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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.

Keywords: foreign investors, local-currency bond markets, exchange rates, bond yields, financial intermediaries, capital flows

JEL Classification: E43, E52, F31, G12

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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; Vayanos and Vila, 2021; 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' positions. As a result, the composition of investors in local-currency bond markets 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 by developing 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 increases in Colombian intermediaries' portfolio holdings of long-term bonds or Colombian pesos relative to US dollars are associated with higher 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. As a result, intermediaries' positions forecast both term premia and currency premia (echoing the analysis of Haddad and Sraer, 2020). These findings reinforce the view that intermediaries are the key 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 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 altering 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. For Colombia, for example, unhedged foreign investor flows raise the return correlation by about 8 percentage points, and it is essential to account for the overall positive correlation.

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 contribute to the observed cross-country differences in the comovement of bond yields and exchange rates.

Our analysis also speaks to how asset purchase policies, such as quantitative easing and foreign exchange interventions, transmit to bond yields and exchange rates. In our framework, intermediaries operate simultaneously in bond and currency markets, which are exposed to correlated risks. As a result, when the net supply of one asset shifts, intermediaries adjust their required premia in both markets. Whether bond purchases appreciate or depreciate the currency—or whether foreign exchange interventions raise or lower bond prices—depends on the sign of the covariance between bond and currency returns, which, in turn, reflects the relative importance of unhedged foreign investor flows versus short-term interest rate shocks, as described above.

We provide evidence on these predictions using two types of auctions conducted in Colombia between 2012 and 2014: Treasury auctions to issue local-currency government bonds and central bank auctions to buy U.S. dollars. We exploit each auction's cutoff price to compare dealers that barely won to those that barely lost. We find that dealers required to absorb more government bonds subsequently trade both bonds *and* dollars at worse prices, consistent with simultaneously demanding higher term and currency premia. Analogously, dealers that sell dollars to the central bank subsequently trade both dollars *and* bonds at worse prices. These results highlight that term premia and currency premia comove positively in response to shifts in the net supply in a single market—consistent with the relative importance of unhedged foreign investor flows in shaping the nature of long-term bond price and currency risk.

Related literature Models of frictional financial intermediation have gained prominence in international 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 analyzing a new mechanism that links foreign investors' bond flows to the portfolios of financial intermediaries, and in turn to the joint dynamics of bond yields and exchange rates. We thus offer a new interpretation of 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). We also trace out implications for the transmission of asset purchase and sale policies, and provide novel evidence based on intermediaries' behavior during Treasury and central bank auctions in Colombia.

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).[1] Hau and Rey (2006) and Camanho et al. (2022) document that net equity flows into foreign markets are associated

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

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 uniquely highlights the relationship between foreign investors and bond–currency return comovement, and its implications for the transmission of asset 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.[2,3]

This paper also contributes to the literature on the transmission of policies that alter the net supply of long-term bonds or foreign currency. 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 are often based 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 show that investor composition shapes the transmission of asset purchase policies by influencing the equilibrium covariance between bond and currency returns, and we extend this insight to interventions in currency markets. Second, we provide evidence based on Treasury auctions of local-currency government bonds and central bank auctions for U.S. dollar purchases, both of which shift the net supply of assets that intermediaries must absorb. Under plausible identifying assumptions, we argue that the trading behavior of intermediaries whose balance sheets are differentially affected by

[2]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).

[3]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).

these policies reveals the channel of interest.

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. 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.[4]

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.[5]

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.

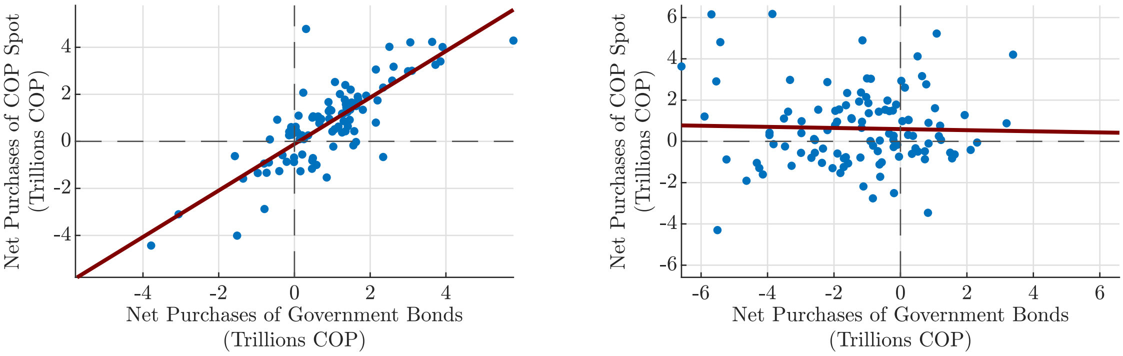
Figure 1a plots foreign investors' monthly net purchases of local-currency bonds (TES) in the secondary government bond market (x-axis) against their net purchases of domestic currency (COP) in the spot foreign exchange market (y-axis).[6] The data lie tightly along the 45-degree line. A regression of 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.

[4]These institutions are subject to FX mismatch regulations overseen by the central bank, *Banco de la República*. The two key metrics are the *Posición Propia de Contado* (PPC) and the *Posición Propia* (PP), both measured as the difference between foreign-currency assets and liabilities relative to bank equity. The PPC captures short-term spot foreign-currency mismatches, while the PP measures overall net FX exposure by also incorporating derivatives positions. Hence, the PPC limits short-run foreign-currency funding risk, whereas the PP constrains total currency risk on and off the balance sheet. During our sample, intermediaries were required to keep PP within $[-5, 20]$ percent of equity and PPC within $[0, 50]$ percent.

[5]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.

[6]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. Following Greenwood et al. (2023), we model foreign and domestic investors' bond demand as exogenous and inelastic. 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.[7]

2 Implications for bond yields and exchange rates

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, two main sets of shocks determine the equilibrium properties of returns on the yield curve trade and the UIP trade: shocks to short-term interest rates, and shocks to domestic and foreign investors' demand for bonds and currencies. As emphasized by Greenwood et al. (2023) and Gourinchas et al. (2025), shocks to short-term interest rates affect the returns from holding bonds of different maturities and currencies through expectations hypothesis and uncovered interest parity channels, while shocks to demand 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 the equilibrium properties of returns on the yield-curve trade and the UIP trade.

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. 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)

[7] 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).

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:

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

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

where $\bar{\iota} > 0$, $\phi_i \in (0,1)$, $\text{var}(\varepsilon_{i_{t+1}}) = \text{var}(\varepsilon_{i^\star_{t+1}}) = \sigma_i^2 > 0$, 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 default-free perpetuities whose payments decline geometrically. 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) a stochastic, time-varying wedge to bond returns, 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 can be interpreted as a time-varying tax on long-term local-currency bond returns. 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 wedge ("taxes") on bond returns. 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 itself governs the equilibrium relationship between intermediaries' positions and excess returns across the yield-curve trade and the UIP trade.[8]

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 $\phi_{s^y} \in [0,1)$, $\varepsilon_{s_{t+1}^y} = \eta_{t+1} + \eta_{t+1}^\star$, $\text{var}(\varepsilon_{s_{t+1}^y}) = \sigma_\eta^2 + \sigma_{\eta^\star}^2 \geq 0$. 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 $\text{var}(\varepsilon_{s_{t+1}^x}) = \sigma_\gamma^2 + \sigma_{\gamma^\star}^2 \geq 0$, 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:

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

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

[8] 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.

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 of our analysis is that foreign investors' local-currency bond demand induces correlated changes in intermediaries' bond and currency positions—and thus to the exposure 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, is governed by 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' bond and currency positions.

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.

