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

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Abstract

In emerging markets, higher bond term premia are typically accompanied by higher currency premia. We attribute this relationship to the prominent role of global investors in local-currency bond markets and their limited use of currency hedging. Using transaction-level data from Colombia's bond and foreign exchange markets, we show that foreign investors' bond trades are systematically accompanied by simultaneous transactions in the spot exchange market, but not in the forward exchange market. We incorporate these *correlated flows* into a portfolio-balance model that also accounts for short-term interest rate risk. The model helps explain cross-country differences in the comovement of bond yields and exchange rates, the observed patterns of positions and returns in bond and foreign exchange markets, and the effects of quantitative easing and foreign exchange interventions.

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

JEL Classification: E43, E52, F31, G12

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1 Introduction

Long-term bond yields and exchange rates are central to the transmission of monetary and asset purchase policies in open economies. We highlight that the joint dynamics of these asset prices differ systematically between advanced and emerging economies. We trace these differences to cross-country variation in both the importance of global investors in local-currency sovereign bond markets and the extent to which they leave currency exposures unhedged. We characterize how these features shape the properties of capital flows, bond and currency risk premia, and the transmission of asset purchase policies.

In advanced economies, excess returns on local-currency bonds and currencies tend to move in opposite directions (Lustig et al., 2019).[1] This negative correlation arises naturally in leading portfolio-balance models: both asset classes are exposed to interest rate risk, but in opposing ways (Greenwood et al., 2023; Gourinchas et al., 2022). In emerging economies, however, we find the opposite pattern—excess bond and currency returns are positively correlated, both across countries and over time. This empirical regularity stands in contrast to standard theoretical predictions, and we show that it cannot be explained by differences in default risk.

We attribute the distinct comovement observed in emerging markets to two key properties of international capital flows into local-currency bond markets. First, flows initiated by global investors—those domiciled outside the emerging economy—closely tie bond market transactions to foreign exchange transactions. Using transaction-level data from Colombia's sovereign bond and foreign exchange markets, we show that when global investors purchase local-currency bonds, they simultaneously acquire domestic currency; conversely, they sell domestic currency when liquidating bond positions. Strikingly, these bond-related flows account for the majority of global investor activity in the spot exchange market. Second, local-currency bond positions of global investors oriented to emerging economies are effectively unhedged (Chen and Zhou, 2025), unlike in advanced economies (Cheema-Fox and Greenwood, 2024). In Colombian data, for example, bond transactions are *not* systematically associated with transactions in the forward exchange market. We thus highlight that any unhedged bond purchases of local-currency bonds by global investors generates flows in both bond and currency markets—a phenomenon we label *correlated flows*.

The role of correlated flows is immediately apparent during a major episode of global

[1] Local-currency excess bond returns are the returns from holding a long term bond for one period, financed by borrowing at the short-term in domestic currency. Excess currency returns are the return from borrowing short-term in foreign currency and lending short-term in domestic currency.

investors' inflows into Colombia's local-currency government bond market (TES). In March 2014, *J.P. Morgan* announced the inclusion of five Colombian TES bonds in its flagship benchmark index for emerging market local-currency government debt. This announcement triggered substantial index-driven purchases: by the time the inclusion was fully implemented in October 2014, foreign investors had acquired nearly 10% of outstanding TES bonds (Williams, 2018). Notably, these purchases were mirrored almost one-for-one by foreign acquisitions of Colombian pesos (COP) in the spot FX market, as shown in Figure 1a. Thus, while the initial shock originated in the bond market, it exerted correlated flows into both bond and spot exchange markets. Importantly, local intermediaries (which we describe in details in the paper) by and large absorbed the imbalances resulting in bond and foreign exchange markets from the demand of global investors, as shown in Figures 1b and 1c.[2]

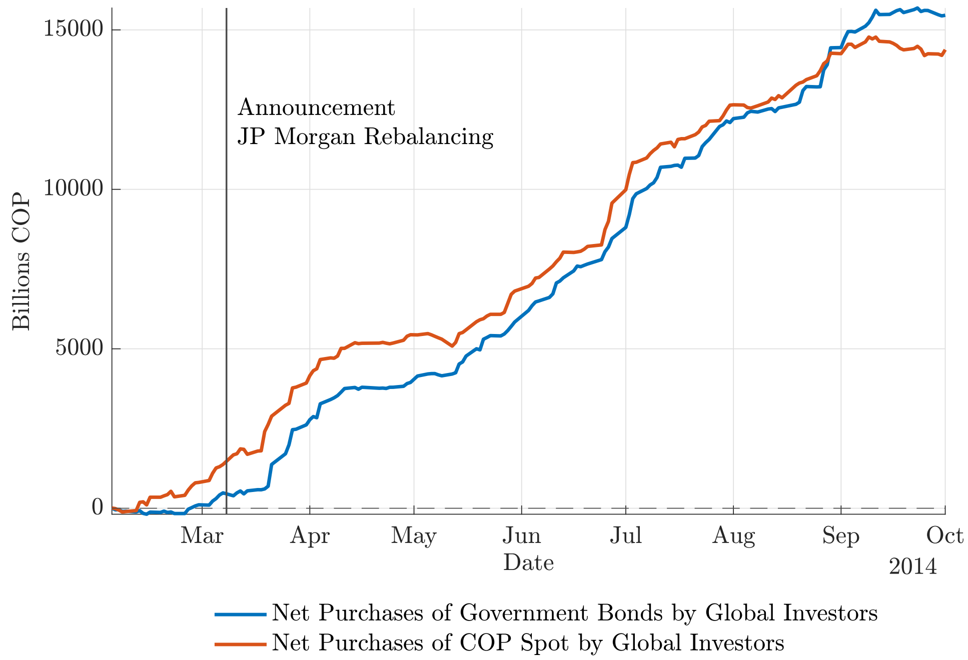
We develop a portfolio balance model in which global investors impart correlated flows across long-term bond and spot exchange markets. In the model, local financial intermediaries absorbs net flows in both bond and currency markets, with a portion of these flows reflecting the correlated demand of global investors. Apart from these features, the structure of our small open economy model follows Greenwood et al. (2023) and Gourinchas et al. (2022).

In equilibrium, returns on bonds and currencies reflect two main sources of correlated risk. First, short-term interest rate risk affects bond and currency returns in opposing ways: an unanticipated increase in the local short-term interest rate lowers the price of long-term bonds while appreciating the domestic currency, thereby generating a negative correlation between excess bond and currency returns. Second, correlated flows from global investors simultaneously alter local intermediaries' exposure to both yield-curve trade and UIP trade, and thus induces positively correlated revisions in term and currency premia. For example, global investors' bond inflows lead local intermediaries to require lower excess bond and currency returns simultaneously—achieved through an equilibrium increase in long-term bond prices and currency appreciation. Importantly, we formally show that global investors' bond purchases generate correlated flows only when they do not take offsetting positions in the forward exchange market—that is, only when the local-currency bond purchases are left, at least in part, unhedged.

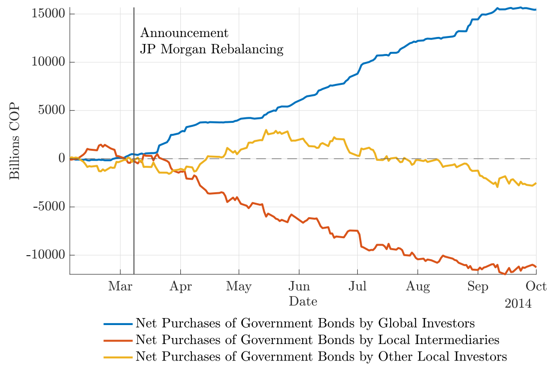
The importance of correlated flows is thus primarily driven by two factors in the model: (i) the relative volatility of global versus domestic investors' purchases of local-currency bonds, and (ii) the extent to which global investors hedge currency risk. Using panel data on

[2]A similar message emerges when one considers the net purchases of spot minus net sales of forwards (see Appendix Figure D.1).

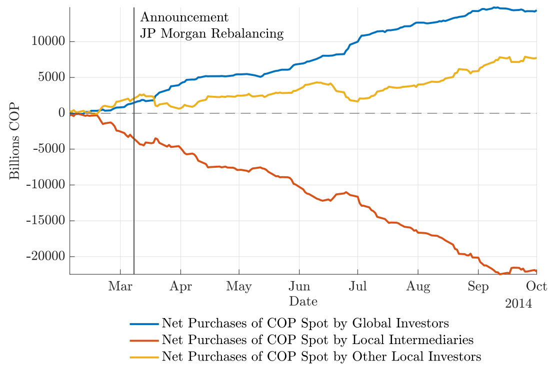
Figure 1
Correlated flows during J.P. Morgan Index Rebalancing



(a) Global Investors' Purchases of TES and COP in J.P. Morgan Index Rebalancing



(b) Net Purchases in TES Market



(c) Net Purchases in COP Spot Market

Note: Figure 1a 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. Figures 1b and 1c 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 Sections 3 and 5). The black vertical line denotes 19th of March 2014, the day the rebalancing was announced.

local-currency bond holdings (Arslanalp and Tsuda, 2012, 2014b) and estimates of global investors' hedging ratios (Cheema-Fox and Greenwood, 2024; Chen and Zhou, 2025), we construct a model-based metric that captures the importance of correlated flows for each country. We find that the importance of correlated flows is larger for emerging economies. In these economies, global investors not only contribute more significantly to fluctuations in bond flows but also tend to hedge currency risk less than their counterparts in advanced economies.

We show that these two factors together explain a substantial share of the cross-country variation in the comovement between excess bond returns and currency returns, both across and within groups of countries.

Furthermore, we provide key evidence that it is *local* financial intermediaries—primary dealers and FX market intermediaries in Colombia—that, by and large, absorb imbalances in these markets.[3] To this end, we measure the returns earned by these intermediaries between 2012 and 2019, conditional on changes in their positions. Consistent with the model's predictions, changes in the positions of local intermediaries in bonds and FX market are positively correlated with subsequent movements in excess returns: when intermediaries accumulate a position in a given market, they earn significant and positive returns in that market. In contrast, purchases by global investors and other domestic investors (excluding intermediaries) are followed by declines in excess returns. Moreover, we document that changes in local intermediaries' bond and FX positions are positively correlated, in line with the importance of correlated flows.

Last, we show that the correlation between bond and currency returns shapes the transmission of asset purchase policies, such as foreign exchange interventions (FXI) and quantitative easing (QE). When correlated flows risk outweighs short-term interest rate risk, a central bank purchase of foreign currency (FXI) increases intermediaries' exposure to the positively correlated risk intrinsic in yield-curve and UIP trades, thus leading to lower bond prices and currency depreciation. Analogously, a central bank purchase of government bonds (QE) reduces intermediaries' exposure to this positively correlated risk, resulting in higher bond prices and an appreciation of the domestic currency. These effects arise even though these asset purchases are confined to a single market.

We test these predictions using proprietary data from 641 auctions conducted in Colombia between 2008 and 2014 by the central bank in order to acquire U.S. dollars. Exploiting a regression discontinuity design around the auction cutoff price, we achieve identification by comparing the secondary market trading behaviors of intermediaries that barely won and barely lost a given U.S. dollar auction. We find that winning an FXI auction, and thus selling dollar for pesos, leads intermediaries to trade at both a depreciated exchange rate *and* at lower long-term bond prices in secondary markets. The implications of the model also help rationalize the empirical observation that QE tends to appreciate the currency in emerging markets (Rebucci et al., 2022; Toraman, 2025), but depreciate it in advanced ones (Bhattarai and Neely, 2022).

[3] In many cases, the same financial institutions operates as dealers in both bond and currency markets.

Related literature We document that excess bond and currency returns are positively correlated in emerging economies, in contrast to evidence for advanced economies (Lustig et al., 2019).[4,5] Using a portfolio-balance framework, Greenwood et al. (2023) and Gourinchas et al. (2022) propose that bonds and currencies exposure to interest rate risk implies a negative correlation in excess bond and currency returns.[6] Within a similar framework, we show that correlated flows in bond and currency markets—resulting from global investors' unhedged purchases of local-currency bonds—induce a positive correlation in bond and currency returns. In addition, our framework rationalizes micro-level patterns of flows in currency and bond markets as well as the observed effects of central banks' asset purchase policies.

We propose a new channel through which global investors in local-currency bond markets shape the dynamics of bond yields and exchange rates.[7] Carstens and Shin (2019) highlights that local-currency bonds shift currency mismatch from emerging market borrowers to foreign lenders, and propose a "U.S. dollar exchange rate risk-taking channel," by which U.S. dollar appreciations alter the risk-taking capacity of constrained global investors that evaluate returns in U.S. dollar terms (see also Bruno and Shin, 2015, and Hofmann et al., 2022a). This channel is consistent with Bertaut et al.'s (2024) evidence that international mutual funds reduce their holdings of emerging market local-currency bonds following dollar appreciations.[8] In contrast, we emphasize that the presence of local-currency bond markets influences the patterns of flows that local intermediaries must absorb, and thus equilibrium bond yields and exchange rates. This mechanism operates whether or not global investors are constrained or whether or not they evaluate returns in U.S. dollar terms; hence, these channels are complementary.

Our proposed mechanism builds on transaction-level evidence of global investors exerting correlated pressure on bond and currency markets, absorbed by local intermediaries, and shaping the joint dynamics of bond yields and exchange rates. Our analysis is thus related to Hau and Rey's (2006) and Camanho et al.'s (2022) equilibrium analyses of exchange rates, equity prices, and equity flows. Consistent with the notion of correlated flows, Hau and Rey

[4] See also Lloyd and Marin (2024).

[5] Bond yields and exchange rates also display an opposite relationship in these two group of countries (Kekre and Lenel, 2024).

[6] Zou (2024) examines the role of time-varying convenience yields in this class of models.

[7] A related literature studies the determinants and dynamics of a country's sovereign debt currency composition (Ottonello and Perez, 2019; Du and Schreger, 2022; Engel and Park, 2022; Lee, 2024).

