob. default})_{j,t-k} + \epsilon^{rx^m}_{j,t+1}$, for $m = \{10y, q\}$. Probability of default is the 10-year sovereign default probability, retrieved from *Refinitiv*. Column (4) reports the correlation between the residualized component of $rx^{q}_{j,t+1}$ and the residualized component of $rx^{(10y)}_{j,t+1}$. Stars denote significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Values in parenthesis are standard errors, and values in square brackets represent the 95 percent confidence interval.

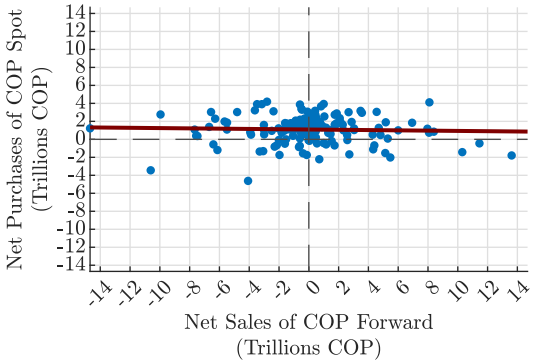
C Additional Tables and Figures

Figure C.1
Flows in COP Spot and Forward markets during J.P. Morgan Index Rebalancing



Note: The figure displays the evolution of the daily accumulated purchases of COP in the spot market net of sales of COP in the forward market during 2014 for different investor groups (described in Section 1 and Section 3). The black vertical line denotes 19th of March 2014, the day the rebalancing was announced.

Figure C.2
Purchases of COP spot and sales of COP forward by foreign investors



Note: This figure displays the monthly-level purchases of COP in the spot market (x-axis) and the monthly-level sales of COP in the forward market (y-axis) by foreign investors. The fitted OLS regression line is also shown.

Table C.1
Investors' Portfolios' and UIP and Yield-Curve Trade Returns

Panel A: Foreign Investors				
Horizon (h)	1M	3M	6M	12M
$E(\Delta d_t^q \times rx_{t+h}^q)$	1.6	-3.0	-17.0*	-39.0**
	(2.3)	(5.0)	(9.0)	(15.4)
Observations	95	93	90	84
$E(\Delta d_t^y \times rx_{t+h}^y)$	-0.0	0.4	-4.6	-15.7***
	(1.7)	(2.0)	(3.2)	(4.8)
Observations	132	132	132	132
$E(\Delta d_t^y \times rx_{t+h}^q)$	6.2	-1.5	-16.4	-42.2**
	(3.8)	(8.0)	(11.7)	(19.4)
Observations	131	129	126	120
$E(\Delta d_t^q \times rx_{t+h}^y)$	-0.1	-1.7	-4.6***	-7.0***
	(1.0)	(1.2)	(1.8)	(2.3)
Observations	96	96	96	96
Panel B: Other Domestic Investors				
Horizon (h)	1M	3M	6M	12M
$E(\Delta d_t^q \times rx_{t+h}^q)$	-4.1**	-7.6*	-14.4**	-25.7**
	(2.1)	(4.5)	(6.3)	(11.8)
Observations	95	93	90	84
$E(\Delta d_t^y \times rx_{t+h}^y)$	-2.9	-11.0**	-13.0**	-19.9**
	(4.2)	(5.3)	(5.8)	(7.9)
Observations	132	132	132	132
$E(\Delta d_t^y \times rx_{t+h}^q)$	-12.1*	-11.1	-37.5**	-25.4
	(6.6)	(10.5)	(15.7)	(24.8)
Observations	131	129	126	120
$E(\Delta d_t^q \times rx_{t+h}^y)$	-0.3	-2.2	-1.3	1.2
	(1.4)	(2.5)	(2.3)	(3.4)
Observations	96	96	96	96

Note: This table reports results from mean t-tests of the product of UIP and yield-curve trade returns with different positions of intermediaries. The 1M, 3M, 6M, and 12M columns denote test for average returns with holding periods of 1, 3, 6, and 12-month, respectively. The null hypothesis is that average returns are equal to zero. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively.

Table C.2
Participation and Bidding Patterns at US Dollar Auctions

Dealer	Participation	Barely Won	Barely Lost
A	97%	78%	16%
B	87%	60%	34%
C	75%	43%	49%
G	74%	40%	38%
D	68%	62%	27%
E	64%	76%	7%
F	62%	73%	9%
M	48%	57%	31%
H	47%	50%	32%
K	45%	35%	51%
J	45%	54%	39%
I	39%	30%	44%
L	29%	16%	69%
N	17%	40%	51%
Q	8%	26%	48%
O	6%	56%	34%
P	2%	15%	69%