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 are associated with 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.*

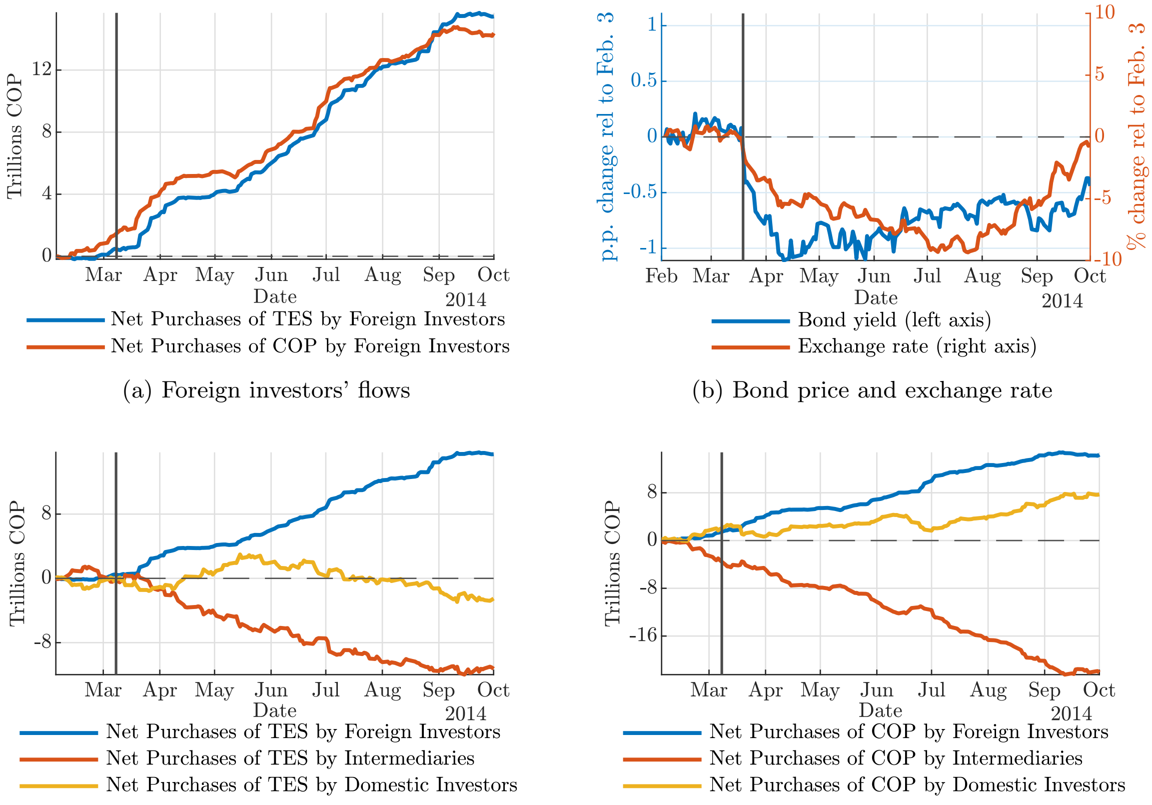
Proof. See Appendix A.4. □

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.[9,10]

[9]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.

[10]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.

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.

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.[11] 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 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

[11] 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.

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 document that intermediaries' positions and portfolio returns suggest that they indeed demand compensation for bearing bond price risk and currency risk.

We compute intermediary holdings measured in domestic currency. For simplicity, we focus on intermediaries' spot FX exposures. This 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).[12] We scale intermediaries' bond and spot positions by total bond (TES) outstanding and by M1, respectively.[13]

A key feature of models with frictional financial intermediation is that intermediaries—the agents that enforce no arbitrage—require positive expected excess returns to absorb any imbalances in bond and foreign exchange markets. The following proposition illustrates how this principle operates in our model.

Proposition 2. *Under Assumption 1, intermediaries earn positive excess returns, on average, on both their bond and currency trades. That is,* $\mathbb{E}(\Delta d_t^y rx_{t+1}^y) \geq 0$ *and* $\mathbb{E}(\Delta d_t^q rx_{t+1}^q) \geq 0$*, where* rx_{t+1}^y *and* rx_{t+1}^q *denote, respectively, the one-period excess returns on the bond and currency positions, and* $\mathbb{E}$ *is the unconditional expectation operator.*

Proof. See Appendix A.4. □

We test whether intermediaries' trades earn positive excess returns in the two markets by constructing their monthly-level trade returns—the realized excess returns associated with

[12]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 were to systematically offload 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. Nevertheless, bond and currency exposures in the relevant "marginal" domestic portfolios would remain correlated due to the participation of foreign investors.

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

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

	UIP Trade Returns				Yield-Curve Trade Returns			
Horizon	1M	3M	6M	12M	1M	3M	6M	12M
	3.4	15.3**	38.8***	74.4***	4.5	13.2**	18.6***	24.9***
	(2.4)	(7.0)	(11.8)	(21.6)	(5.2)	(6.1)	(7.0)	(8.2)
Observations	83	81	78	72	120	120	120	120

Note: This table reports results from mean t-tests of UIP trade and yield-curve trade returns for intermediaries. UIP trade returns are computed following equation (21) and yield-curve trade returns are computed using equation (22). 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.

their marginal trades. Specifically, the UIP trade returns are computed as:

$$\text{UIP Trade Returns}_{t,h} = \Delta d_t^q \times rx_{t+h}^q, \qquad h = 1, 3, 6, 12, \tag{21}$$

where Δd_t^q is a change in intermediary position associated with selling USD to buy COP (measured in USD), and rx_{t+h}^q denotes excess currency returns over a holding period of h months.

Intermediaries' yield-curve trade returns are computed analogously as:

$$\text{Yield-Curve Trade Returns}_{t,h} = \Delta d_t^y \times rx_{t+h}^y, \qquad h = 1, 3, 6, 12, \tag{22}$$

where Δd_t^y is the change in intermediaries' position towards the acquisition of long-term domestic government bonds, and rx_{t+h}^y denotes the corresponding excess bond returns. For simplicity, we use the 10-year local-currency bond and measure returns in domestic currency. After calculating trade returns for each holding period, we perform mean t-tests to assess whether the returns are significantly different from zero.

Table 1 reveals that UIP and yield-curve trade returns are, on average, positively related to changes in intermediaries' positions. Returns are noisier for 1-month horizon, but all average returns are statistically significant for 3-, 6- and 12-month holding periods.[14] Consistent with Proposition 2, these findings suggest that intermediaries—both primary dealers and FX market intermediaries—are the agents enforcing no arbitrage. This evidence aligns with Haddad and Sraer (2020), who show that, for the US, banks' interest rate exposure predicts bond returns.

[14] Analogously, Appendix Table C.1 shows that this is not the case for domestic and foreign investors.

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 government bond issuance and 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. We next formalize this connection in the simplified version of our model.

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.4. □

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 fundamental sources of risk are asset-specific *independent* shocks (fluctuations in the bond return wedge and long-run nominal exchange rate). 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 managing 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, thus accounting for 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 A.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 values chosen by 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.

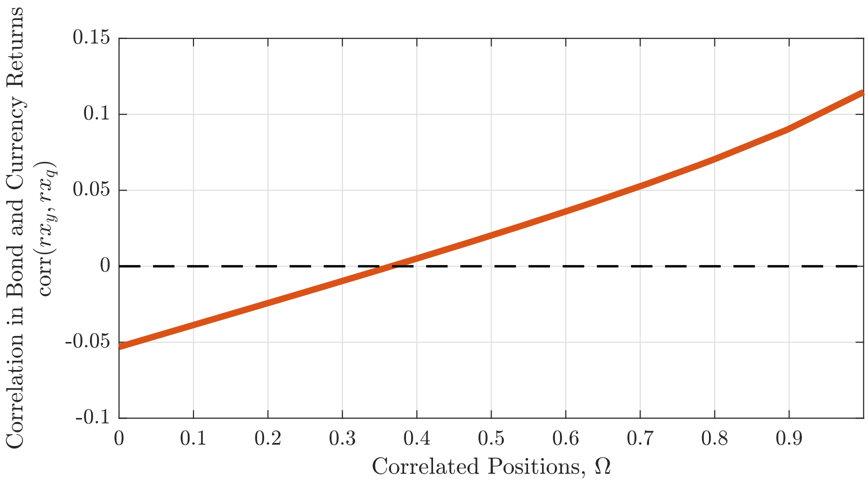
In this baseline calibration we set the currency-risk hedge ratio, α, to 0. We argue that this is a valid approximation of the data. Appendix Figure C.2 documents that there is no consistent relationship between foreign investors net purchases of COP in the spot market and their net sales of COP in the 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, *i.e.*, leaving the overall volatility of demand shocks unchanged.