[8] In the context of bond markets, some evidence shows that broad-based dollar appreciations around advanced economies' monetary policy announcements are associated with an increase in emerging market bond spreads and real activity (Hofmann et al., 2020) and a reduction in emerging market bond holdings by foreign investment funds (Hofmann et al., 2022b). In the context of equity markets, Bruno et al. (2022) show that exchange rate fluctuations also tend to amplify stock market returns in emerging market economies, once expressed in U.S. dollar terms.

(2006) and Camanho et al. (2022) document that net equity flows into the foreign market are associated with a foreign currency appreciation.[9,10] Rey and Stavrakeva (2024) proposes an exchange rate decomposition based on international equity market clearing conditions, and use it to characterize the transmission of U.S. macroeconomic and risk aversion news. Koijen and Yogo (2020) estimates a demand system to study exchange rates jointly with short-term rates, long-term yields and equity prices. Pandolfi and Williams (2019) examines how capital flows driven by mechanical rebalancings of benchmark indexes impact government bond prices, liquidity, and exchange rates. 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.

This paper speaks to a broader literature on the role of global investors in emerging economies' real and financial fluctuations (Calvo et al., 1993), the determinants 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, 2024), sovereign and firm borrowing costs (Fang et al., 2024; Zhou, 2024; Morelli et al., 2022; Moretti et al., 2024; Morais et al., 2019), the patterns of capital flows (Avdjiev et al., 2022), and the co-movement of a country's long-term yields with global bond markets (Xu, 2024). Furthermore, this paper belongs to a growing literature that emphasizes the key role of local banks in financial intermediation and asset prices determination in emerging economies, such as, for example, di Giovanni et al. (2021); Gutierrez et al. (2023); Keller (2024); De Leo et al. (2024b); Fendoglu et al. (2019); Gonzalez et al. (2021).

2 Bond Yields and Exchange Rates in Emerging Economies

In a panel of advanced economies, Lustig et al. (2019) documents a negative correlation between excess bond returns and excess currency returns in these economies. In contrast to advanced economies, this section shows that emerging economies (EMs) feature a positive correlation between excess bond and currency returns, both in the time series and in the cross section.

[9] At the same time, Hau and Rey (2006) documents a *negative* correlation between excess equity returns (differentials) and excess currency returns across 17 OECD economies, and interpret it through endogenous portfolio rebalancing: whenever foreign equity holdings outperform domestic holdings, domestic investors repatriate some of the foreign equity wealth to decrease the exchange rate exposure, leading to a foreign currency depreciation. Camanho et al. (2022) provides fund-level evidence in support of this channel.

[10] The notion of correlated flows is also central in the identification strategy of Hau et al. (2010).

2.1 Correlation between bond and currency excess 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. More precisely, the return from holding a long-term bond for one period, financed by borrowing at the short-term rate in domestic currency.

We use Q_t to denote the nominal spot exchange rate in terms of domestic currency per U.S. dollar, where $\Delta q_{t+1} = \log\left(\frac{Q_{t+1}}{Q_t}\right)$ represents 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.

Data We select all emerging and advanced economies with bond benchmark indexes on *Datastream*. We use monthly data from January 2006 to December 2021.[11] The dataset includes spot exchange rates, 10-year government bond total return indexes, and 3-month deposit rates.[12] Our sample includes 8 emerging economies that have available data for the above variables (Colombia, India, Indonesia, Mexico, Poland, South Africa, South Korea and Thailand),[13] and 8 advanced economies, selected following the same criteria (Australia, Canada, the Eurozone, Japan, New Zealand, Sweden, Switzerland, and the United Kingdom).

Analysis Table 1 reports the estimated slope coefficients in a set of regressions of excess currency returns, $rx_{j,t+1}^q$, on local-currency bond excess returns, $rx_{j,t+1}^{(10y)}$. We report the results for three specifications: no fixed effects, time (month) fixed effects, and currency fixed effects. Across all specifications, there is a negative association between local currency excess

[11] 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.
[12] Note that the long maturity bond return data from *Datastream* may pertain to coupon government bonds.
[13] We exclude China as strict capital controls can distort international flows and their properties. Nevertheless, our results are similar when including China in the analysis.

Table 1
Excess Foreign Exchange and Local-Currency Bond Returns

	Annualized foreign exchange excess returns					
	Advanced economies			Emerging Markets		
	(1)	(2)	(3)	(4)	(5)	(6)
Annualized local-currency bond return	-0.41***	-0.72***	-0.41***	0.41***	0.20***	0.41***
(in local currency)	(0.07)	(0.10)	(0.07)	(0.07)	(0.05)	(0.07)
Time FE	No	Yes	No	No	Yes	No
Currency FE	No	No	Yes	No	No	Yes
N	1,528	1,528	1,528	1,162	1,162	1,162
R-squared	0.05	0.06	0.04	0.10	0.03	0.10

Note: Columns (1) and (4) of the table report the estimated slope coefficient for the following baseline regression $rx^q_{j,t+1} = \alpha + \beta rx^{(10y)}_{j,t+1} + \epsilon_{j,t+1}$. Columns (2) and (5) add time (month) fixed effects. Columns (3) and (6) add currency fixed effects. Standard errors are in parentheses. In all panels, HAC standard errors were used, allowing for 12-month autocorrelation. Significance stars follow conventional levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

bond returns and excess currency returns for advanced economies, while there is a positive relationship in emerging economies. In emerging economies high excess bond returns are associated with high excess currency returns both in the cross-section of currencies and in the time series.

2.2 Does default risk explain the comovement in bond-currency returns?

A possible explanation for the positive association between bond and currency excess returns in emerging economies is default risk. An increase in default risk can lead to lower excess returns on both bonds and currencies, driven by currency depreciation and lower bond prices.

We use 10-year credit default swap (CDS) spreads from *Datastream* to proxy for default risk.[14] We residualize bond and currency returns by controlling for the contemporaneous and lagged CDS spreads. We then regress the residualized excess currency returns ($\epsilon^{rx^q}_{j,t+1}$) on residualized excess bond returns ($\epsilon^{rx^y}_{j,t+1}$). Table 2 reveals that residualized returns display a significant relationship with coefficients that are similar to those in Table 1. Moreover, the share of the covariance in excess returns that is unexplained by CDS spreads as $\frac{\text{cov}(\epsilon^{rx^y}_{j,t+1}, \epsilon^{rx^q}_{j,t+1})}{\text{cov}(rx^y_{j,t+1}, rx^q_{j,t+1})}$ is approximately two thirds of the overall covariance in excess returns.

These results are relevant as the comovement in bond and currency premia is regarded as a key disciplining moment for modern portfolio-balance models of bond yields and exchange rates, such as Gourinchas et al. (2022) and Greenwood et al. (2023). These models are a combination of earlier frameworks that emphasize the role of "quantities" and were developed

[14]CDS for emerging economies are available only for foreign-currency denominated bonds.

Table 2
Excess Foreign Exchange and Local-Currency Bond Returns, and CDS Spreads

	Residualized foreign exchange excess returns		
	(1)	(2)	(3)
Residualized local-currency bond return	0.33***	0.14**	0.33***
(in local currency)	(0.06)	(0.06)	(0.06)
Time FE	No	Yes	No
Currency FE	No	No	Yes
N	947	947	947
R-squared	0.06	0.02	0.06

Note: Column (1) 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 $rx^{m}_{j,t+1} = \sum_{k=0}^{1} \phi_k (\text{CDS Spread})_{j,t-k} + \epsilon^{rx^m}_{j,t+1}$, for $m = \{10y, q\}$. Column (2) adds time (month) fixed effects. Column (3) adds currency fixed effects. All excess returns are annualized. Standard errors are in parentheses. In all columns, HAC standard errors were used, allowing for 12-month autocorrelation. Significance stars follow conventional levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

independently for long-term bond (Vayanos and Vila, 2021) and currency (Gabaix and Maggiori, 2015) markets. The formulations of Gourinchas et al. (2022) and Greenwood et al. (2023), originally developed to explain empirical moments of advanced economies, emphasize the role of short-term interest rate risk in the joint dynamics of bond yields and exchange rates. In this sense, our evidence for emerging economies poses a challenge to these models. To reconcile these models with the new cross-country evidence, in the next section, we begin by characterizing the patterns of capital flows in long-term local currency and spot FX markets using transaction-level data from Colombia.

3 Correlated flows in bond and currency markets

We leverage transaction-level data from Colombia's government bond and foreign exchange markets, which provide insights into foreign investors' behavior in both arenas. Colombia offers a representative example of a small open economy with levels of foreign participation in its sovereign bond market comparable to those of other emerging markets.

3.1 Institutional setup and data

Government bonds (*Títulos de Tesorería*, TES) Since the 2000s, the majority of Colombia's sovereign debt is denominated in domestic currency (COP). For instance, in 2020, the total fiscal debt reached USD 177 billion, equivalent to approximately 65% of GDP. Two-thirds of total debt was denominated in COP, comprising 20% in inflation-adjusted bonds and 46% in standard COP-denominated instruments.

The *Ministry of Finance* annually publishes rankings of financial sector participants competing for inclusion in the "primary dealers" (PD) program for TES. Due to limited membership, only institutions ranked above a specified threshold—10^{th} place prior to 2022, and 15^{th} place thereafter—qualify as primary dealers. 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, detailed below, experiences a significantly higher daily turnover of around COP 2 trillion (USD 500 million).

Colombia foreign exchange market (FX) 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 the foreign exchange market 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. On average, the daily turnover for the spot market is USD 1.5 billion, while the forward market sees a turnover of USD 4 billion. These institutions are subject to FX mismatch regulations overseen by the Central Bank of Colombia. The two most relevant regulations pertain to the *Posición Propia Contado* (PPC) and the *Posición Propia* (PP). Both indicators measure the difference between assets and liabilities denominated in foreign currency, relative to the institution's total equity. The key distinction is that the PP includes transactions involving derivatives, whereas the PPC does not. The regulatory framework permits banks to maintain a PP within a range of -5 to 20 percent, and a PPC between 0 and 50 percent of their equity. These thresholds allow financial intermediaries to hold a certain degree of currency imbalance on their balance sheets.

Colombia micro-level data We use several datasets to perform our analysis. Transactions involving purchases and sales of TES 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 of Colombia. All trades executed on these platforms are registered in the Central Securities Depository (*DCV*), overseen by the Central Bank of Colombia. 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 of Colombia. Additionally, we analyze FX Spot, Next-Day, and Forward markets in the interdealer market using data from *SET-ICAP FX*.[15]

3.2 Evidence on correlated flows in bond and currency markets

Central to our analysis is the simple observation that when foreign investors purchase local-currency government bonds, they simultaneously need to purchase COP through the foreign exchange market. Figure 2 plots the monthly-level foreign investor net purchases of COP (in exchange for foreign currency) through the FX market (y-axis) together with the foreign net purchases of TES through the secondary market for government bonds (x-axis).[16] Net purchases in both markets from foreign investors align tightly around the 45-degree line. A regression of COP purchases by foreigners on TES purchases by foreigners has a slope that is statistically not different from 1, with an R-squared of 65%. Overall, this evidence suggests that foreign flows to local-currency sovereign bond markets occur simultaneously with flows to the spot FX market. In addition, it suggests that a large portion of spot FX market transactions by foreign investors is due to their purchase or sale of Colombia sovereign bonds. We denote the occurrence of these simultaneous flows as *correlated flows*.

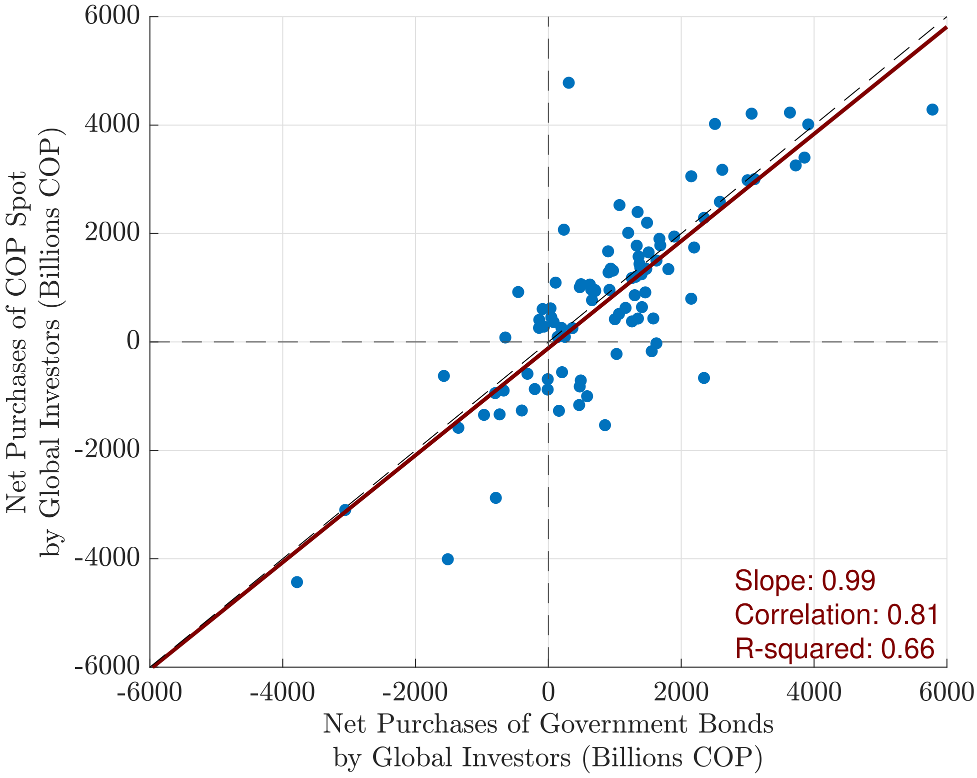
Correlated flows from foreign investors may have limited implications for currency markets overall if foreign investors systematically hedge their domestic currency exposure by selling it in forward markets to offset their spot market purchases of COP. As a result, their net exposure to the local currency—and that of other investors—may not necessarily change with flows into the government bond market.