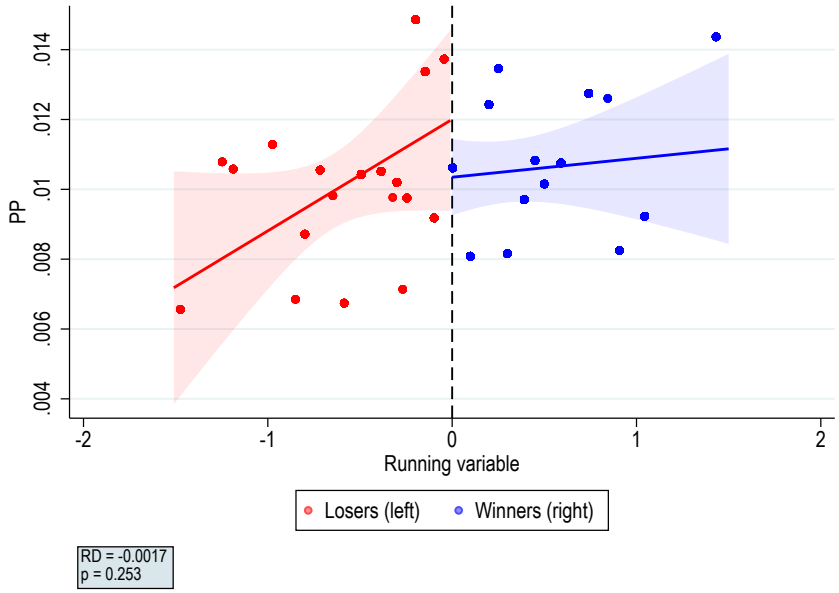
Note: Dealers are anonymized and sorted by overall participation. "Barely Won" and "Barely Lost" report, for each dealer, the share of its bids within the optimal bandwidth around the cutoff that fall on the winning and losing side, respectively.

Table C.3
Transition Probability Matrix at US Dollar Auctions

	State at $t+1$			
State at t	Partially Winner	Winner	Partially Loser	Loser
Partially Winner	0.0%	0.0%	66.7%	33.3%
Winner	0.9%	43.9%	44.9%	10.3%
Partially Loser	0.1%	6.0%	76.9%	17.0%
Loser	0.0%	4.2%	63.1%	32.7%

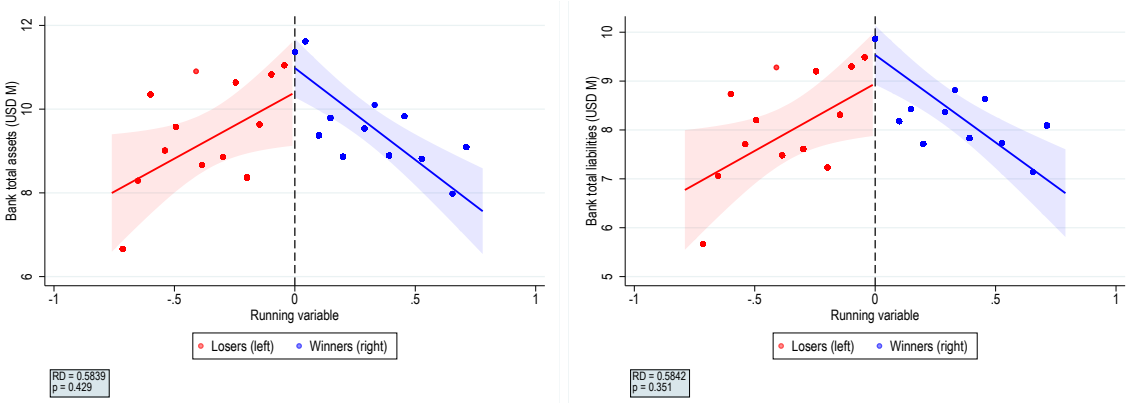
Note: Each cell reports the probability (in %) of transitioning from state i at time t to state j at time $t+1$. States are mutually exclusive. Partially Winner and Partially Loser denote dealers who won or lost within the optimal bandwith around the cutoff. Winner and Loser denote dealers who won or lost outside that bandwidth.

Figure C.3
Balance of pre-auction positions around the auction cutoff



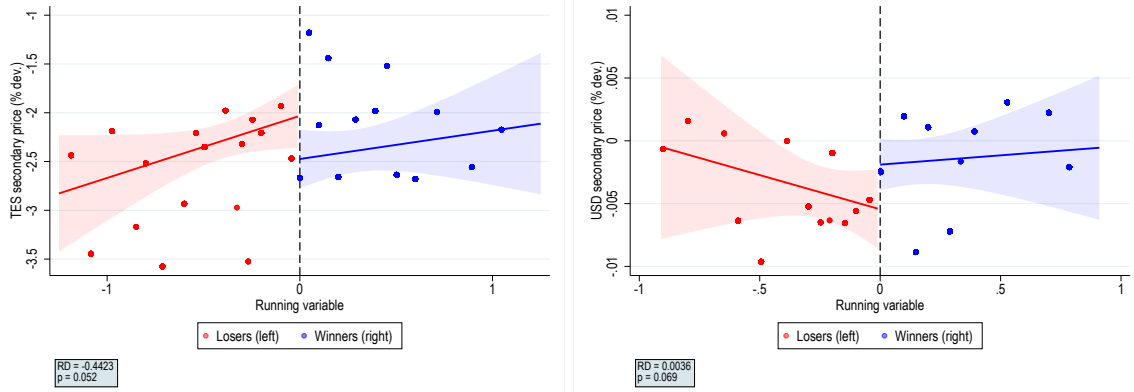
Note: Binned sample means of dealers' pre-auction positions on each side of the cutoff, with local linear fits and 95% confidence bands. The running variable is the distance of the dealer's bid price to the auction cutoff price. The estimated discontinuity is small and statistically insignificant ($p = 0.25$).