Figure 3 depicts the correlation in bond and currency returns as a function of the extent of correlated positions in intermediaries' portfolios. In the counterfactual economy without correlated positions, 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 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

[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 A.1 reports the baseline calibration.

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 thus to correlated positions). 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 of bond and currency returns is a key determinant of the effects government's asset purchases or sales, *i.e.*, policies that alter the position of intermediaries in either the bond or currency market. This class of policies, including quantitative easing/tightening and foreign exchange interventions, are increasingly prevalent across economies. The following proposition formalizes the effects of these policies on bond yields and exchange rates.

[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.

Proposition 4. *In the baseline model of Section 2:*

(a) A government's purchase of local-currency long-term bonds, modeled as a reduction in η_t *in equation (11), increases the price of long-term bonds. In addition, it leads to an appreciation of the home currency if and only if* $\text{cov}_t(rx^y_{t+1}, rx^q_{t+1}) > 0$.

(b) 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.4. □

Even if government bond purchases/sales are confined to a single market—the government bond market—they affect not only equilibrium bond yields but also exchange rates. Likewise, central bank purchases/sales of foreign currency affect not only the exchange rate but also the price of long-term bonds. These "cross-market" effects arise from two central features of our small open economy framework and are 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 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 consider a set of auctions conducted by either the Treasury or the central bank in Colombia. As we describe below, these auctions allow us to identify the effects of asset purchases or sales that alter the net supply of intermediaries in either the bond market or foreign exchange markets. As we explain below, we restrict this analysis to the sample period from March 2012 through December 2014.

[17] In this model, asset purchases/sales should be interpreted as a 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.

Treasury auctions in the local-currency bond market The Treasury conducts weekly auctions of local-currency government bonds (TES) as the core instrument of domestic public debt financing.[18] Participation is restricted to institutions included in the Ministry of Finance's Primary Dealer Program for Public Debt Securities, whose members are designated on a fiscal-year basis. In exchange for privileged access to primary auctions, these institutions, the "intermediaries", are required to underwrite a minimum share of total annual issuance.

Our auction sample (March 2012 to December 2014) comprises 491 auctions in which the Treasury issued TES at standard benchmark maturities of 1, 5, and 10 years, corresponding to the short-, medium-, and long-term segments of the domestic yield curve. In practice, issuance is concentrated through repeated re-openings of existing benchmark securities, which enhances liquidity and facilitates direct comparability between primary issuance and secondary market trading. Secondary market transactions take place through the electronic platforms described in Section 1, allowing us to link auction outcomes with contemporaneous and subsequent market prices.

TES auctions follow a multi-unit, uniform-price format. Prior to each auction, the Treasury announces the total amount to be issued along with the characteristics of the security. Bids are submitted within a fixed 30-minute window (9:30–10:00 a.m.), during which authorized participants can submit and revise price–quantity pairs. Each participant may submit up to five bids. At the close of the auction, bids are ranked in descending order of price, and allocations proceed sequentially until the preannounced issuance amount is exhausted. All winning bids are executed at a common clearing price (the cutoff price).

On average, each auction involves approximately ten participating institutions, predominantly private commercial banks, with an average of 3.7 bids per participant. This relatively concentrated but competitive structure mirrors the institutional setup of other sovereign bond markets. For context, the outstanding stock of TES at end-2014 amounted to approximately COP 192.9 trillion (about USD 100 billion), representing the bulk of central government domestic debt (see Table 2 for additional descriptive statistics on Treasury auctions).

Central bank auctions in the foreign exchange market The central bank conducted foreign exchange auctions as part of a daily preannounced program of dollar purchases aimed at accumulating international reserves. Although such operations were conducted between 2008 and 2014, we focus on the 2012–2014 period, when auctions became effectively daily and

[18] These auctions serve a dual role: they ensure the placement of government securities needed to finance the annual budget, while supporting liquidity in the secondary market. Issuance takes place within the annual financing framework defined by the budget law and the government's financial plan for each fiscal year.

when detailed secondary-market transaction data are available, allowing us to link auction outcomes to market prices.[19]

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 if submitted offers were insufficient, although in practice allocations averaged 99.2% of the announced quota. 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).

Empirical 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 bond and foreign exchange markets. The assumption in this comparison is that bidders close to the threshold—those who barely win and those who barely lose—are ex ante similar. Under this assumption, differences in secondary-market asset prices within a narrow window around the cutoff reflect only the differential impact of the auction on winners' and losers' balance sheets. We provide evidence supporting the comparability of marginal bidders. Table C.2

[19] 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
TES Bonds and US Dollar Auctions: Summary Statistics

	Mean	Std. Dev.	Min	P25	Median	P75	Max
Panel A: TES Bond Auctions (491 auctions, March 2012–December 2014)							
Number of Participants	10.3	3.3	1.0	8.0	11.0	13.0	17.0
Winning Participants	8.3	3.0	0.0	6.0	9.0	11.0	14.0
Losing Participants	2.0	2.5	0.0	0.0	1.0	3.0	13.0
Bids per Auction	37.5	27.4	1.0	11.0	38.0	53.0	153.0
Winning Bids per Auction	17.0	11.1	0.0	9.0	15.0	22.0	73.0
Losing Bids per Auction	20.5	19.7	0.0	0.0	20.0	33.0	127.0
Cutoff Yield	4.93	1.41	1.50	3.90	4.84	6.09	7.85
Bid Range per Auction	0.44	0.34	0.00	0.00	0.45	0.66	1.80
TES Purchase by Marginal Winning bid$^{(a)}$	4.66	5.97	0.02	0.57	2.61	5.22	112.60
Panel B: 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

Note: This table presents summary statistics for all 491 TES auctions and 650 US Dollar auctions and in our sample. $^{(a)}$ Amounts are expressed in millions of US dollars. In TES auctions, each dealer may submit up to five bids, whereas in US dollar auctions only one bid is permitted. Aggregating at the dealer level, the average purchase by the marginal winning dealer in TES auctions is USD 9.5 million, nearly twice the corresponding amount in US dollar auctions.

shows that participation and outcomes are not systematically different across institutions, whereas Table C.3 documents limited persistence in auction outcomes.

In foreign exchange auctions, we rank of each dealer's bid relative to the cutoff, with zero corresponding to the marginal winning bid and negative (positive) values indicating losers (winners). In bond auctions, where dealers can submit multiple bids, we use the most competitive bid for each dealer and construct ranks analogously around the cutoff price. Dealers near the cutoff reflect similar valuations, enabling a comparison of marginal winners and losers.

Formally, we estimate the following local weighted regression centered around the auction cutoff price:

$$\arg\min_{\boldsymbol{\gamma}} \sum_{i=1}^{I} \left[y_i - \gamma_0 - \gamma_1 D_i - \gamma_2(\text{rank}_i) - \gamma_3(\text{rank}_i) \times D_i - \gamma_4(\text{trade\_vol}_i) \times D_i\right]^2 K\left(\frac{\text{rank}_i}{h}\right) \tag{23}$$

where y_i denotes either bond or dollar prices (in logs) in their respective secondary markets, measured immediately following the auction, but during the same trading day.[20] The variable

[20]To avoid issues related to unit scaling over time, we express each secondary market trade as a % deviation (log-difference) from the median spot price of the corresponding day.

rank_i denotes the ordinal position of bid i relative to the auction cutoff c: $\text{rank}_i = 0$ for the marginal (cutoff) bid, positive values for winning bids (with $\text{rank}_i = 0$ the lowest accepted bid), and negative values for losing bids (with $\text{rank}_i = -1$ the highest rejected bid). Note that in US dollar procurement auctions, the central bank buys dollars at the lowest price (*i.e.*, the lowest bids win), whereas in TES bond auctions the government sells bonds at the highest price (*i.e.*, the highest bids win). We normalize the rank assignment to impose a unified sign convention across auction types, such that positive ranks always denote winning bids and negative ranks denote losing bids. The variable $D_i = \mathbb{1}\{\text{rank}_i \geq 0\}$ is an indicator equal to one if bid i was accepted. The variable trade_vol_i (centered) denotes the trading volume of sovereign bonds that each bank conducts with foreign investors, measured as the total volume in the month preceding the auction and computed by the central bank staff.[21] The function $K(\cdot)$ is a triangular kernel with bandwidth h. The parameter of interest in equation (23) is γ_1, which captures the difference in subsequent market outcomes between dealers that barely won and those that barely lost the auction.