Figure 3 reports foreign investors net purchases of COP in the spot market (on the y-axis) and their net sales of COP in the forward market (on the x-axis). If all foreign investor purchases in the spot market were fully hedged in the forward market, we would observe the data points to align along the 45-degree line, while a partial hedge would result in a positive relationship between the two variables with slope less that 1. However, we observe no consistent relationship, indicating that foreign investors do not systematically hedge their bond positions. This is consistent with Chen and Zhou's (2025) evidence that hedge ratios of U.S. mutual funds oriented to emerging economies' bonds are generally small, and often

[15] A challenge we face is that, while TES trades can be directly attributed to individual foreign investors, FX transactions may be conducted either directly by these investors or through intermediaries, obscuring the identity of the ultimate buyer. Consequently, it is not possible to establish a precise link between FX transactions and TES trades at the individual transaction level.

[16] For context, during this period total outstanding debt in TES market was around COP 250 trillion, and around one-quarter of it was held by global investors.

Figure 2
Correlated Flows in TES and COP Spot Markets



Note: This figure displays the monthly net purchases of TES bonds by global investors in billions COP (x-axis) and the monthly net purchases of COP in the spot market by global investors (y-axis). "Slope" is the estimate of the slope of a linear regression of the y-axis variable on the x-axis variable, with the corresponding R-squared.

negative.[17,18] In the model of Section 4, we show the role that the extent of currency hedging plays in the importance of correlated flows.

In summary, global investors exhibit correlated flows in both bond and currency markets, with minimal to no hedging in the forward exchange market. We next incorporate these features into a portfolio-balance model.

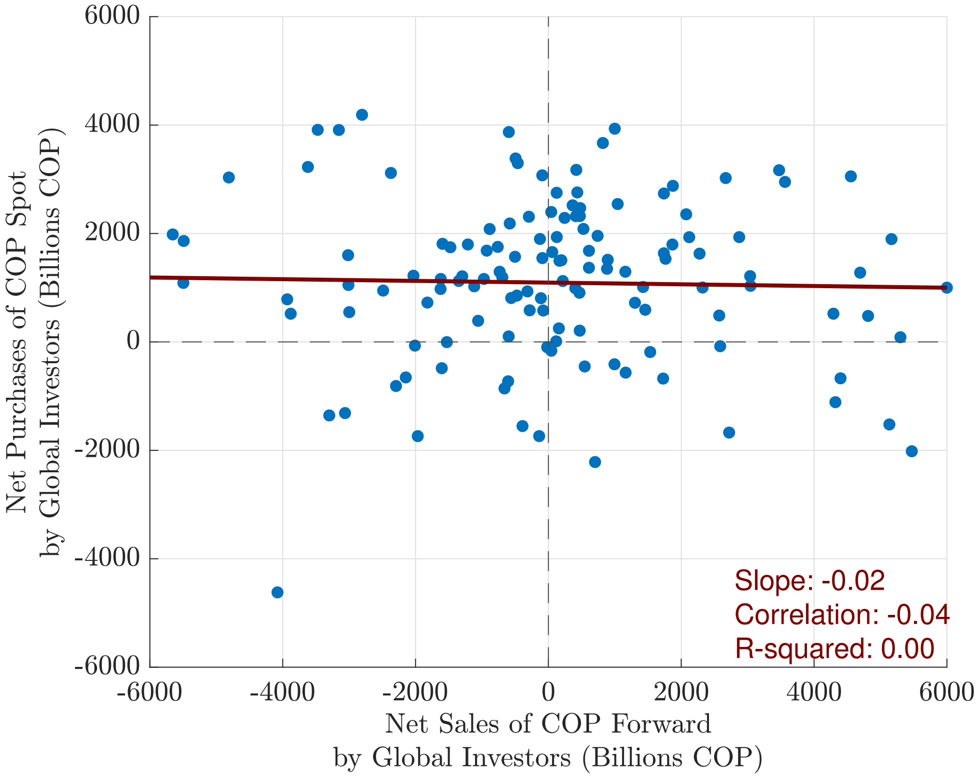
4 Bond and Currency Premia in a Model of Correlated Flows

Our baseline model extends the portfolio-balance models of Greenwood et al. (2023) and Gourinchas et al. (2022) to a setting with correlated flows in bond and foreign exchange

[17]This evidence, including the observation that foreign investors' transactions in the forward exchange market are around three times larger than their transactions in the spot exchange market, aligns with De Leo et al.'s (2024b) analysis, which suggests that foreign investors primarily utilize the forward market for currency speculation rather than for hedging purposes.

[18]In Appendix B we show that global investors in the TES market are primarily institutional investors such as mutual, pension, and sovereign wealth funds.

Figure 3
Purchases of COP Spot and Sales in Future Markets



Note: This figure displays the monthly-level foreign purchases of COP in the spot market (x-axis) and the monthly-level foreign sales of COP in the forward market (y-axis). Slope is the slope of a regression of the y-axis variable on the x-axis variable, with the corresponding R-squared.

market, consistent with the micro-level evidence from Section 3.[19]

In our small-open economy model, sovereign bond and foreign-exchange markets are integrated with one another but segmented from other financial markets. A group of local intermediaries trades in both 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 sources of risk: interest rate risk, as in Greenwood et al. (2023) and Gourinchas et al. (2022), and risk associated with correlated flows due to global investors in local-currency bond markets.

In this section, we show that interest rate risk and correlated flows imply opposite correlations between bond and currency returns. If advanced and emerging economies are differently exposed to these sources of risk, they would present different comovement patterns, consistent with Section 2. In Section 5 we present additional testable implications of the

[19] Greenwood et al. (2023) and Gourinchas et al. (2022) build on Vayanos and Vila (2021) and Gabaix and Maggiori (2015).

model and confront it with data from Colombia's long-term local-currency bond and foreign exchange markets. In Section 6 we present the model's implication for the asset price effects of asset purchase policies.

4.1 Baseline Model

The discrete-time small-open economy model includes four financial assets: domestic and foreign short- and long-term bonds, denominated in their respective currency. There are two types of agents: local and global bond investors and local intermediaries. Bond investors have a preference— resulting in inelastic demand—for assets of specific currencies and maturities. Local 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. Consistent with the small open economy setting, the returns on foreign short- and long-term bonds, such as U.S. dollar treasuries, follow an exogenous process. We follow Greenwood et al. (2023) and express returns in logs.

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 with potentially correlated shocks:

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

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

where $\bar{\iota} > 0$, $\phi_i \in (0, 1)$, $\mathrm{var}_t[\varepsilon_{i_{t+1}}] = \mathrm{var}_t[\varepsilon_{i^{\star}_{t+1}}] = \sigma_i^2 > 0$, and $\mathrm{corr}[\varepsilon_{i_{t+1}}, \varepsilon_{i^{\star}_{t+1}}] = \rho \in [0, 1]$.

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.[20] Equation (3) expresses the bond's return as consisting of three components: (i) a carry component, y_t; (ii) a capital gain component, $\frac{\delta}{1-\delta}(y_{t+1} - y_t)$; and (iii) a stochastic, time-varying wedge to bond returns, g_t. This 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

[20] Equation (3) is derived in Appendix C.1 and uses Campbell and Shiller (1988) approximation for log returns.

on local-currency bond returns, or a time-varying convenience yield, and does not play an essential role in the analysis. This time-varying wedge in bond returns follows:

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

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

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:

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

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 yield on foreign long-term bond is determined as

$$y^\star_t = (1-\delta) \sum_{j=0}^{\infty} \delta^j \, \mathrm{E}_t[i^\star_{t+j} + rx^{y,\star}_{t+j+1}], \tag{6}$$

where $rx^{y,\star}_{t+j+1}$ is exogenous from the perspective of the small open economy. For simplicity, we assume that local intermediaries do not hold foreign long-term bonds.

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 home currency, i.e. on the "UIP trade"—the trade that borrows short-term in foreign currency and lends short-term in domestic currency, is:

$$rx^q_{t+1} = (i_t - i^\star_t) - (q_{t+1} - q_t). \tag{7}$$

Iterating this expression forward and taking expectations yields:

$$q_t = \sum_{j=0}^{\infty} \mathrm{E}_t[(i^\star_{t+j} - i_{t+j}) + rx^q_{t+j+1}] + \mathrm{E}_t \, q_{t+\infty}. \tag{8}$$

Equation (8) 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 follows a random walk. That is:

$$q_{t+\infty} = \varepsilon_{q_t}, \tag{9}$$

where $\text{var}_t[\varepsilon_{q_t}] = \sigma_q^2 \geq 0$. 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 differential inflation rates across countries, while maintaining real exchange rate stationarity.

Local intermediaries Local intermediaries are the marginal investors in domestic long-term bond and foreign exchange markets. They maximize their next-period wealth through mean-variance preferences with a risk tolerance parameter τ. Let d_t^y denote the market value of the intermediary' holdings of long-term domestic bonds and d_t^q denote the value of the net intermediary's position in the borrow-foreign and lend-domestic FX trade, all denominated in domestic currency. Defining $\mathbf{d}_t \equiv [d_t^y, d_t^q]'$ and $\mathbf{rx}_{t+1} \equiv [rx_{t+1}^y, rx_{t+1}^q]'$, intermediaries solve:

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

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

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

Equation (11) links the intermediaries' expected excess returns on different assets to their asset holdings. The variance-covariance matrix of excess returns governs the equilibrium relationship of excess returns across the yield-curve trade and the UIP trade.

In Appendix C.3, we show that d_t^q represents the net exposure of the intermediaries to the UIP trade, consisting of the sum of long spot and long forward positions.

Net supplies and correlated flows 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:

$$s_{t+1}^y = \bar{s}^y + \phi_{s^y}(s_t^y - \bar{s}^y) + \varepsilon_{s_{t+1}^y}, \tag{12}$$

where $\bar{s}^y > 0$, $\phi_{s^y} \in [0, 1)$, $\varepsilon_{s_{t+1}^y} = \eta_{t+1} + \eta_{t+1}^\star$, $\text{var}_t[\varepsilon_{s_{t+1}^y}] = \sigma_\eta^2 + \sigma_{\eta^\star}^2 \geq 0$. We distinguish here between demand shocks coming from local investors, η_{t+1}, and global investors, $\eta_{t+1}^\star$, 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 local and global investors), denominated in units of domestic currency, follow a stochastic process such that

$$s^x_{t+1} = \phi_{s^q} s^x_t + \varepsilon_{s^x_{t+1}}, \tag{13}$$

where $\phi_{s^q} \in [0,1)$, $\varepsilon_{s^x_{t+1}} = \gamma_{t+1} + \gamma^\star_{t+1}$, and $\text{var}_t[\varepsilon_{s^x_{t+1}}] = \sigma^2_\gamma + \sigma^2_{\gamma^\star} \geq 0$, distinguishing between demand shocks coming from local investors, γ_{t+1}, and global investors, $\gamma^\star_{t+1}$.

Departing from the framework of Greenwood et al. (2023) and Gourinchas et al. (2022), we allow for a non-zero correlation between the demand of domestic long-term bond and foreign exchange in the spot market by global investors. In particular, consistent with the micro evidence from Section 3, we assume that any purchase of domestic long-term bonds by foreign bond investors is accompanied by a simultaneous purchase of home currency in the spot market —of same local-currency amount. That is:

$$\text{corr}_t(\eta^\star_{t+1}, \gamma^\star_{t+1}) = 1. \tag{14}$$

This correlation arises naturally, as global investors intending to purchase domestic long-term bonds must inevitably acquire a corresponding amount of the home currency.

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

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

Hedging We assume that a constant fraction $\alpha \in [0,1]$ of global investor spot currency 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 exposure by selling domestic currency in the forward market.

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

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

where $\varepsilon_{s^f_{t+1}} = -\alpha\gamma^\star_{t+1}$ and $\text{var}_t[\varepsilon_{s^f_{t+1}}] = \alpha^2\sigma^2_{\gamma^\star}$. 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 local and global 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 $\text{var}_t[\varepsilon_{s^q_{t+1}}] = \sigma^2_\gamma + (1-\alpha)^2\sigma^2_{\gamma^\star}$.

As a result, the overall correlation in net supplies is (using eqs. (12)-(17)):

$$\Omega \equiv \text{corr}_t(s^y_{t+1}, s^q_{t+1}) = \frac{\text{cov}_t[s^y_{t+1}, s^q_{t+1}]}{\sqrt{\text{var}_t(s^y_{t+1})}\sqrt{\text{var}_t(s^q_{t+1})}} = \frac{(1-\alpha)\sigma_{\eta^\star}\sigma_{\gamma^\star}}{\sqrt{(\sigma^2_\eta + \sigma^2_{\eta^\star})}\sqrt{(\sigma^2_\gamma + (1-\alpha)^2\sigma^2_{\gamma^\star})}}. \tag{18}$$

The cross-market correlation in global investors' flows generates correlation of net supply across bond and foreign exchange markets in proportion to the relative importance of foreign flows in domestic bond and foreign exchange markets. Equation (18) highlights two key implications of our model. First, the relative importance of global investors in local-currency bond markets can be measured in terms of their relative volatility. When global investors play a relatively greater role in overall flow volatility, the cross-market correlation in flows is higher. Second, the amount of hedging done by global investors shapes the dynamics of this correlation. The comovement in net supplies is strongest when foreign investors do not hedge their FX positions ($\alpha = 0$). Conversely, when $\alpha = 1$, global investor flows are fully hedged and impose no effective FX pressure, resulting in zero cross-market net supply correlation.

Market clearing The market clearing condition is:

$$\mathbf{s}_t = \mathbf{d}_t, \tag{19}$$

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

Equilibrium Equilibrium expected excess returns must satisfy the intermediaries' optimality condition (11) as well as the market clearing condition (19), implying:

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

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, $\mathbf{z}_t = [i_t - \bar{\imath}, i^*_t - \bar{\imath}, g_t, q_{t+\infty}, s^y_t - \bar{s}^y, s^q_t]'$. Appendix C.2 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.