Figure C.4
Balance of dealer characteristics around the auction cutoff



Note: Binned sample means of dealers' total assets (left) and total liabilities (right) on each side of the cutoff, with local linear fits and 95% confidence bands. The running variable is the distance of the dealer's bid price to the auction cutoff price. The estimated discontinuities are statistically insignificant ($p = 0.43$ and $p = 0.35$, respectively).

Figure C.5
Binned RD plots: secondary-market prices around the auction cutoff



Note: Binned sample means of TES (left) and USD (right) secondary-market prices on each side of the cutoff, with local linear fits and 95% confidence bands. The running variable is the distance of the dealer's bid price to the auction cutoff price. The displayed RD estimates and p-values correspond to the sharp estimates reported in the text.

Table C.4
Effect of winning the US dollar auction on secondary-market prices

	Sharp RDD		Fuzzy RDD	
	TES Sec. Prices	USD Sec. Prices	TES Sec. Prices	USD Sec. Prices
	(1)	(2)	(3)	(4)
RD Estimate (Winner)	−0.44*	0.004*	−0.10*	0.001*
	(0.23)	(0.002)	(0.06)	(0.0004)
z	0.64*	−0.01	0.64*	−0.01
	(0.34)	(0.01)	(0.34)	(0.01)
$z \times T$	−0.35	0.01	−0.23	0.01
	(0.50)	(0.01)	(0.54)	(0.01)
Observations	4,675	3,891	4,675	3,891

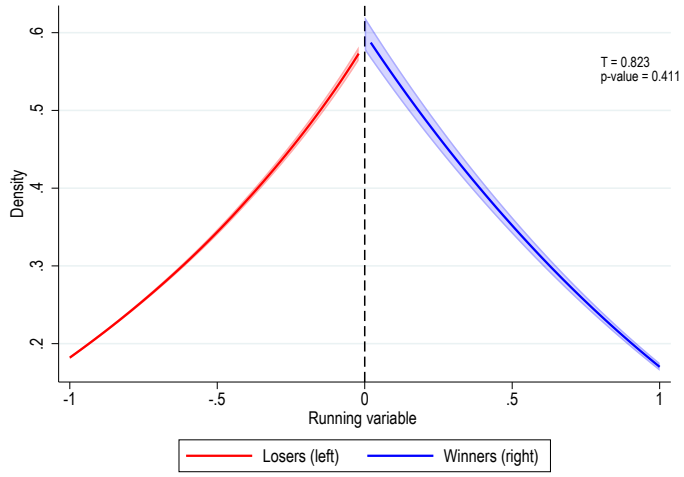
Note: This table reports the classic RD coefficients underlying Figure 4 for the US dollar auction (purchase sample). Columns (1)–(2) report the sharp estimate β_{RD} of equation (21); columns (3)–(4) report the fuzzy estimate β_{FRD} of equation (22), which recovers the effect of one additional million dollars of awarded volume. The dependent variable is the % deviation of the post-auction mean secondary-market price (same variable in both markets). All specifications use a uniform kernel and the data-driven bandwidth of Calonico et al. (2014) (CCT). Standard errors clustered at each value of the running variable in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table C.5
First stage of the fuzzy RDD: effect of winning on awarded volume

	Awarded volume (USD mn)	
	TES Sec. Prices (1)	USD Sec. Prices (2)
First stage (Winner)	4.47***	4.48***
	(0.39)	(0.36)
z	0.00	0.00
	(0.00)	(0.00)
$z \times T$	1.18*	1.85**
	(0.71)	(0.92)
Observations	4,933	4,580

Note: This table reports the first stage of the fuzzy RDD that underlies columns (3)–(4) of Table C.4 for the US dollar auction (purchase sample), corresponding to equation (22). The dependent variable in both columns is the awarded volume in millions of US dollars; the "First stage (Winner)" row reports the jump in awarded volume at the cutoff. Columns (1) and (2) correspond, respectively, to the fuzzy specifications for TES and USD secondary-market prices, and differ only in the estimation sample and bandwidth determined by the respective outcome. The jump is highly significant in both samples (implied first-stage t-statistics around 11 to 12), confirming a strong instrument. All specifications use a uniform kernel and the data-driven bandwidth of Calonico et al. (2014) (CCT). Standard errors clustered at each value of the running variable in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Figure C.6
Manipulation (density) test — US dollar auction



Note: Manipulation (density) test for the US dollar auction (purchase sample), following Cattaneo et al. (2020). The figure reports the estimated density of the running variable on each side of the cutoff, together with the test statistic ($T = 0.823$) and its p-value (0.411). The null of no manipulation is not rejected.