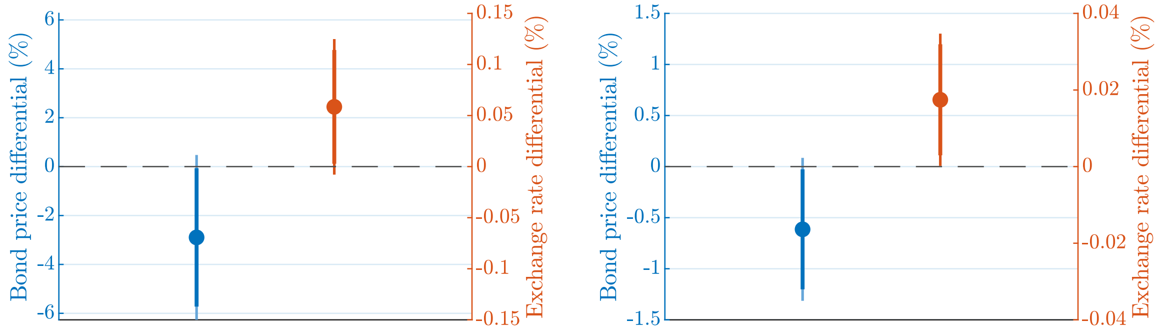
This empirical framework speaks to the effects of Proposition 4 in the following sense. Provided that frictions generate dispersion in secondary market prices, differences in the prices charged by barely winning and barely losing intermediaries are informative about the structure of the intermediary sector's supply curves (see eq. (10)). For instance, an intermediary that barely wins the Treasury auction absorbs a marginal quantity of long-term bonds relative to an intermediary that barely loses. The relative bond price at which it trades traces out the slope of the bond supply curve, while the relative exchange rate at which it trades reveals the intermediary's perceived covariance between bond and currency returns.[22]

Asset price effects of asset purchases/sales We document that asset purchase policies affect bond price and exchange rates in a manner consistent with Proposition 4. Figure 4 reports the estimates of γ_1 in equation (23), while Appendix Table C.4 reports the estimates of all other coefficients. The issuance of local-currency government bonds leads to an increase in bond yields *and* a depreciation of the Colombian peso against the US dollar. Quantitatively, auction winners—dealers that purchase TES—subsequently trade bonds at prices 2.9% lower and dollars at prices 0.059% higher than auction losers. These magnitudes are economically large, corresponding to roughly one standard deviation of daily changes in both exchange

[21]We include the interaction $D_i \times \text{trade\_vol}_i$ to ensure that the baseline results are not driven by differential exposure to foreign investors across participants.

[22]A cross-sectional approach also mitigates concerns related to the information effects of central bank interventions—such as those discussed in Candian et al. (2023)—which inevitably appear in high-frequency asset price responses around the intervention.

Figure 4
The responses of bond prices and exchange rates to asset purchases/sales



(a) Local-currency bond sales (b) Foreign currency purchases

Note: This figure reports the estimates of γ_1 in equation (23), along with 90% (darker) and 95% (lighter) confidence intervals constructed using robust standard errors. All specifications use a bandwidth of two ranks, consistent with Calonico et al. (2014). Appendix Table C.4 reports the full set of estimates of equation (23).

rate and bond prices.[23]

Through the lenses of Proposition 4(a), these patterns imply that intermediaries perceive bond and currency returns to be positively correlated. As they are required to absorb more local-currency government bonds, they demand not only a higher term premium, leading to lower bond prices as in, *e.g.*, Greenwood and Vayanos (2014), but also a higher currency premium, leading to a depreciation of the exchange rate.

Central bank purchases of US dollars also have significant effects on both the exchange rate and bond prices. Dollar auction winners—dealers that sell USD to the central bank—subsequently trade FX at prices 0.017% higher and bonds at prices 0.61% lower than auction losers. These effects are economically meaningful, corresponding to roughly one-third of the standard deviation of daily exchange rate changes and one-fifth of the daily bond price changes.[24] These effects are consistent with the prediction in Proposition 4(b). Because bond and currency returns are positively correlated, greater exposure to Colombian peso risk induced by winning the dollar auction leads intermediaries to demand not only a higher currency premium (a weaker peso) but also a higher term premium (lower long-term bond prices).

[23]The marginal winning bids amount to USD 4.66 million in TES purchases, and, accounting for multiple bids per dealer, this aggregates to roughly USD 9.5 million at the marginal winner level (see Table 2), corresponding to approximately 0.3–0.5% of average daily TES turnover.

[24]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.

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 $\Delta q_{t+1} = \log\left(Q_{t+1}/Q_t\right)$ 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.[25] The dataset includes spot exchange rates,

[25] 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.

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 (24). 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.

10-year government bond total return indexes, and 3-month deposit rates.[26] Our sample includes Australia, Canada, Colombia, India, Indonesia, Japan, Mexico, New Zealand, Poland, South Africa, South Korea, Sweden, Switzerland, Thailand, and the United Kingdom.

[26] 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).

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

$$rx^{q}_{j,t+3} = \alpha + \beta rx^{(10y)}_{j,t+3} + \epsilon_{j,t+3}. \tag{24}$$

Table 3 (Columns (1)-(2)) reports the estimated β of equation (24) 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 insignificant. These conclusions apply also when using 1-month excess returns, as documented in Appendix Table B.1.

We provide evidence that rules out time-varying default risk as an explanation for 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.[27] 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

[27] 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.

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.

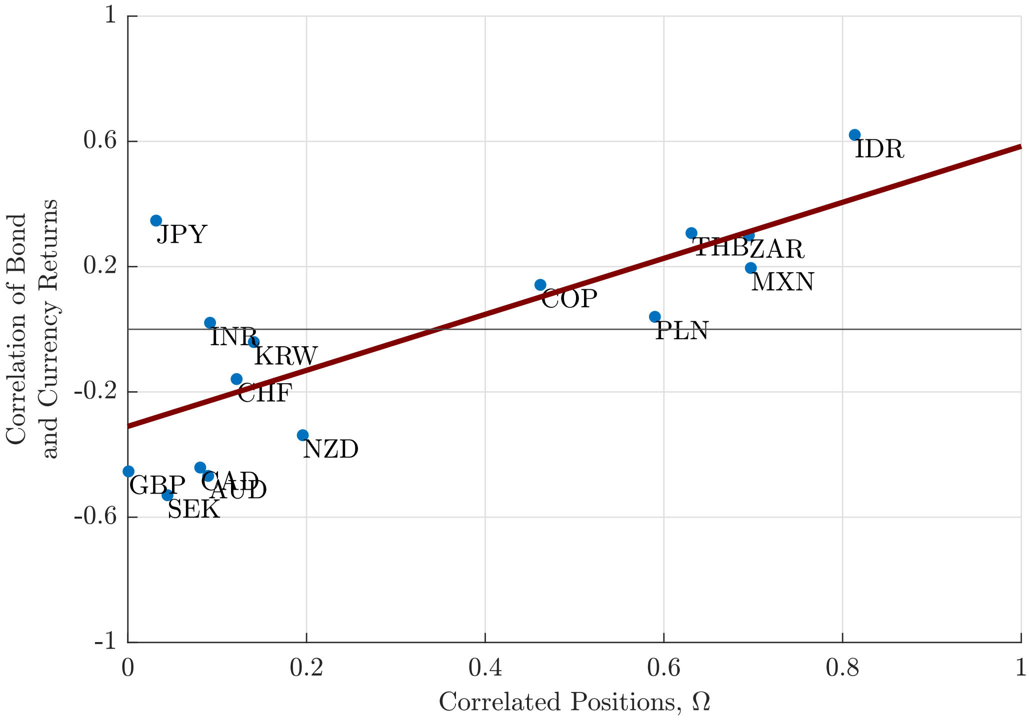
advanced economies, we use hedge ratios for global fixed-income investors from Cheema-Fox and Greenwood (2024). For emerging economies, we use the estimates of hedge ratios for US mutual funds documented in Chen and Zhou (2025). While the evidence on hedging ratios for emerging economies is based on US mutual funds, we note that these are main foreign investor type in Colombia's local currency government bond market (see Appendix B.1).[28]

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 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

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

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).