4.2 Comovement of excess bond and currency returns

To characterize the correlation between excess bond and foreign exchange returns, we first present analytical results for a special case of the model, and then turn to a numerical analysis of the calibrated model. Consider the following special case of the model:

Assumption 1. *Short-term interest rates are deterministic ($\sigma_i = 0$), asset-specific shocks are transitory ($\phi_g = 0$) and feature same volatility ($\sigma_g = \sigma_q$), and net supply shocks are transitory ($\phi_{s_y} = \phi_{s_q} = 0$) with same investor-specific volatilities ($\sigma_\eta = \sigma_\gamma$, and $\sigma_{\eta^\star} = \sigma_{\gamma^\star}$). Besides, the long-term bonds have near-infinite duration ($\delta \to 1$), and agents are sufficiently risk-tolerant (τ is large enough).*

Under these restrictions, we highlight the following result:

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

Proof. See Appendix C.4. □

Proposition 1 demonstrates that, in a simplified version of the model without interest rate risk, the correlation between excess bond and foreign exchange returns is positive whenever global investors operate in the local-currency bond market, and thus net supplies are positively correlated (see eq. (18)). Without interest rate shocks, the fundamental sources of risk are asset-specific *independent* shocks (fluctuations in the bond return wedge and long-term nominal exchange rate). If net supply fluctuations were independent, bond and FX premia would also be uncorrelated. However, when net supply fluctuations are correlated, their comovement is reflected in the joint distribution of premia.[21]

Correlated flows generate correlated returns as they directly link the net supply in bond and currency markets that local intermediaries must absorb, and thus in the premia they require. This effect occurs even in models where intermediaries managing bonds and currency are distinct entities. That said, whenever local intermediaries operate across both markets, these effects are amplified, as changes in positions in one market impart correlated changes in returns in both markets, as we discuss in Section 6.

We now turn to examine the determinants of the bond-FX comovement using a calibrated version of the baseline model, which includes short-term interest rate risk.

Calibration Our calibration approach does not target directly the empirical comovement in excess bond and currency returns. Instead, it relies on the time series properties of short-term interest rates as well as net supply volumes, the standard deviations of excess bond returns and excess currency returns, and conventional parameter values whenever possible. The

[21] Interestingly, Gabaix and Maggiori's (2015) model illustrates how capital flows into emerging market *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 excess supply of different currencies, but also changing the excess supply of local-currency bonds of different maturities, in a way that rationalizes the positive comovement of term and currency premia in emerging economies.

model is calibrated on Colombian data at a quarterly frequency. To discipline the processes of short-term interest rates (ϕ_i, σ_i, ρ), we use 3-month interbank rates from Colombia and the United States. To discipline the persistence of the net supply shocks (ϕ_{s^y}, ϕ_{s^q}), we use Colombian transaction-level data in bond and FX markets. We compute the quarterly positions of local intermediaries in both markets, as well as their fluctuations stemming from local and global investors.[22] The TES (COP) holdings are computed as a fraction of the total value of TES outstanding bonds (M1 money aggregate). We set the risk aversion of local intermediaries ($1/\tau$) to 0.03, in line with the range of values chosen by Gourinchas et al. (2022). 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-hedge ratio, α, to 0. Table C.1 reports the values of the resulting baseline parameters.

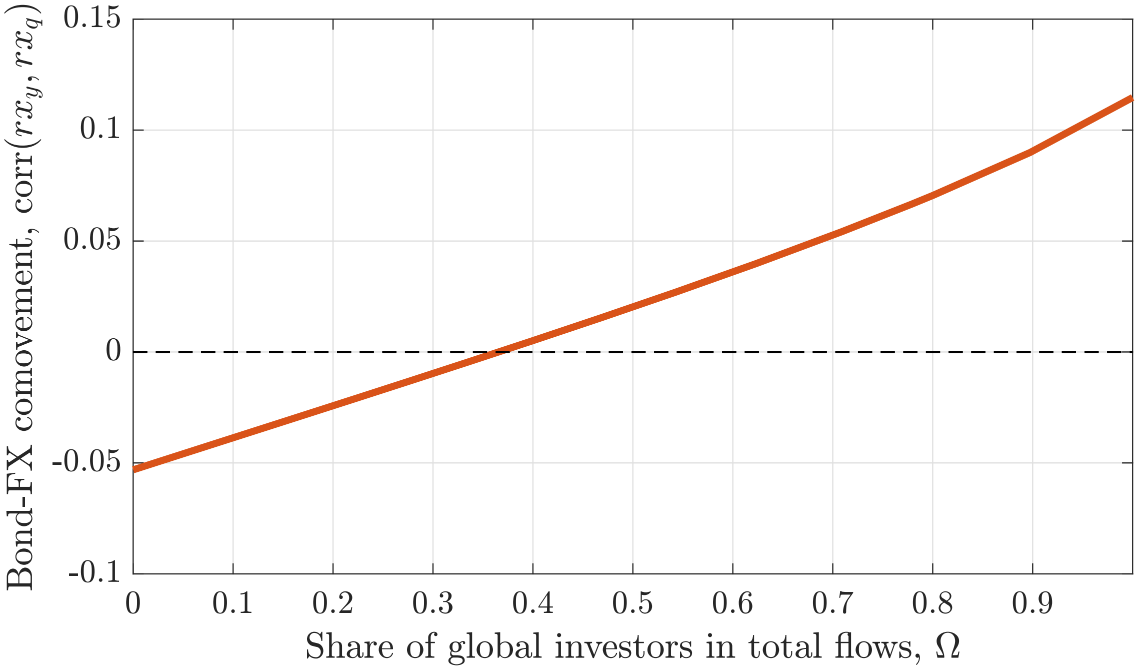
Figure 4 depicts the correlation between excess bond and currency returns, for different composition of investors' flows (achieved through different relative volatility of foreign to domestic investors, for a given level of overall volatility of bond flows). Two key insights emerge. First, the correlation in excess bond and currency returns increases with the relevance of global investors, governed by Ω (see eq. (18)). A higher variance of global investors' flows (for a given total variance of flows) increases the correlation in bond and currency net supply movements and thus the correlation of bond and currency returns. Second, absent correlated flows ($\Omega = 0$), the correlation in excess returns is negative, as the only source of correlated risk are short-term interest rates shocks—a result originally presented in Greenwood et al. (2023) and Gourinchas et al. (2022). Interest rate risk, in fact, affects the yield-curve trade and the UIP trade in opposite directions. An increase in domestic short-term rates results in lower domestic long-term bond prices, which is detrimental to the yield-curve trade, but it simultaneously appreciates the domestic currency, benefiting the UIP trade.[23]

Cross-country evidence on the importance of correlated flows Our objective is to construct an estimated Ω in equation (18) for the emerging and advanced economies in

[22]For simplicity, we calibrate the parameters of the net supply processes as symmetric across markets, which represents a reasonable approximation of the properties of the data.

[23]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. Short-rate movements in emerging economies are notoriously relatively more synchronized with those in the U.S., weakening the relative importance of interest rate risk in determining the bond-currency return correlation in these economies. The correlation in innovations in short-term rates is around 65% for Colombia *vis a vis* the U.S., and around 35% for Germany *vis a vis* the U.S. (c.f. Gourinchas et al., 2022).

Figure 4
Correlation in Bond and Currency Excess Returns



Note: The figure depicts the equilibrium correlation in bond and currency excess returns for different levels of correlation in net supplies, $\Omega \equiv \text{corr}_t(s^y_{t+1}, s^q_{t+1})$ (achieved by different relative importance of foreign to home standard deviations of supply shocks, see eq. (18)). Table C.1 reports the baseline calibration.

our sample. To map eq. (18) to cross-country data of holdings shares of local-currency government debt securities, we make two assumptions. First, we assume assume that investors relative importance in currency markets is comparable to their relative importance in bond markets, namely $\sigma_\eta = \sigma_\gamma$, and $\sigma_{\eta^\star} = \sigma_{\gamma^\star}$. Because we only observe cross-country data from sovereign debt markets (not currency markets), unlike for Colombia, this assumption allows us to nevertheless construct an empirical measure of Ω. Second, we assume that overall outstanding amounts of local-currency bonds are constant. This allows us to use the investors holdings shares, instead of the investors' overall holdings, to construct our estimate of Ω.

Under these two assumptions, one can rewrite equation (18) as:

$$\text{Estimated } \Omega = \frac{(1-\alpha)\sigma^2_{\eta^\star}}{\sqrt{(\sigma^2_\eta + \sigma^2_{\eta^\star})}\sqrt{(\sigma^2_\eta + (1-\alpha)^2\sigma^2_{\eta^\star})}}. \tag{21}$$

where $\sigma_{\eta^\star}$ and σ_η can be computed as the standard deviation of the share of foreign and non-bank domestic investors in local-currency government debt securities, respectively, using data on investor holding shares of emerging and advanced economies' sovereign debt from Arslanalp and Tsuda (2014a) and Arslanalp and Tsuda (2012).[24] That is, we consider

[24]The non-bank domestic investors exclude domestic bank and central bank holdings. For emerging economies, we construct these shares based on the share of non-bank domestic investors for all sovereign debt since there is no breakdown for local-currency government debt securities.

Table 3
Estimated Relevance of Correlated Flows across Countries

Country	Correlated Flows Ω	Foreigners (std. dev., %)	Domestic Non-Bank (std. dev., %)	Hedging Ratios α
Emerging Markets (median)	**0.61**	**8.36**	**7.42**	**-0.22**
Colombia	0.46	8.29	8.72	0.05
India	0.09	1.16	4.00	-0.20
Indonesia	0.81	9.27	4.63	-0.09
Korea	0.14	4.07	11.56	-0.33
Mexico	0.70	12.21	8.88	-0.24
Poland	0.59	8.44	8.14	-0.38
South Africa	0.70	10.62	6.70	0.09
Thailand	0.63	4.52	3.97	-0.36
Advanced Economies (median)	**0.08**	**6.24**	**9.47**	**0.75**
Australia	0.09	6.24	9.45	0.75
Canada	0.08	3.39	5.32	0.76
Japan	0.03	2.70	9.87	0.56
New Zealand	0.20	8.59	8.03	0.74
Sweden	0.04	7.94	9.99	0.91
Switzerland	0.12	7.54	9.47	0.75
United Kingdom	0.001	2.10	20.41	0.93

Note: Column 1 computes our estimated measure of overall correlation in net supplies, given in eq. (21). The table also contains the standard deviation in the share of local-currency sovereign debt securities by foreigners (column 2) and domestic non-bank investors (column 3) using data from Arslanalp and Tsuda (2012) and Arslanalp and Tsuda (2014b). Column 4 computes the hedging ratio for each country, following Cheema-Fox and Greenwood (2024) for advanced economies, and Chen and Zhou (2025) for emerging economies.

domestic banks as the relevant "local intermediaries" (In Section 5, we provide evidence supporting the notion that domestic banks act as "local intermediaries" in long-term bond and currency markets in Colombian data). As measures of the hedging shares, α, we resort to estimates from the existing literature. For advanced economies, we use the hedge ratio for global fixed income investors from Cheema-Fox and Greenwood (2024). For emerging economies, we use Chen and Zhou's (2025) estimates of the hedge ratio of U.S. mutual funds. While the data for emerging economies is based only on U.S. mutual fund data, we assume that this reflects hedging behavior of the broader population of global investors.[25]

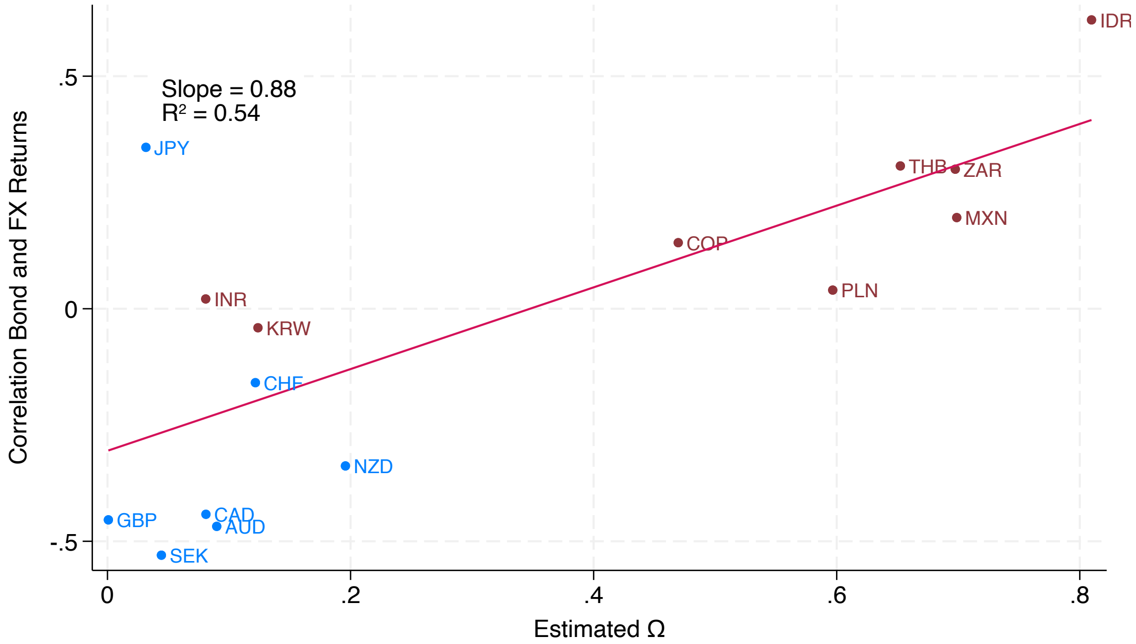
Table 3 presents the estimated Ω, alongside $\sigma_{\eta^\star}$, σ_η, and α for the different countries in the sample. While there is considerable variation across countries, the median Estimated Ω is 61% in emerging economies, while 8% in advanced economies. That is, unhedged foreign investors drive a larger portion of the volatility of inflows in local-currency bond markets in emerging economies than in advanced economies (relative to their respective non-bank domestic investors).

The fact that hedge ratios are systematically different between emerging and advanced economies is not surprising. Foreign investors are typically attracted to emerging markets by the significantly higher interest rate differentials compared to advanced economies. Hedging currency risk in such scenarios is costly, as it effectively involves paying away the interest rate

[25] As Chen and Zhou (2025) highlight, the hedge ratios of U.S. mutual funds oriented to emerging economies is often negative. In Appendix Figure B.2 we re-compute Ω by truncating the distribution of hedging ratios so that $\alpha \geq 0$. One can draw similar conclusions.

differential (if CIP approximately holds).[26] Moreover, several emerging economies (sovereign and corporates) issue debt in U.S. dollars, offering an alternative to buying local-currency assets while costly hedging local-currency risk, which could be part of the explanation for the difference in hedging ratios across these two groups of countries.

Figure 5
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 eq. (21) (x-axis). Countries in red (blue) are part of the emerging (advanced) economies sample.

Importantly, consistent with the model's mechanism, Figure 5 reveals that countries with higher Estimated Ω also feature, on average, a higher comovement of bond and currency returns. While our empirical measure of Ω is admittedly crude, as it makes a number of simplifying assumptions, we take this evidence as indicative of a significant relationship of the relative importance unhedged foreign flows in total flow volatility and the comovement in bond and currency returns. In Appendix Figure B.3, we reproduce Figure 5 by holding alternatively hedge ratios and relative volatilities fixed to their median value across countries and show that both factors independently contribute to the cross-country variation in the comovement between bond and currency returns.

[26]This has led many investment advisors, such as Meketa Investment Group (2022) to recommend clients to avoid hedging currency exposure in emerging markets, while suggesting hedging is more appropriate for investments in advanced economies.

5 Positions and Returns of Local Intermediaries

Our model has two broad implications that speak to positions and returns of intermediaries in bond and currency markets. First, intermediaries earn positive excess returns in both markets *on average*, as we outline in Proposition 2 below. Second, if correlated flows are a dominant force determining net supplies intermediated by local intermediaries, the positions of intermediaries in both markets should be positively correlated (see eq. (18)). In this section, we outline these implications and confront them with micro-level data from Colombia.

The following proposition outlines the properties of the model with respect to the returns accrued from the positions held by local intermediaries.

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

Proof. Using equation (11), one can show that

$$\mathbb{E}(d_t^y rx_{t+1}^y) = \tau^{-1}\left[\text{var}_t(rx_{t+1}^y)\mathbb{E}\left((d_t^y)^2\right) + \text{cov}_t(rx_{t+1}^y, rx_{t+1}^q)\mathbb{E}\left(d_t^q d_t^y\right)\right]; \tag{22}$$

$$\mathbb{E}\left(d_t^q rx_{t+1}^q\right) = \tau^{-1}\left[\text{var}_t(rx_{t+1}^q)\mathbb{E}\left((d_t^q)^2\right) + \text{cov}_t(rx_{t+1}^y, rx_{t+1}^q)\mathbb{E}\left(d_t^y d_t^q\right)\right]. \tag{23}$$

Using the market clearing condition (19), the processes of net supplies, (12) and (8), the properties of foreign and home investors' flows, (14) and (15), as well as Proposition 1, one can show that $\mathbb{E}(d_t^y rx_{t+1}^y) \geq 0$ and $\mathbb{E}(d_t^q rx_{t+1}^q) \geq 0$.

Furthermore, equation (19) then implies that inelastic demand of local and foreign investor delivers negative excess returns, on average. □

We hypothesize that, in Colombia, designated dealers in both markets are the natural counterparties absorbing bond and currency demand shocks, and thus the empirical counterpart of the model's "local intermediaries". We refer to the designated dealers in the treasury market as PDs and those in the foreign exchange market as IMCs.

We test whether these intermediaries earn positive excess returns in both markets. To do so, we construct monthly-level returns for different investor groups in the two markets. More specifically, we compute the UIP trade returns as:

$$\text{UIP Trade Ret}_{t,h}^j = X_t^{Curr,j} \times rx_{t+h}^q \qquad h = 1, 3, 6, 12. \tag{24}$$

where $X_t^{Curr,j}$ is the flow of investor j associated with the sale of USD in exchange for COP (measured in USD), and rx_{t+h}^q are the currency returns described in Section 2 for a holding period of h months. We compute the yield-curve trade returns as:

$$\text{Yield-Curve Trade Ret}_{t,h}^{j} = X_t^{Bond,j} \times rx_{t+h}^{(n)} \qquad h = 1, 3, 6, 12. \tag{25}$$

where $X_t^{Bond,j}$ is the flow of investor j associated with the purchase of long-term government bonds in domestic currency. $rx_{t+h}^{(n)}$ are the yield trade return described in Section 2. For simplicity, we compute these returns using the 10-year local-currency government bond and we measure returns in domestic currency. In both markets we consider three investor groups: local intermediaries (either IMCs or PDs), foreign investors, and other domestic intermediaries. After calculating the trade returns for various holding periods, we perform mean t-Tests to evaluate whether the trade returns are significantly different from zero, with the null hypothesis being that the returns are equal to zero.

We present results of these analyses in Table 4. In general, we find that UIP (yield-curve) trade returns are positive for IMCs (PDs), and negative both for foreigners and other domestics. Results are noisier for the 1 and 3-month holding period, but all average returns (both positive and negative) are statistically different from zero for 6 and 12-month holding periods. These findings support the model's implication outlined in Proposition 2, as well as our hypothesis that IMCs and PDs act as "local intermediaries" in Colombia.

Next, we explore another implication of the model concerning the positions of intermediaries in both markets. Specifically, for the group of PDs and IMCs, we compute their holdings of TES and COP (based on purchases in the FX spot market), respectively, measured in domestic currency. For TES we use directly the data on holdings as a share of the total TES outstanding. For COP holdings, we take the total liquid assets in the financial system in January 2013 (the start of our sample for this data) as the initial holdings of COP by IMCs. We then, accumulate monthly purchases of COP from IMCs in the FX spot market and normalize these holdings by M1 measure of money available in Colombia. To test the relationship between these variables, we estimate the following regression:

$$\text{COP}_t^{IMC} = \alpha + \beta \text{TES}_t^{PD} + \varepsilon_t \tag{26}$$

where $\text{COP}_t^{h,IMC}$ are the holdings of COP by IMCs, and TES_t^{PD} are the holdings of TES by PDs. We perform this analysis at both monthly and quarterly frequencies and report the corresponding regression coefficients in Table 5. The estimates reveal a positive relationship between the two variables. The correlation is around 0.4, in line with our estimate of Ω in Section 4, which used only local-currency bond holdings data and hedge ratios. The overall positive relationship in intermediary positions supports the view that correlated flows are an

Table 4
UIP and Yield-Curve Trade Returns

Panel A: UIP Trade Returns	1M	3M	6M	12M
Intermediaries	3.393	15.251**	38.845***	74.420***
	(2.397)	(7.049)	(11.839)	(21.646)
Foreigners	0.929	-5.264	-19.877*	-46.449**
	(2.264)	(5.031)	(10.240)	(17.715)
Others	-4.322**	-9.988**	-18.968***	-27.972**
	(1.960)	(4.725)	(6.883)	(13.473)
Observations	83	81	78	72

Panel B: Yield-Curve Trade Returns	1M	3M	6M	12M
Intermediaries	4.540	13.224**	18.645***	24.924***
	(5.181)	(6.141)	(6.992)	(8.157)
Foreigners	-0.427	-1.847	-3.828	-9.814***
	(1.830)	(1.988)	(2.691)	(3.639)
Others	-4.113	-11.377**	-14.817**	-15.110*
	(4.422)	(5.531)	(6.104)	(7.659)
Observations	120	120	120	120

Note: This table reports results from mean *t*-Tests of UIP trade (Panel A) and yield-curve trade (Panel B) returns for different investor groups. UIP trade returns are computed following equation (24) and yield-curve trade returns are computed using equation (25). 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.

important driver of both capital flows and associated premia in these markets.

Table 5
Correlation in Intermediaries Position

Dependent Variable: COP Holdings by IMCs	Monthly	Quarterly
TES Holdings by PDs	2.239***	1.990**
	(0.720)	(0.806)
Correlation	0.45	0.40
Observations	95	32
R-Squared	0.20	0.16

Note: This table presents OLS estimations of COP holdings by IMCs on TES holdings in the bond market by PDs with different types of fixed effects. Kraay-Driscoll robust standard errors are presented in parenthesis. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively.

6 The Effects of Asset Purchases in Emerging Economies

The portfolio balance model described above yields clear predictions regarding the effects of asset purchases, including quantitative easing (QE) and foreign exchange interventions (FXI). The following proposition formalizes these predictions.

Proposition 3.

(a) A domestic central bank's purchase of foreign currency, modeled as an increase in γ_t *in equation (17), causes a home currency depreciation and a decrease in the price of long-term bonds if and only if* $\mathrm{cov}_t(rx^y_{t+1}, rx^q_{t+1}) > 0$.

(b) A domestic central bank's purchase of local-currency long-term bonds, modeled as a reduction in η_t *in equation (12), causes an increase in the price of long-term bonds and home currency appreciation if and only if* $\mathrm{cov}_t(rx^y_{t+1}, rx^q_{t+1}) > 0$.

Proof. Consider a unit decrease in η_t in (12), 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. (C.12) derived in Appendix C.2, such impulse causes a currency appreciation if and only if $\mathrm{cov}_t(rx^y_{t+1}, rx^q_{t+1}) > 0$. This proves part (b). The proof of part (a) is analogous, and follows from considering a unit increase in γ_t in (17). □

Proposition 3 characterizes the effects of asset purchase policies that are confined to a single market on both bond yields and exchange rates. It shows that FXI—interventions in the FX market—can influence the price of long-term bonds, while QE—purchases of long-term bonds—can affect the exchange rate. These cross-market effects arise from two central features of our small open economy framework.

First, local intermediaries simultaneously intermediate positions in both the bond and currency markets. As a result, a shift in the net supply of one asset alters their exposure and induces changes in the required risk premia on both assets. Second, the magnitude and direction of these effects depend on the stochastic properties of bond yields and exchange rates, embodied in the covariance of excess returns. As discussed earlier, this covariance reflects the relative strength of correlated foreign investor flows versus short-term interest rate shocks (see, for example, Figure 4).

In economies where correlated flow risk dominates, the risks associated with the UIP trade and the yield-curve trade are positively correlated. In such settings, a central bank purchase of foreign currency (i.e., FXI) increases intermediaries' exposure to domestic yield curve risk, thus lowering the equilibrium price of long-term domestic bonds. Analogously, a central bank purchase of domestic bonds (QE) reduces intermediaries' exposure to currency risk, leading to an appreciation of the domestic currency.

Taken together, when foreign investors play a significant role in local-currency bond markets, FXI tends to raise the price of long-term bonds, while QE tends to appreciate the exchange rate. Crucially, these cross-asset spillovers arise even though each policy targets only one market at a time.[27]

We now turn to examine how these predictions hold up in the data.

Central bank U.S. dollar auctions (FXI) We present empirical evidence that sterilized foreign exchange interventions have significant effects on both the exchange rate and long-term bond prices.[28] We test Proposition 3(a) using proprietary data from 651 multiunit uniform price auctions conducted daily in Colombia between June 2008 and December 2014. The auction mechanics were as follows: prior to each auction, the central bank announced the maximum amount of U.S. dollars to be purchased. Each auction lasted three minutes, during which participants could submit and revise their bids, specifying both an ask price in COP/USD and the total dollar amount offered. At the close of the auction, bids were ranked in ascending order by price. The central bank then accepted offers starting with the lowest ask price, purchasing sequentially until its pre-announced demand was fulfilled. The cutoff price (applied uniformly to all winning bids) was thus determined by the highest ask price among those from whom the central bank acquired a positive amount.

Descriptive statistics for the auctions are presented in Table 6. On average, each auction involved 8 participating financial institutions, primarily private banks (the list of authorized bidders is publicly available). The central bank purchased an average of USD 23 million per day, with amounts occasionally reaching up to USD 50 million. For context, during the same period, the total daily turnover in the Colombian COP/USD spot market was approximately USD 950 million, with an average individual transaction size of USD 0.785 million.

For identification, we exploit the inherent discontinuity generated by the auction's cutoff price to compare the behavior of marginal winners and marginal losers in their subsequent trading activity in both the bond and foreign exchange secondary markets. We argue that, within a narrow window around the cutoff, the exchange rate becomes locally decoupled

[27]Formally, QE in our model should be interpreted as a central bank bond purchase carried out under the full variance-covariance structure implied by all exogenous processes, rather than as the effect of a bond purchase in a counterfactual setting where asset purchases are the sole source of variation (and analogously for FXI).

[28]Sterilized FXI are aimed at (i) accumulating international reserves, (ii) correcting short-term exchange rate misalignments, and (iii) reducing excessive exchange rate volatility.

Table 6
U.S. Dollar Auctions: Summary Statistics

	Mean	St. Dev.	Min	Pctl(25)	Median	Pctl(75)	Max
Cutoff price[(a)]	1,885	93.9	1,756	1,804	1,882	1,932	2,372
Ask price std. dev.	0.59	0.49	0.07	0.30	0.46	0.66	4.14
Ask price range	1.71	1.40	0.10	0.90	1.30	2.00	9.18
Announced demand[(b)]	23.2	10.1	10.0	15.0	20.1	31.9	50.0
Total offered	47.5	21.9	5.0	29.5	46.0	61.0	135.5
Total purchased	23.1	10.0	5.0	15.0	20.1	30.5	50.0
Number of bidders	8.14	2.58	2	6	8	10	15
Number of winners	4.91	2.10	1	3	5	6	11
Number of losers	3.23	2.20	0	2	3	5	10

Note: This table presents summary statistics for all 641 auctions in our sample. Ask price range is the difference between the highest and the lowest ask price submitted by bidders in each auction. Announced demand is the maximum amount of USD that the CBC announces it will purchase at each auction. [(a)]Prices are measured in COP/USD. [(b)]Amounts are measured in million USD.

from broader macroeconomic and financial variables, thereby creating a localized quasi-experimental setting. This identification strategy relies on the assumption that bidders near the threshold (barely winners and barely losers) are ex-ante similar.