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 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).[29] In addition, many emerging economies—both 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 of frictional 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, as well as intermediaries' trading behavior following government interventions in either bond or currency markets. 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

[29] 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.

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

We use the Campbell and Shiller (1988) log-linear approximation to model the before-tax return on default-free long-term bonds. We assume that agents take as given the exogenous tax described in the model section. These bonds are self-amortizing perpetuities whose payments decline geometrically, are free of default risk, and have a face value of 1 at time t. Let P^y_t be the price and Y_t the yield-to-maturity of these long-term bonds at time t. At $t+1$, this instrument will offer a coupon payment of C, a principal repayment of $1-\kappa$ for some $\kappa \in [0,1]$, and κ units of the asset. Here, κ is the continuation rate. The gross before-tax return on long-term bonds from t to $t+1$ is thus

$$1 + R^y_{t+1} = \frac{C + 1 - \kappa + \kappa P^y_{t+1}}{P^y_t}, \tag{A.1}$$

where

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

Taking a log-linear approximation of the long-term bond's return around the point where it is trading at par at $t+1$ obtains

$$r^y_{t+1} \approx \theta + \delta p^y_{t+1} - p^y_t, \tag{A.3}$$

where $\theta \equiv \ln(1+C)$ and $\delta \equiv \kappa/(1+C)$ are parameters. We can iterate this equation forward and apply this approximation to Y_t to get

$$p^y_t \approx \frac{1}{1-\delta}\theta - \frac{1}{1-\delta} y_t. \tag{A.4}$$

We plug equation (A.4) into (A.3) to get the approximate one-period log return on the long-term bond

$$r^y_{t+1} \approx \frac{1}{1-\delta} y_t - \frac{\delta}{1-\delta} y_{t+1}, \tag{A.5}$$

where $D = (1-\delta)^{-1}$ is the Macaulay duration when the instrument is trading at par.

Lastly, one can subtract the tax g_t from this return to get expression (3).

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:

$$d_t^x[i_t - i_t^\star - (q_{t+1} - q_t)] + d_t^f[f_t - q_{t+1}] \tag{A.6}$$

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:

$$d_t^q[i_t - i_t^\star - (q_{t+1} - q_t)] - d_t^f[i_t - i_t^\star - (f_t - q_t)] \tag{A.7}$$

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 $\text{devs}_t \equiv i_t - i_t^\star - (f_t - q_t)$.

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:

$$\max_{\mathbf{d}_t} \left\{ \mathbf{d}_t' \, \mathrm{E}_t[\mathbf{rx}_{t+1}] - \frac{1}{2\tau} \mathbf{d}_t' \, \mathrm{var}_t[\mathbf{rx}_{t+1}] \mathbf{d}_t \right\}, \tag{A.8}$$

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

$$\mathrm{E}_t[\mathbf{rx}_{t+1}] = \tau^{-1} \, \mathrm{var}_t[\mathbf{rx}_{t+1}] \mathbf{d}_t. \tag{A.9}$$

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

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

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

$$\alpha^* = f(\alpha^*). \tag{A.11}$$

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:

$$\mathrm{E}_t[\mathbf{rx}_{t+1}] = \tau^{-1}\,\mathrm{var}_t[\mathbf{rx}_{t+1}]\mathbf{d}_t. \tag{A.12}$$

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

$$\mathrm{E}_t[\mathbf{rx}_{t+1}] = \tau^{-1}\mathbf{V}\mathbf{s}_t, \tag{A.13}$$

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.12), yielding individual excess return equations:

$$\mathrm{E}_t\left[rx^y_{t+1}\right] = \frac{1}{\tau}\left[V_y \cdot s^y_t + C_{y,q} \cdot s^q_t\right]; \tag{A.14a}$$

$$\mathrm{E}_t\left[rx^q_{t+1}\right] = \frac{1}{\tau}\left[C_{y,q} \cdot s^y_t + V_q \cdot s^q_t\right], \tag{A.14b}$$

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:

$$y_t = \left\{\bar{\imath} + \frac{1-\delta}{1-\delta\phi_i} \cdot (i_t - \bar{\imath})\right\} + \frac{1-\delta}{1-\delta\phi_g} g_t + \tau^{-1}\left\{\frac{1-\delta}{1-\delta\phi_{s^y}} V_y \cdot s^y_t + \frac{1-\delta}{1-\delta\phi_{s^q}} C_{y,q} \cdot s^q_t\right\}; \tag{A.15}$$

$$q_t = \left\{ \frac{1}{1-\phi_i} \cdot (i_t^\star - i_t) \right\} + \bar{q}_t + \tau^{-1} \left\{ \frac{1}{1-\phi_{s^y}} C_{y,q} \cdot s_t^y + \frac{1}{1-\phi_{s^q}} V_q \cdot s_t^q \right\}. \tag{A.16}$$

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,

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

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

$$\mathbf{y}_{t+1} = \mathbf{a} + \mathbf{A}\mathbf{z}_{t+1} = \mathbf{a} + \mathbf{A}\Phi\mathbf{z}_t + \mathbf{A}\varepsilon_{t+1}. \tag{A.17}$$

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

$$\mathbf{rx}_{t+1} = [\mathbf{B}_0\mathbf{a} + \mathbf{B}_1\mathbf{a} + \mathbf{r}_0] + [\mathbf{B}_0\mathbf{A} + \mathbf{B}_1\mathbf{A}\Phi + \mathbf{R}_1]\mathbf{z}_t + [\mathbf{B}_1\mathbf{A}]\varepsilon_{t+1}, \tag{A.18}$$

which implies that

$$E_t[\mathbf{rx}_{t+1}] = [\mathbf{B}_0\mathbf{a} + \mathbf{B}_1\mathbf{a} + \mathbf{r}_0] + [\mathbf{B}_0\mathbf{A} + \mathbf{B}_1\mathbf{A}\Phi + \mathbf{R}_1]\mathbf{z}_t; \tag{A.19}$$

$$\mathbf{V} \equiv \text{var}_t[\mathbf{rx}_{t+1}] = \mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1'. \tag{A.20}$$

Going back to the market-clearing condition in equation (A.13), $\mathbf{s}_t = [s_t^y, s_t^q]'$ 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.13) as

$$[\mathbf{B}_0\mathbf{a} + \mathbf{B}_1\mathbf{a} + \mathbf{r}_0] + [\mathbf{B}_0\mathbf{A} + \mathbf{B}_1\mathbf{A}\Phi + \mathbf{R}_1]\mathbf{z}_t = \tau^{-1}(\mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1')(\mathbf{S}_1\mathbf{z}_t). \tag{A.21}$$