Formally, we estimate the following regression discontinuity design (RDD) centered around the auction cutoff price:

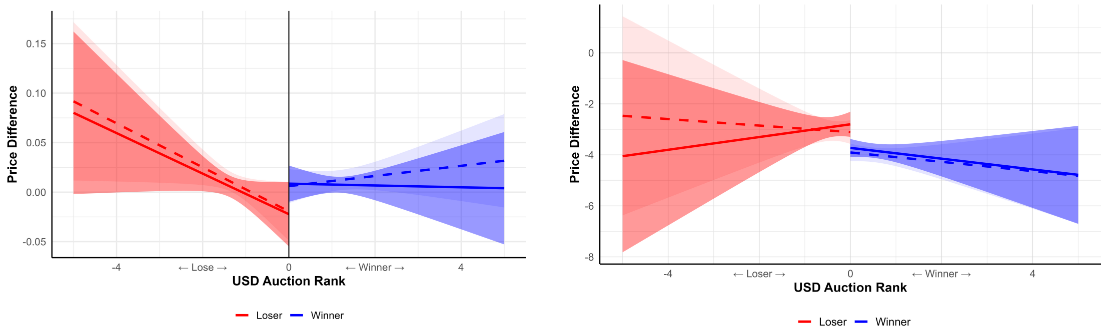
$$\arg\min_{\boldsymbol{\gamma}} \sum_{i=1}^{I} [y_i - \gamma_0 + \gamma_1 D_i + \gamma_2(bid_i - c) + \gamma_3(bid_i - c) \times D_i]^2 \, K\left(\frac{bid_i - c}{h}\right) \tag{27}$$

where y_i denotes either bond prices or USD prices in the secondary market, measured during the trading day immediately following the auction, but still within the same calendar day;[29] $(bid_i - c)$ is the standardized distance of bid i from the auction cutoff price c (positive for winners, negative for losers); $D_i = \mathbb{1}\{bid_i \geq c\}$ is a treatment indicator equal to one if bid i was accepted; and $K(\cdot)$ is a triangular kernel function with bandwidth h. The parameter of interest, γ_1, captures the local average treatment effect of winning the auction on subsequent market outcomes.

To illustrate, Appendix Figure D.2 displays a histogram of FX trades in the secondary spot market following the auction, distinguishing between auction winners and losers. As can be visually observed, the distribution of spot FX prices for winners is slightly shifted to the right, suggesting that they negotiated higher prices on average.

[29]The term secondary market refers to both the secondary market for government bonds and the spot foreign exchange market. 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.

Figure 6
Effects of FXI (U.S. Dollar Purchases) on Secondary Market Prices



(a) Exchange Rate (b) Long-term Bond Price

Note: This figure presents the results from estimating equation (27), with robust standard errors. The dotted line shows a linear fit weighted by the trading volume in the secondary market, corresponding to either spot FX transactions (left panel) or sovereign bond trades (right panel) conducted by each bank with foreign investors. Dependent variables are measured as a % deviation (log-difference) from the median spot price of the corresponding day. The bandwidth is selected optimally according to the procedure proposed by Calonico et al. (2014), and statistical significance is evaluated at the 5% level.

More formally, the results from estimating equation (27) are presented numerically in Table D.1 and graphically in Figure 6, where panel (a) illustrates the effects on the spot exchange rate and panel (b) depicts the effects on bond prices, in line with the prediction in Proposition 3(a). As shown, central bank purchases of U.S. dollars lead to both a depreciation of the exchange rate and a decline in bond prices. Specifically, auction winners—dealers that sell USD to the central bank—subsequently trade FX at prices that are 0.031 % higher than those of auction losers (dummy coefficient in column 3 of Table D.1). This effect is economically meaningful, representing approximately 60% of the standard deviation of that variable (0.053%). Similarly, auction winners trade sovereign bonds at prices that are 1.15% lower than those of auction losers (dummy coefficient in column 1 of Table D.1), corresponding to about 40% of the standard deviation in bond prices (2.87%).

Quantitative Easing Using a high-frequency identification strategy, Rebucci et al. (2022) and Toraman (2025) show that QE—central bank purchases of long-term government bonds—led to currency appreciation in emerging market economies during the COVID-19 period (see also Arslan et al., 2020). This stands in contrast to the experience of advanced economies, where QE is typically associated with currency depreciation (Bauer and Neely, 2014; Neely, 2015; Swanson, 2021; Bhattarai and Neely, 2022), evidence that, at least in part, motivated the theoretical analyses in Greenwood et al. (2023) and Gourinchas et al. (2022).

The differing effects of QE across emerging and advanced economies can be understood through the lens of the covariance structure of bond yields and exchange rates. As emphasized in Proposition 3(b), when excess returns on bonds and currencies are driven primarily by correlated flows, QE tends to appreciate the currency. By contrast, when short-term interest rate risk dominates, QE is more likely to lead to depreciation. Thus, the response of exchange rates to QE hinges on the underlying sources of risk in each economy.

7 Discussion

Our analysis is framed within a portfolio-balance framework à la Greenwood et al. (2023). We adopt a number of simplifying assumptions to illustrate the key implications of correlated flows that we emphasize. As concluding remarks, this section discusses some elements commonly explored in the literature that, while not altering our main insights, could enrich and extend the conclusions of our analysis.

Purchases of other assets by global investors The correlation of global investor flows depends on the source of their currency spot purchases. Figure 2 shows that most spot market transactions by global investors are linked to sovereign bond purchases in Colombia. However, in countries where non-residents use the spot market to acquire other assets—such as equities or local-currency corporate bonds—or to engage in trade of goods and services denominated in local currency, these factors generally act to lower $\text{corr}_t(\eta^*_{t+1}, \gamma^*_{t+1})$ in equation (14). To the extent that equity/trade-related spot purchases are more common in advanced economies, these features could help further explain the lower correlation between bond and currency returns observed in those countries, even for similar investor compositions.

The sources of global investors' flows In our baseline model, following Greenwood et al. (2023), we assume that global investors' bond demand is exogenous and inelastic. However, global investors' demand is clearly more nuanced in practice. For instance, global investors' time-varying risk-bearing capacity can influence bond positions (Morelli et al., 2022; Akinci et al., 2022). Risk bearing capacity, in turn, may depend on investors' wealth, possibly linked to shifts in U.S. monetary policy (Kekre et al., 2024; Miranda-Agrippino and Rey, 2020) or fluctuations in the value of the U.S. dollar (Carstens and Shin, 2019; Bruno and Shin, 2015; Hofmann et al., 2022a). We emphasize that correlated flows and their implications arise regardless of the underlying source of global investors' bond demand, yet the equilibrium correlation in bond and currency returns may vary depending on the specific sources underlying investors' demand.

General equilibrium effects Our baseline model treats short-term interest rate fluctuations as exogenous. Embedding it within a general equilibrium framework would shed light on how endogenous movements in short-term rates contribute to the correlation of excess bond and currency returns. For instance, if FX inflows lead to a temporary appreciation of the home currency—by compressing currency risk premia—this would increase current home consumption via expenditure switching, and lower the home short-term interest rate. The endogenous decline in the short-term rate would raise *realized* excess returns on long-term bonds, along with the higher *realized* excess currency returns due to the exchange rate appreciation following the original FX inflow. Together, these effects generate a positive correlation between excess bond and currency returns. Kekre and Lenel (2024) argue that an analogous mechanism—stemming from shocks to the UIP condition emphasized by Itskhoki and Mukhin (2021)—is a natural candidate explanation for why long-term yields in emerging markets tend to be relatively high when their currency is relatively weak.[30]

Investor heterogeneity Another natural extension would recognize that investors differ in characteristics such as risk tolerance, portfolio elasticity, and investment horizon. Sovereign bonds are held by a diverse set of investors across countries (Fang et al., 2022; Zhou, 2024), and preferences over currency denominations may further segment investor demand (Faia et al., 2024). While our analysis intentionally adopts a stylized setting, incorporating this heterogeneity could shed light on how further differences in investor composition shape the comovement of asset prices across markets.

We highlight the role of correlated flows—a mechanism frequently cited by policymakers and market participants but largely overlooked in the international finance literature—and explore its implications. Embedding correlated flows into macroeconomic frameworks with endogenous bond demand and investor heterogeneity can offer further insight into the comovement of asset prices, the transmission of quantitative easing and foreign exchange interventions, and a broader set of related questions.

[30] Local-currency debt, portfolio-balance frictions and correlated flows can be incorporated in the analyses of emerging economies' financial crises (Calvo et al., 2006; Calvo, 1998; Caballero and Krishnamurthy, 2001; Mendoza, 2010; Bocola and Lorenzoni, 2020; Fontanier, 2024), and more broadly in emerging economies' business cycles (Neumeyer and Perri, 2005; Uribe and Yue, 2006; Aguiar and Gopinath, 2007; García-Cicco et al., 2010; Fernández and Gulan, 2015; Fernández-Villaverde et al., 2011; Coulibaly, 2023; Arellano et al., 2020).

8 Conclusion

The composition of investors holding local-currency bonds shapes the equilibrium dynamics of a country's exchange rate. When local intermediaries face portfolio-balance constraints, the flows they must absorb influence bond prices and exchange rates by affecting term premia and currency premia. Using micro-level data from Colombia's local-currency sovereign bond market, along with spot and forward exchange markets, we document that global investor flows into the bond market are systematically linked to corresponding flows into the foreign exchange spot market, but not into the forward market. Incorporating these features into an equilibrium model, we show that correlated (unhedged) flows increase the co-movement between bond and currency premia, consistent with macro-level evidence on excess bond and currency returns as well as micro-level evidence on investor-specific returns in these markets.

The properties of a country's exchange rates, in turn, determine the impact of policies that alter the net supply of bonds or foreign currency. For instance, quantitative easing policies that reduce the net supply of sovereign bonds mediated by local intermediaries, lead to a simultaneous increase in bond prices *and* the value of the home currency, a prediction supported by the data. Analogously, foreign exchange interventions that reduce the net supply of foreign currency mediated by local intermediaries, depreciate the value of the domestic currency *and* lower bond prices, for which we provide empirical support.

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Appendix

A Additional Evidence on Excess Bond and Currency Returns

A.1 Default Risk as a Control

Using credit default swaps (CDS) to measure default risk, we show in Section 2 that default risk is not the primary driver of the relationship between excess bond and currency returns in emerging economies. We prodive additional evidence in this section. Table A.1 incorporates CDS spreads as a control in the baseline regression analysis. The positive correlation between bond and currency returns remains, whether or not one includes time or country fixed effects. While multicollinearity could be a potential concern, the low correlations between CDS spreads and excess bond returns ($\rho = -0.03$) and between CDS spreads and excess currency returns ($\rho = 0.07$) mitigate this issue.

We further investigate the relationship between excess bond and currency returns by categorizing CDS spreads into low, medium, and high groups based on relative CDS levels within each country. Specifically, Panel A of Table A.2 sorts each country's excess returns into CDS buckets according to its own historical CDS spreads over time. The positive correlation between bond and currency excess returns persists even during periods when countries experience low CDS levels relative to their own history. This relationship appears robust and is not driven by specific dates or countries. Across all CDS environments (low, medium, and high relative to a country's history), the positive correlation remains significant, even after controlling for month and country (currency) fixed effects.

Panel B of Table A.2 extends this analysis by categorizing CDS spreads at the monthly level. In this framework, countries are sorted into low, medium, and high CDS groups within each month, enabling a cross-sectional analysis where all countries are compared relative to one another during the same time period. The positive correlation between bond and currency excess returns persists. Similar to the results obtained when sorting CDS spreads by country, these correlations are not attributable to specific countries or particular dates.