Equation (A.21) 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

$$(\mathbf{B}_0 + \mathbf{B}_1)\mathbf{a} = -\mathbf{r}_0. \tag{A.22}$$

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

$$[\mathbf{B}_0 \mathrm{A} + \mathbf{B}_1 \mathrm{A}\Phi] = \mathbf{A} \circ [\mathbf{B}_0 \mathbf{E} + \mathbf{B}_1 \mathbf{E}\Phi], \tag{A.23}$$

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,

$$[\mathbf{A} \circ (\mathbf{B}_0 \mathbf{E} + \mathbf{B}_1 \mathbf{E}\Phi) + \mathbf{R}_1]\mathbf{z}_t = \tau^{-1}(\mathbf{B}_1 \mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1')\mathbf{S}_1\mathbf{z}_t. \tag{A.24}$$

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

$$\mathbf{A} = [\tau^{-1}\mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1'\mathbf{S}_1 - \mathbf{R}_1] \oslash [\mathbf{B}_0\mathbf{E} + \mathbf{B}_1\mathbf{E}\Phi], \tag{A.25}$$

where $\oslash$ is element-wise matrix division. To further characterize the solution to the problem in (A.25), 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 $\mathbf{S}_1$ ($\mathbf{S}_1^{[1-3]} = \mathbf{0}_{2\times3}$) 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.16) 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

$$\Sigma = \begin{bmatrix} \Sigma_1 & 0_{3\times 1} & 0_{3\times 2} \\ 0_{1\times 3} & \Sigma_2 & 0_{1\times 2} \\ 0_{2\times 3} & 0_{2\times 1} & \Sigma_3 \end{bmatrix} \quad \text{where} \quad \Sigma_1 = \begin{bmatrix} \sigma_i^2 & \rho\sigma_i^2 & 0 \\ \rho\sigma_i^2 & \sigma_i^2 & 0 \\ 0 & 0 & \sigma_g^2 \end{bmatrix}, \quad \Sigma_3 = \begin{bmatrix} \sigma_{sy}^2 & \sigma_{\eta^*}\sigma_{\gamma^*} \\ \sigma_{\eta^*}\sigma_{\gamma^*} & \sigma_{sq}^2 \end{bmatrix},$$

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

$$\mathbf{V} = (\mathbf{B}_1\mathbf{A}_1\Sigma_1\mathbf{A}_1'\mathbf{B}_1') + (\mathbf{B}_1\mathbf{A}_2\Sigma_2\mathbf{A}_2'\mathbf{B}_1') + (\mathbf{B}_1\mathbf{A}_3\Sigma_3\mathbf{A}_3'\mathbf{B}_1'). \tag{A.26}$$

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

$$\mathbf{A}_3 = \mathbf{F}_3(\mathbf{A}_3) \equiv \tau^{-1}[(\mathbf{B}_1\mathbf{A}_1\Sigma_1\mathbf{A}_1'\mathbf{B}_1')+(\mathbf{B}_1\mathbf{A}_2\Sigma_2\mathbf{A}_2'\mathbf{B}_1')+(\mathbf{B}_1\mathbf{A}_3\Sigma_3\mathbf{A}_3'\mathbf{B}_1')]\oslash[\mathbf{B}_0\mathbf{E}+\mathbf{B}_1\mathbf{E}\Phi]^{[5-6]}. \tag{A.27}$$

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.27), and using $\mathbf{V}$ in its matrix form, the equilibrium price-impact coefficients must satisfy

$$\begin{bmatrix} \alpha_{sy}^y & \alpha_{sq}^y \\ \alpha_{sy}^q & \alpha_{sq}^q \end{bmatrix} = \tau^{-1} \begin{bmatrix} \frac{1-\delta}{1-\delta\phi_{sy}} V_y & \frac{1-\delta}{1-\delta\phi_{sq}} C_{y,q} \\ \frac{1}{1-\phi_{sy}} C_{q,y} & \frac{1}{1-\phi_{sq}} V_q \end{bmatrix}. \tag{A.28}$$

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

$$\begin{bmatrix} \left(\frac{\delta}{1-\delta\phi_i}\right)^2 \sigma_i^2 + \left(\frac{\delta}{1-\delta\phi_g}\right)^2 \sigma_g^2 & -\frac{\delta}{1-\delta\phi_i}\frac{1}{1-\phi_i}\sigma_i^2(1-\rho) \\ -\frac{\delta}{1-\delta\phi_i}\frac{1}{1-\phi_i}\sigma_i^2(1-\rho) & \left(\frac{1}{1-\phi_i}\right)^2 2\sigma_i^2(1-\rho)+\sigma_q^2 \end{bmatrix}. \tag{A.29}$$

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.28) in the contribution of supply risk to the variance-covariance matrix, and using this and (A.29) in (A.26), along with denoting the constants

$$g_y \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{sy}}\sigma_\eta, \quad g_y^* \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{sy}}\sigma_{\eta^*}, \quad g_q \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{sq}}\sigma_\gamma, \quad g_q^* \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{sq}}\sigma_{\gamma^*}, \tag{A.30}$$

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

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

$$V_y = \left(\frac{\delta}{1-\delta\phi_i}\right)^2 \sigma_i^2 + \left(\frac{\delta}{1-\delta\phi_g}\right)^2 \sigma_g^2 + (V_y)^2(g_y^2+g_{y^*}^2) + (C_{y,q})^2(g_q^2+g_{q^*}^2) + 2g_{y^*}g_{q^*}V_yC_{y,q}; \tag{A.31a}$$

$$V_q = \left(\frac{1}{1-\phi_i}\right)^2 2\sigma_i^2(1-\rho) + \sigma_q^2 + (C_{y,q})^2(h_y^2+h_{y^*}^2) + (V_q)^2(h_q^2+h_{q^*}^2) + 2h_{y^*}h_{q^*}V_qC_{y,q}; \tag{A.31b}$$

$$C_{y,q} = -\frac{\delta}{1-\delta\phi_i}\frac{1}{1-\phi_i}\sigma_i^2(1-\rho) + V_yC_{y,q}(g_yh_y+g_{y^*}h_{y^*}) + V_qC_{y,q}(g_qh_q+g_{q^*}h_{q^*}) \tag{A.31c}$$

$$+ (C_{y,q})^2 g_{q^*}h_{y^*} + V_yV_qg_{y^*}h_{q^*}.$$

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

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

which completes the full write-down of the solution method. One must now combine these three equations to find qualitative properties of the three unknowns. Instead, in the next subsection we prove Proposition 3, which effectively reduces this system of equations into a more manageable set that yields qualitatively similar implications.

A.4 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.15) and (A.16) 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

$$\mathbb{E}(\Delta d_t^y rx_{t+1}^y) = \mathbb{E}(d_t^y rx_{t+1}^y) - \mathbb{E}(d_{t-1}^y rx_{t+1}^y). \tag{A.32}$$

We can use the law of iterated expectations on the second term in the right-hand side of

(A.32) to obtain:

$$\mathbb{E}(d^y_{t-1} rx^y_{t+1}) = \mathbb{E}\left(\mathrm{E}_t(d^y_{t-1} rx^y_{t+1})\right) = \mathbb{E}(d^y_{t-1}\, \mathrm{E}_t\, rx^y_{t+1}), \tag{A.33}$$

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

$$\mathbb{E}(d^y_{t-1} rx^y_{t+1}) = \tau^{-1}\, \mathrm{var}_t(rx^y_{t+1})\mathbb{E}(d^y_{t-1} d^y_t) + \tau^{-1}\, \mathrm{cov}_t(rx^y_{t+1}, rx^q_{t+1})\mathbb{E}(d^y_{t-1} d^q_t). \tag{A.34}$$

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

$$\mathbb{E}(d^y_{t-1} d^y_t) = \mathbb{E}(d^y_{t-1} d^q_t) = 0. \tag{A.35}$$

This equation, along with (A.32), implies that:

$$\mathbb{E}(\Delta d^y_t rx^y_{t+1}) = \mathbb{E}(d^y_t rx^y_{t+1}). \tag{A.36}$$