Table A.1
Foreign exchange and local-currency bond excess returns: CDS spreads

	Annualized foreign exchange excess returns					
	Emerging E. (w/o CDS spreads)			Emerging E. (w/ CDS spreads)		
	(1)	(2)	(3)	(4)	(5)	(6)
Annualized local-currency bond return	0.37***	0.19***	0.38***	0.43***	0.20***	0.42***
(in local currency)	(0.06)	(0.04)	(0.06)	(0.07)	(0.06)	(0.07)
CDS spread (%)				4.98***	2.33**	8.77***
				(1.56)	(1.17)	(2.67)
Time FE	No	Yes	No	No	Yes	No
Currency FE	No	No	Yes	No	No	Yes
N	1,353	1,352	1,353	1,102	1,102	1,102
R-squared	0.07	0.03	0.08	0.09	0.03	0.10

Note: The first three columns show the slope of baseline regression $rx^q_{j,t+1} = \alpha + \beta rx^{(10y)}_{j,t+1} + \epsilon_{j,t+1}$ using different sets of fixed effects. The last three columns add to the baseline regression credit default swaps as controls and also reports those coefficients for various sets of fixed effects. Standard errors are in parentheses. In all panels, HAC standard errors were used, allowing for 12-month autocorrelation. Significance stars follow conventional levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A.2
Correlation of bond and foreign exchange excess returns sorted by CDS spread

Panel A: Correlation of excess returns: CDS spreads sorted by country

	Annualized foreign exchange excess returns								
	Low CDS spread			Medium CDS spread			High CDS spread		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Annualized local-currency bond return	0.43***	0.13	0.43***	0.42***	0.11	0.41***	0.63***	0.26	0.63***
(in local currency)	(0.15)	(0.10)	(0.16)	(0.12)	(0.07)	(0.12)	(0.13)	(0.19)	(0.14)
Time FE	No	Yes	No	No	Yes	No	No	Yes	No
Currency FE	No	No	Yes	No	No	Yes	No	No	Yes
N	317	296	317	269	227	269	252	193	252
R-squared	0.10	0.01	0.10	0.12	0.01	0.12	0.15	0.04	0.15

Panel B: Correlation of excess returns: CDS sorted each month

	Annualized foreign exchange excess returns								
	Low CDS spread			Medium CDS spread			High CDS spread		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Annualized local-currency bond return	0.29***	0.06*	0.30***	0.48***	0.10	0.48***	0.67***	0.31*	0.67***
(in local currency)	(0.11)	(0.03)	(0.11)	(0.14)	(0.11)	(0.14)	(0.14)	(0.17)	(0.14)
Time FE	No	Yes	No	No	Yes	No	No	Yes	No
Currency FE	No	No	Yes	No	No	Yes	No	No	Yes
N	303	253	303	262	206	262	273	230	273
R2	0.04	0.00	0.05	0.13	0.00	0.12	0.20	0.06	0.20

Note: Panel A and Panel B show the correlation between the FX excess returns and local currency bond excess returns for emerging market countries, sorted by either their own sample-average CDS spreads (Panel A) or by its CDS magnitude across countries within the same month (Panel B).
Standard errors are in parenthesis. In all panels, HAC standard errors were used, allowing for 12-month autocorrelation. Significance stars follow conventional levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

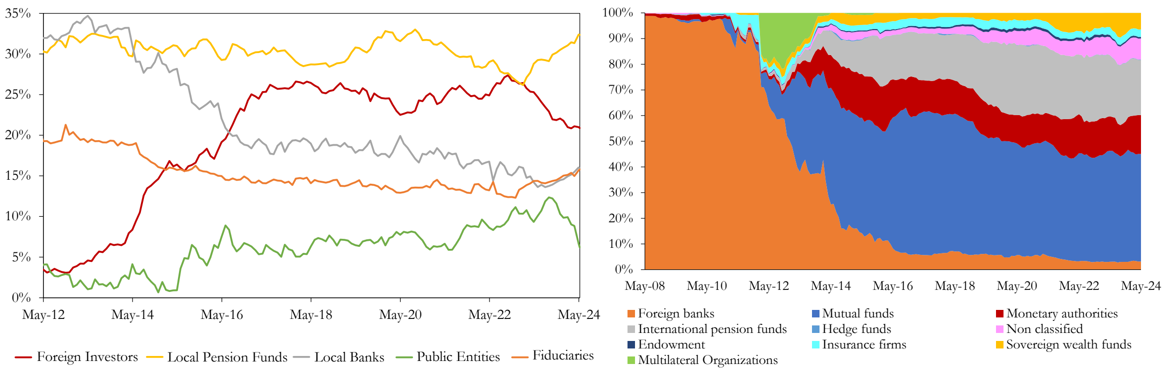
B Global investor type and hedging in fixed income

B.1 Global investor type in Colombia

Our evidence from Colombia suggests that foreigners tend to produce correlated flows 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 global 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.1
Participation in the Colombian TES market



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

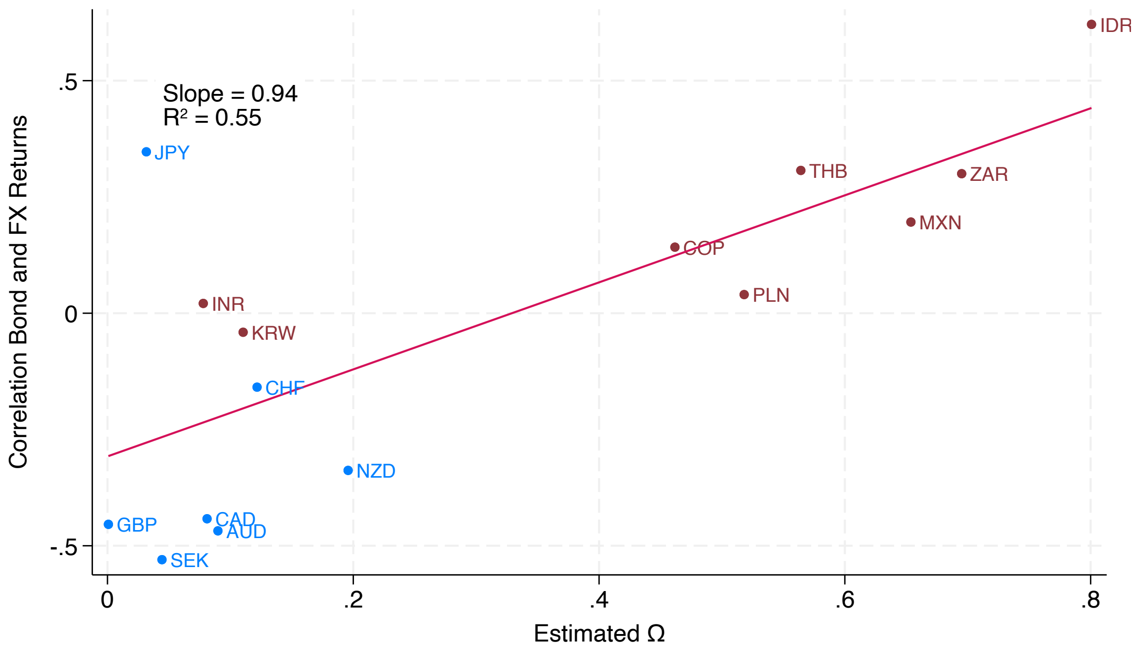
Note: The data presented correspond to all trades registered with the Central Securities Depository (DCV), which operates under the supervision of the Central Bank of Colombia. Panel A shows the TES participation (percentage of total outstanding TES volume) across major entities, while Panel B focuses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

Figure B.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).

Figure B.2
Comovement in Excess Returns and Ω

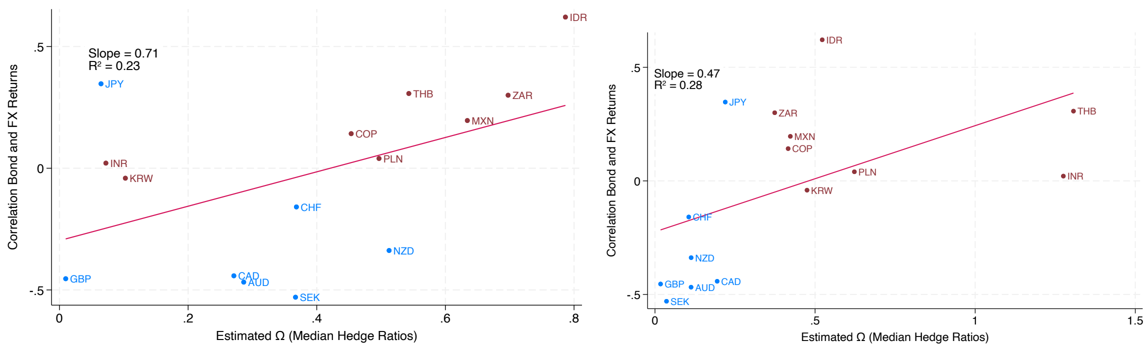


Note: This figure displays the correlation of bond and currency excess returns (y-axis) and the Estimated Ω from Equation 21 (x-axis). In the computation for Estimated Ω we restrict $\alpha \geq 0$. Countries in red (blue) are part of the emerging (advanced) economies sample.

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.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. 21 (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.

C Model Appendix

C.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_t^y 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 amortization rate. The gross before-tax return on long-term bonds from t to $t+1$ is thus

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

where

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

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

$$r_{t+1}^y \approx \theta + \delta p_{t+1}^y - p_t^y, \tag{C.3}$$

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

$$p_t^y \approx \frac{1}{1-\delta}\theta - \frac{1}{1-\delta} y_t. \tag{C.4}$$

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

$$r_{t+1}^y \approx \frac{1}{1-\delta} y_t - \frac{\delta}{1-\delta} y_{t+1}, \tag{C.5}$$

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).

C.2 Solving the Baseline Model

In this subsection, we derive the system of equations necessary to solve the baseline model presented in Section 4.1. 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 three equations with three unknowns. The resulting equations can be studied to derive qualitative implications about the model. We close out Appendix C by proving the main propositions of the paper.

C.2.1 Equilibrium Conjecture and Properties

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

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

where the 6×1 state vector $\mathbf{z}_t = [i_t - \bar{\iota}, i_t^* - \bar{\iota}, g_t, q_{t+\infty}, s_t^y - \bar{s}^y, s_t^q]'$ 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 $\Phi = \text{diag}(\phi_i, \phi_i, \phi_g, 0, \phi_{s^y}, \phi_{s^q})$. 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

$$\alpha^* = f(\alpha^*). \tag{C.7}$$

Within this context, local 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.

C.2.2 Equilibrium Solution

The first-order condition of the local intermediaries that we derived is written again for completeness

$$\mathrm{E}_t[\mathbf{rx}_{t+1}] = \tau^{-1}\,\mathrm{var}_t[\mathbf{rx}_{t+1}]\mathbf{d}_t. \tag{C.8}$$

This, coupled with the usual market clearing condition that supply equals demand ($\mathbf{d}_t = \mathbf{s}_t$), and letting $\mathbf{V} = \mathrm{var}_t[\mathbf{rx}_{t+1}]$, we get

$$\mathrm{E}_t[\mathbf{rx}_{t+1}] = \tau^{-1}\mathbf{V}\mathbf{s}_t, \tag{C.9}$$

with

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

We can write out equation (C.8), yielding individual excess return equations:

$$\mathrm{E}_t\left[rx^y_{t+1}\right] = \frac{1}{\tau}\left[V_y \cdot s^y_t + C_{y,q} \cdot s^q_t\right]; \tag{C.10a}$$

$$\mathrm{E}_t\left[rx^q_{t+1}\right] = \frac{1}{\tau}\left[C_{y,q} \cdot s^y_t + V_q \cdot s^q_t\right], \tag{C.10b}$$

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 (8), as well as the exogenous processes, we can characterize equilibrium bond yields and foreign exchange prices:

$$y_t = \left\{\bar{\imath} + \frac{1-\delta}{1-\delta\phi_i}\cdot(i_t - \bar{\imath})\right\} + \frac{1-\delta}{1-\delta\phi_g}g_t + \left\{\tau^{-1}V_y \cdot \bar{s}^y\right\} + \tau^{-1}\left\{\frac{1-\delta}{1-\delta\phi_{s^y}}V_y\cdot(s^y_t - \bar{s}^y) + \frac{1-\delta}{1-\delta\phi_{s^q}}C_{y,q}\cdot s^q_t\right\}; \tag{C.11}$$

$$q_t = \left\{\frac{1}{1-\phi_i}\cdot(i^\star_t - i_t)\right\} + \mathrm{E}_t\, q_{t+\infty} + \tau^{-1}\left\{C_{y,q}\bar{s}^y + \frac{1}{1-\phi_{s^y}}C_{y,q}\cdot(s^y_t - \bar{s}^y) + \frac{1}{1-\phi_{s^q}}V_q\cdot s^q_t\right\}. \tag{C.12}$$

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

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

where we have used equations (1), (2), (3), (7), and the fact that $rx^y_{t+1} \equiv r^y_{t+1} - i_t$. Additionally,

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

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

$$\mathbf{y}_{t+1} = \mathbf{a} + \mathbf{A}\mathbf{z}_{t+1} = \mathbf{a} + \mathbf{A}\Phi\mathbf{z}_t + \mathbf{A}\varepsilon_{t+1}. \tag{C.13}$$

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

$$\mathbf{rx}_{t+1} = [\mathbf{B}_0\mathbf{a} + \mathbf{B}_1\mathbf{a} + \mathbf{r}_0] + [\mathbf{B}_0\mathbf{A} + \mathbf{B}_1\mathbf{A}\Phi + \mathbf{R}_1]\mathbf{z}_t + [\mathbf{B}_1\mathbf{A}]\varepsilon_{t+1}, \tag{C.14}$$

which implies that

$$E_t[\mathbf{rx}_{t+1}] = [\mathbf{B}_0\mathbf{a} + \mathbf{B}_1\mathbf{a} + \mathbf{r}_0] + [\mathbf{B}_0\mathbf{A} + \mathbf{B}_1\mathbf{A}\Phi + \mathbf{R}_1]\mathbf{z}_t; \tag{C.15}$$

$$\mathbf{V} \equiv \text{var}_t[\mathbf{rx}_{t+1}] = \mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1'. \tag{C.16}$$

Going back to the market-clearing condition in equation (C.9), $\mathbf{s}_t = [s^y_t, s^q_t]'$ can be written as $\mathbf{s}_t = \mathbf{s}_0 + \mathbf{S}_1\mathbf{z}_t$, where

$$\mathbf{S}_1 \equiv \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}, \quad \text{and} \quad \mathbf{s}_0 = \begin{bmatrix} \bar{s}^y \\ 0 \end{bmatrix},$$

which allows us to write equation (C.9) as

$$[\mathbf{B}_0\mathbf{a} + \mathbf{B}_1\mathbf{a} + \mathbf{r}_0] + [\mathbf{B}_0\mathbf{A} + \mathbf{B}_1\mathbf{A}\Phi + \mathbf{R}_1]\mathbf{z}_t = \tau^{-1}(\mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1')(\mathbf{s}_0 + \mathbf{S}_1\mathbf{z}_t). \tag{C.17}$$

Equation (C.17) 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

$$(\mathbf{B}_0 + \mathbf{B}_1)\mathbf{a} = \left[\tau^{-1}\mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1'\mathbf{s}_0 - \mathbf{r}_0\right]. \tag{C.18}$$

Recall how $\mathbf{B}_0$ and $\mathbf{B}_1$ look like. The last row of the sum 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

$$[\mathbf{B}_0\mathrm{A} + \mathbf{B}_1\mathrm{A}\Phi] = \mathbf{A} \circ [\mathbf{B}_0\mathbf{E} + \mathbf{B}_1\mathbf{E}\Phi], \tag{C.19}$$

where $\circ$ is the element-wise matrix multiplication and $\mathbf{E}$ is a 3×5 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,

$$[\mathbf{A} \circ (\mathbf{B}_0\mathbf{E} + \mathbf{B}_1\mathbf{E}\Phi) + \mathbf{R}_1]\mathbf{z}_t = \tau^{-1}(\mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1')\mathbf{S}_1\mathbf{z}_t. \tag{C.20}$$

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

$$\mathbf{A} = [\tau^{-1}\mathbf{B}_1\mathbf{A}\Sigma\mathbf{A}'\mathbf{B}_1'\mathbf{S}_1 - \mathbf{R}_1] \oslash [\mathbf{B}_0\mathbf{E} + \mathbf{B}_1\mathbf{E}\Phi], \tag{C.21}$$

where $\oslash$ is element-wise matrix division. To further characterize the solution to the problem in (C.21), we can partition $\mathbf{z}_t$ as $\mathbf{z}_t = [\mathbf{z}_{1,t}', \mathbf{z}_{2,t}', \mathbf{z}_{3,t}']'$, where $\mathbf{z}_{1,t} = [i_t - \bar{\iota}, i_t^* - \bar{\iota}, g_t]'$, $\mathbf{z}_{2,t} = q_{t+\infty}$, and $\mathbf{z}_{3,t} = [s_t^y - \bar{s}^y, s_t^q]'$. Similarly, we partition $\mathbf{A} = [\mathbf{A}_1, \mathbf{A}_2, \mathbf{A}_3]$, where $\mathbf{A}_1$ is the 2×3 matrix of loadings on $\mathbf{z}_{1,t}$, $\mathbf{A}_2$ is the 2×1 matrix of loadings on $\mathbf{z}_{2,t}$, and $\mathbf{A}_3$ is the 2×2 matrix of loadings on $\mathbf{z}_{3,t}$.