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

$$\mathbb{E}(d^y_t rx^y_{t+1}) = \tau^{-1}\left[\mathrm{var}_t(rx^y_{t+1})\mathbb{E}\left((d^y_t)^2\right) + \mathrm{cov}_t(rx^y_{t+1}, rx^q_{t+1})\mathbb{E}\left(d^q_t d^y_t\right)\right]; \tag{A.37}$$

$$\mathbb{E}\left(d^q_t rx^q_{t+1}\right) = \tau^{-1}\left[\mathrm{var}_t(rx^q_{t+1})\mathbb{E}\left((d^q_t)^2\right) + \mathrm{cov}_t(rx^y_{t+1}, rx^q_{t+1})\mathbb{E}\left(d^y_t d^q_t\right)\right]. \tag{A.38}$$

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 $\mathbb{E}(d^y_t rx^y_{t+1}) \geq 0$ and $\mathbb{E}(d^q_t rx^q_{t+1}) \geq 0$. □

Proof of Proposition 3. Assumption 1 implies that $V_y = V_q$, which simplifies our system of equations (A.31a)–(A.31c) as follows:

$$V_y = \sigma_g^2 + (V_y)^2\tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2) + (C_{y,q})^2\tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2) + 2V_y C_{y,q}\tau^{-2}\sigma_{\eta^*}^2; \tag{A.39a}$$

$$C_{y,q} = 2V_y C_{y,q}\tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2) + (C_{y,q})^2\tau^{-2}\sigma_{\eta^*}^2 + (V_y)^2\tau^{-2}\sigma_{\eta^*}^2. \tag{A.39b}$$

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

$$V_y = \sigma_g^2 + \tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2)\left[(V_y)^2 + (C_{y,q})^2 + 2\Omega V_y C_{y,q}\right]; \tag{A.40a}$$

$$C_{y,q} = \tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2)\left[2V_y C_{y,q} + (C_{y,q})^2\Omega + (V_y)^2\Omega\right]. \tag{A.40b}$$

First, setting $\Omega = 0$, it can be readily seen from equations (A.40a)-(A.40b) that the only real solution implies $C_{y,q} = 0$. Second, dividing both sides of (A.40b) by V_y and rearranging, we obtain

$$\frac{C_{y,q}}{V_y}\left(1 - 2V_y\tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^\star}^2)\right) = \Omega\, V_y\, \tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^\star}^2)\left(1 + \left(\frac{C_{y,q}}{V_y}\right)^2\right). \tag{A.41}$$

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

$$\text{sign}(C_{y,q}) = \text{sign}(\Omega), \tag{A.42}$$

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

$$1 - 2V_y\tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^\star}^2) > 0. \tag{A.43}$$

□

Proof of Proposition 4. Consider a unit decrease in η_t in (11), which implies a reduction in bond net supply s_y without a corresponding movement in currency net supply (i.e. $s_q = 0$). By the equilibrium solution of the exchange rate, eq. (A.16) derived in Appendix A.3, such impulse causes a currency appreciation if and only if $\text{cov}_t(rx^y_{t+1}, rx^q_{t+1}) > 0$. This proves part (a). The proof of part (b) is analogous, and follows from considering a unit increase in γ_t in (17). □

Table A.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

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.

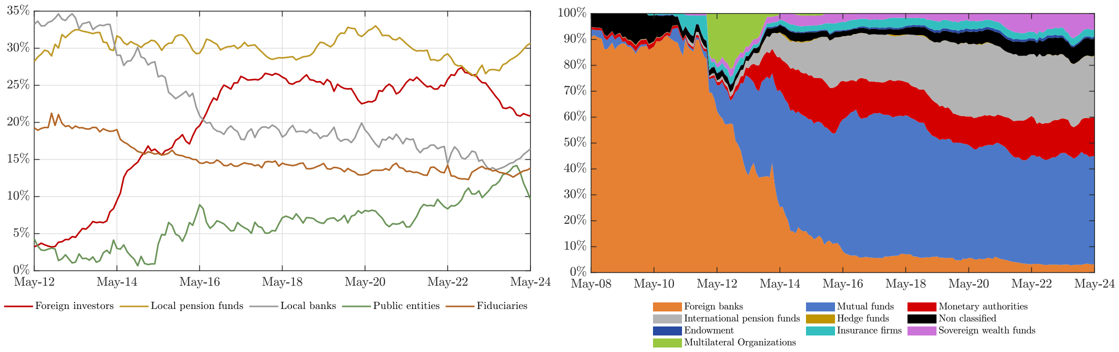
Figure B.1b shows the share of bond holding across foreign investors. Before 2014 foreign banks held the largest share of sovereign bonds among foreign investors, although their overall market participation was relatively low. Since 2014, mutual funds have become the dominant investors, followed by international 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.

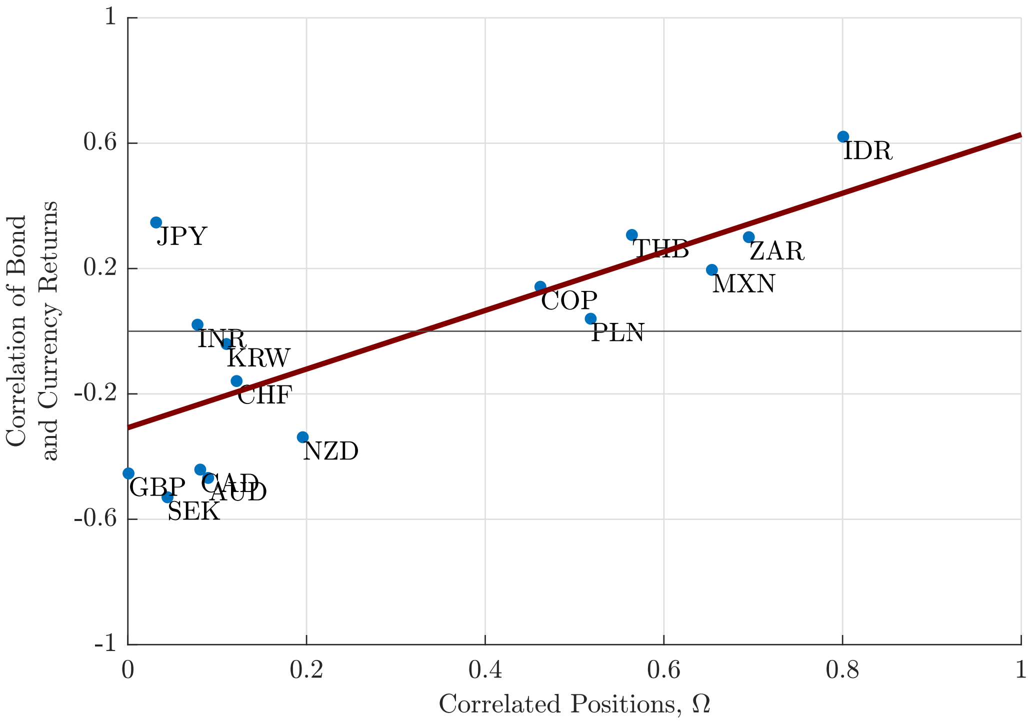
Figure B.1
Participation in the Colombian TES market



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

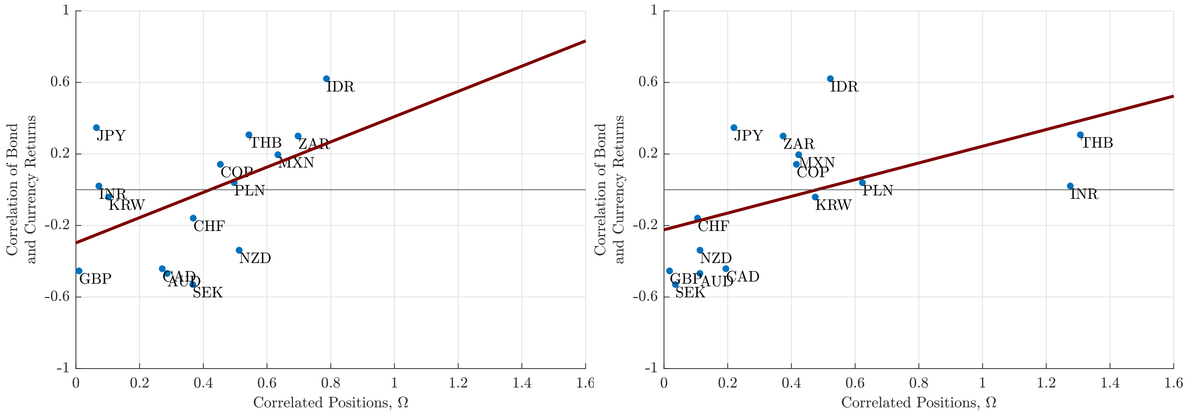
Note: The data presented correspond to all trades registered with the Central Securities Depository (DCV), which operates under the supervision of the Central Bank of Colombia. Panel A shows the TES participation (percentage of total outstanding TES volume) across major entities, while Panel B focuses 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.