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

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

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

For $\mathbf{A}_2$, which contains the FX-specific shock, we can already see from the equilibrium price in equation (C.12) that $\mathbf{A}_2 = [0, 1]'$. In other words, the specific shock on the price of the exchange rate has no impact on the long-term bond price, while affecting the FX rate one-for-one.

Lastly, we now move to the supply shocks; that is, pinning down $\mathbf{A}_3$. Due to the orthogonality of the different shocks, the variance-covariance matrix Σ can be partitioned as

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

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

$$\mathbf{V} = (\mathbf{B}_1\mathbf{A}_1\Sigma_1\mathbf{A}_1'\mathbf{B}_1') + (\mathbf{B}_1\mathbf{A}_2\Sigma_2\mathbf{A}_2'\mathbf{B}_1') + (\mathbf{B}_1\mathbf{A}_3\Sigma_3\mathbf{A}_3'\mathbf{B}_1'). \tag{C.22}$$

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

$$\mathbf{A}_3 = \mathbf{F}_3(\mathbf{A}_3) \equiv \tau^{-1}[(\mathbf{B}_1\mathbf{A}_1\Sigma_1\mathbf{A}_1'\mathbf{B}_1')+(\mathbf{B}_1\mathbf{A}_2\Sigma_2\mathbf{A}_2'\mathbf{B}_1')+(\mathbf{B}_1\mathbf{A}_3\Sigma_3\mathbf{A}_3'\mathbf{B}_1')]\oslash[\mathbf{B}_0\mathbf{E}+\mathbf{B}_1\mathbf{E}\Phi]^{[5-6]}. \tag{C.23}$$

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 (C.23), and using $\mathbf{V}$ in its matrix form, the equilibrium price-impact coefficients must satisfy

$$\begin{bmatrix} \alpha_{sy}^y & \alpha_{sq}^y \\ \alpha_{sy}^q & \alpha_{sq}^q \end{bmatrix} = \tau^{-1}\begin{bmatrix} \frac{1-\delta}{1-\delta\phi_{sy}}V_y & \frac{1-\delta}{1-\delta\phi_{sy}}C_{y,q} \\ \frac{1-\delta}{1-\delta\phi_{sy}}C_{q,y} & \frac{1-\delta}{1-\delta\phi_{sy}}V_q \end{bmatrix}. \tag{C.24}$$

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

$$\begin{bmatrix} \left(\frac{\delta}{1-\delta\phi_i}\right)^2\sigma_i^2 + \left(\frac{\delta}{1-\delta\phi_g}\right)^2\sigma_g^2 & -\frac{\delta}{1-\delta\phi_i}\frac{1}{1-\phi_i}\sigma_i^2(1-\rho) \\ -\frac{\delta}{1-\delta\phi_i}\frac{1}{1-\phi_i}\sigma_i^2(1-\rho) & \left(\frac{1}{1-\phi_i}\right)^2 2\sigma_i^2(1-\rho)+\sigma_q^2 \end{bmatrix}. \tag{C.25}$$

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 (C.24) in the contribution of supply risk to the variance-covariance matrix, and using this and (C.25) in (C.22), along with denoting the constants

$$g_y \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{sy}}\sigma_\eta, \quad g_y^* \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{sy}}\sigma_{\eta^*}, \quad g_q \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{sq}}\sigma_\gamma, \quad g_q^* \equiv \tau^{-1}\frac{\delta}{1-\delta\phi_{sq}}\sigma_{\gamma^*}, \tag{C.26}$$

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

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

$$V_y = \left(\frac{\delta}{1-\delta\phi_i}\right)^2 \sigma_i^2 + \left(\frac{\delta}{1-\delta\phi_g}\right)^2 \sigma_g^2 + (V_y)^2(g_y^2 + g_{y^*}^2) + (C_{y,q})^2(g_q^2 + g_{q^*}^2) + 2g_{y^*}g_{q^*}V_yC_{y,q}; \tag{C.27a}$$

$$V_q = \left(\frac{1}{1-\phi_i}\right)^2 2\sigma_i^2(1-\rho) + \sigma_q^2 + (C_{y,q})^2(h_y^2 + h_{y^*}^2) + (V_q)^2(h_q^2 + h_{q^*}^2) + 2h_{y^*}h_{q^*}V_qC_{y,q}; \tag{C.27b}$$

$$C_{y,q} = -\frac{\delta}{1-\delta\phi_i}\frac{1}{1-\phi_i}\sigma_i^2(1-\rho) + V_yC_{y,q}(g_yh_y + g_{y^*}h_{y^*}) + V_qC_{y,q}(g_qh_q + g_{q^*}h_{q^*}) \tag{C.27c}$$

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

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 1, which effectively reduces this system of equations into a more manageable set that yields qualitatively siimlar implications.

C.3 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:

$$d_t^x[i_t - i_t^\star - (q_{t+1} - q_t)] + d_t^f[f_t - q_{t+1}] \tag{C.28}$$

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 $d_t^q = d_t^x + d_t^f$, we rewrite the expression above as:

$$d_t^q[i_t - i_t^\star - (q_{t+1} - q_t)] + d_t^f[i_t - i_t^\star - (f_t - q_t)] \tag{C.29}$$

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

$$\max_{\mathbf{d}_t} \left\{ \mathbf{d}_t' \operatorname{E}_t[\mathbf{rx}_{t+1}] - \frac{1}{2\tau} \mathbf{d}_t' \operatorname{var}_t[\mathbf{rx}_{t+1}] \mathbf{d}_t \right\}, \tag{C.30}$$

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

$$\operatorname{E}_t[\mathbf{rx}_{t+1}] = \tau^{-1} \operatorname{var}_t[\mathbf{rx}_{t+1}] \mathbf{d}_t. \tag{C.31}$$

or:

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

and thus:

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

Covered interest parity (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.

C.4 Proof of Proposition 1

Proof of Proposition 1. The assumptions spelled out imply that $V_y = V_q$, which simplifies our system of equations to the following

$$V_y = \sigma_g^2 + (V_y)^2 \tau^{-2} (\sigma_\eta^2 + \sigma_{\eta^*}^2) + (C_{y,q})^2 \tau^{-2} (\sigma_\eta^2 + \sigma_{\eta^*}^2) + 2 V_y C_{y,q} \tau^{-2} \sigma_{\eta^*}^2; \tag{C.32a}$$

$$C_{y,q} = 2 V_y C_{y,q} \tau^{-2} (\sigma_\eta^2 + \sigma_{\eta^*}^2) + (C_{y,q})^2 \tau^{-2} \sigma_{\eta^*}^2 + (V_y)^2 \tau^{-2} \sigma_{\eta^*}^2. \tag{C.32b}$$

We can use equation (18) to rewrite this system as

$$V_y = \sigma_g^2 + \tau^{-2} (\sigma_\eta^2 + \sigma_{\eta^*}^2) \left[(V_y)^2 + (C_{y,q})^2 + 2\Omega V_y C_{y,q} \right]; \tag{C.33a}$$

$$C_{y,q} = \tau^{-2} (\sigma_\eta^2 + \sigma_{\eta^*}^2) \left[2 V_y C_{y,q} + (C_{y,q})^2 \Omega + (V_y)^2 \Omega \right]. \tag{C.33b}$$

First, setting $\Omega = 0$, it can be readily seen from equations (C.33a)-(C.33b) that the only real solution implies $C_{y,q} = 0$. Second, differentiating both sides of this equation with respect to

Ω, we achieve

$$\frac{d(C_{y,q})}{d\Omega} = \tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2)\left[2V_y \frac{d(C_{y,q})}{d\Omega} + 2C_{y,q}\frac{d(C_{y,q})}{d\Omega}\Omega + C_{y,q}^2 + V_y^2\right]. \tag{C.34}$$

Next, collecting all terms that contain $\frac{dC_{y,q}}{d\Omega}$ on the left-hand side yields

$$\frac{d(C_{y,q})}{d\Omega} = \frac{\tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2)\left[C_{y,q}^2 + V_y^2\right]}{1 - \tau^{-2}(\sigma_\eta^2 + \sigma_{\eta^*}^2)\left(2V_y + 2C_{y,q}\Omega\right)}. \tag{C.35}$$

To ensure that the denominator is positive, we require agents to be risk-tolerant enough. That is, for τ sufficiently large, we get that $\frac{d(C_{y,q})}{d\Omega} > 0$, which completes our proof.

□

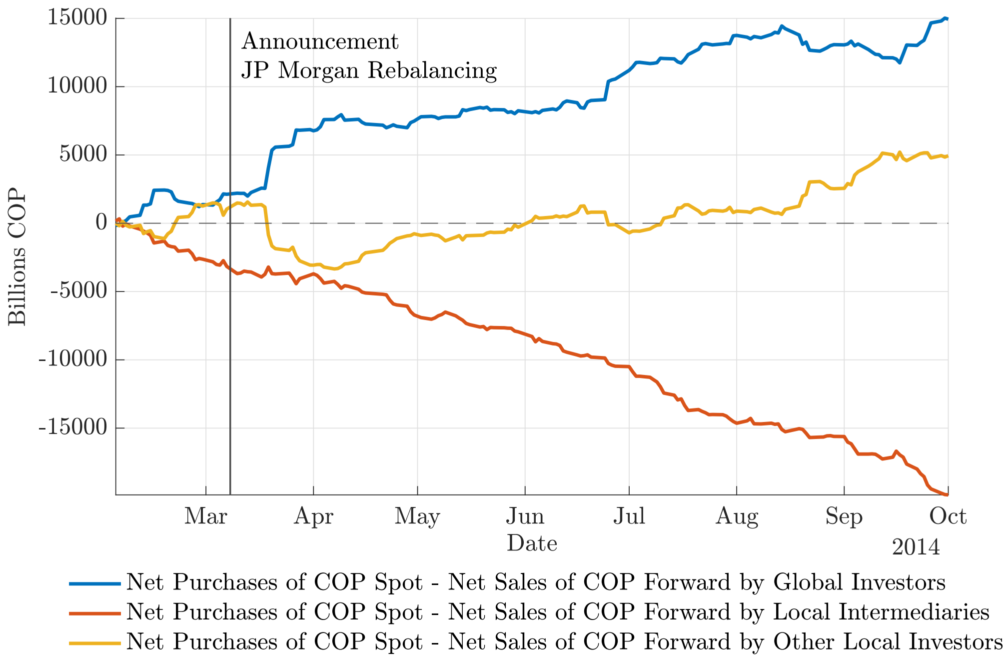
C.5 Calibration

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
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

Table C.1
Baseline calibration

D Additional Tables and Figures

Figure D.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 Sections 3 and 5). The black vertical line denotes 19th of March 2014, the day the rebalancing was announced.

Table D.1
RDD estimates for bond and FX prices

VARIABLES	Bond Price	Bond Price	FX Price	FX Price
Rank	0.250	-0.0460	-0.0205**	-0.00312
	(0.450)	(0.175)	(0.0100)	(0.00352)
Dummy	-1.151*	0.0157	0.0310*	0.0115*
	(0.677)	(0.280)	(0.0181)	(0.00662)
Dummy*Rank	-0.475	-0.0175	0.0196	-0.00163
	(0.495)	(0.194)	(0.0132)	(0.00450)
Dummy*Exposure	-0.000749		-2.83e-05*	
	(0.000478)		(1.54e-05)	
Constant	-2.551***	-0.963	-0.0223	-0.00320
	(0.654)	(0.588)	(0.0146)	(0.00522)
Observations	431	6,487	247	2,403

Note: Authors' calculations. Standard errors in parentheses. (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The *Exposure* variable (centered) refers to the trading volume of sovereign bonds that each bank conducts with foreign investors. Bond (TES) prices are expressed as deviations from the daily mean price. FX selling prices are denoted in COP/USD. A bandwidth of rank 2 was used for this estimation, consistent with Calonico et al. (2014).

Figure D.2
Secondary market prices after FXI auction