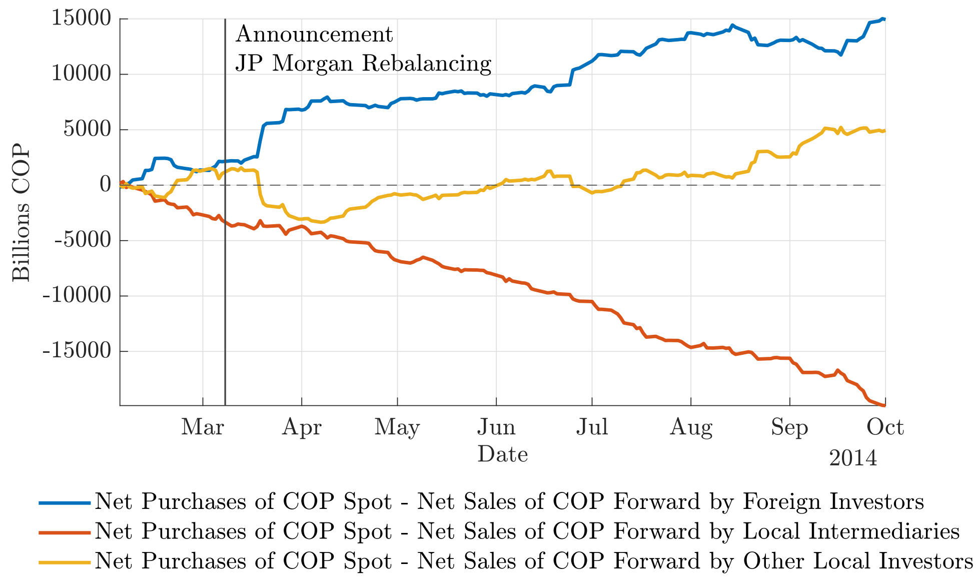
Table B.1
Summary of FX and bond excess returns (1-month excess returns)

Country	Regression coefficient	Correlation	Residualized excess returns: Regression coefficient	Residualized excess returns: 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

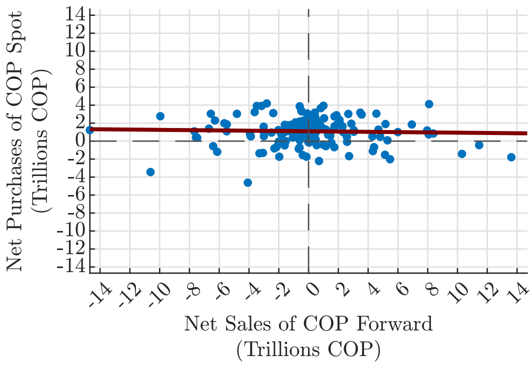
Figure C.1
Flows in COP Spot and Forward markets during J.P. Morgan Index Rebalancing



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
UIP and Yield-Curve Trade Returns on Investors' Portfolios

	UIP Trade Returns				Yield-Curve Trade Returns			
Horizon	1M	3M	6M	12M	1M	3M	6M	12M
Foreign Investors	0.9	-5.3	-19.9^{*}	-46.4^{**}	-0.4	-1.8	-3.8	-9.8^{***}
	(2.3)	(5.0)	(10.2)	(17.7)	(1.8)	(2.0)	(2.7)	(3.6)
Domestic Investors	-4.3^{**}	-10.0^{**}	-19.0^{***}	-28.0^{**}	-4.1	-11.4^{**}	-14.8^{**}	-15.1^{*}
	(2.0)	(4.7)	(6.9)	(13.5)	(4.4)	(5.5)	(6.1)	(7.7)
Observations	83	81	78	72	120	120	120	120

Note: This table reports results from mean t-tests of UIP trade and yield-curve trade returns for domestic and foreign investors. UIP trade returns are computed following equation (21) and yield-curve trade returns are computed using equation (22). 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 TES bond and U.S. Dollar Auctions

	TES Auctions				U.S. Dollar Auctions		
Dealer	Participation	Barely Won	Barely Lost	Dealer	Participation	Barely Won	Barely Lost
H	97%	29%	2%	A	97%	75%	14%
O	96%	31%	2%	B	87%	54%	29%
A	94%	29%	2%	C	75%	39%	40%
I	86%	29%	1%	G	74%	40%	34%
P	81%	38%	3%	D	68%	53%	23%
J	81%	25%	8%	E	64%	55%	7%
Y	80%	29%	3%	F	62%	59%	9%
G	80%	33%	0%	M	48%	43%	27%
C	80%	30%	0%	H	47%	49%	30%
D	63%	13%	5%	K	45%	33%	35%
R	56%	37%	2%	J	45%	52%	32%
M	45%	29%	4%	I	39%	29%	33%
Z	43%	26%	5%	L	29%	15%	46%
L	27%	41%	2%	N	17%	38%	31%
W	27%	18%	5%	Q	8%	30%	54%
X	20%	17%	2%	O	6%	63%	20%
V	19%	10%	8%	P	2%	15%	62%

Note: Dealers (anonymized) are sorted by participation. Barely Winner and Barely Loser denote winners and losers within a bandwidth rank of $[-2, 2]$ around the cutoff price.

Table C.3
Transition Probability Matrix at TES bond and U.S. Dollar Auctions

State at t	**State at** $t+1$			
	Partially Winner	Winner	Partially Loser	Loser
Panel A: TES Auctions				
Partially Winner	16.4%	73.4%	2.3%	8.0%
Winner	32.8%	54.9%	3.0%	9.3%
Partially Loser	30.7%	50.7%	5.3%	13.3%
Loser	26.8%	38.8%	4.3%	30.1%
Panel B: USD Auctions				
Partially Winner	55.3%	11.8%	23.6%	9.4%
Winner	51.7%	28.2%	14.4%	5.6%
Partially Loser	43.9%	6.8%	32.6%	16.8%
Loser	33.4%	4.9%	35.6%	26.0%

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 a rank bandwidth of $[-2, 2]$ around the cutoff price. Winner and Loser denote dealers who won or lost outside that bandwidth.

Table C.4
Estimated effects of asset purchases/sales

	TES Auctions		USD Auctions	
	TES Bond Prices	FX Prices	TES Bond Prices	FX Prices
Rank	2.13**	−0.05**	0.38	−0.01
	(0.94)	(0.023)	(0.28)	(0.01)
Dummy	−2.90*	0.06*	−0.61*	0.02**
	(1.72)	(0.03)	(0.36)	(0.01)
Dummy × rank	−2.16***	0.04*	−1.34***	0.01
	(0.82)	(0.02)	(0.28)	(0.01)
Dummy × trade_vol	0.001	−0.00002	0.0001	−0.00002***
	(0.001)	(0.00002)	(0.001)	(0.00001)
Constant	2.06	−0.02	−1.28***	−0.01
	(1.90)	(0.05)	(0.48)	(0.01)
Observations	238	181	615	603

Note: This table reports the estimates of equation (23), along with robust standard errors in parentheses. All specifications use a bandwidth of two ranks, consistent with Calonico et al. (2014).