Asset Elasticities and Currency Risk Transfer*

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Abstract

We estimate international asset elasticities of demand and supply using exogenous variation in bond-specific currency wedges, leveraging security-level data on international portfolio holdings from Euro Area (EA) and U.S. investors. Our identification strategy relies on using demand variation from the excess portfolio share of each security, relative to an equal-weighted portfolio, as an exposure measure in a Bartik style instrument. We find that U.S. investors, regardless of the type, reallocate away from dollar and local currency denominated emerging market (EM) bonds when currency wedges increase. In contrast, EA insurance companies and nonbanks respond to the same wedges by increasing their exposure both to local currency and euro denominated bonds, whereas EA banks exhibit similar behavior to U.S. investors, rebalancing away from local currency and euro bonds. Our estimates suggest substantial supply elasticities: for the average EM country, an 8 basis points increase in the local currency wedge implies a 0.26% reduction in local currency bond issuance relative to GDP. These findings, which account for issuer×time fixed effects, are not driven by changes in borrower fundamentals and imply time-varying currency risk transfer across investor types and between issuers and investors. We present a model that rationalizes these results.

Keywords: *Local currency, euro, dollar bonds, emerging market vs advanced country issuers and heterogenous investors, time-varying currency risk premia*

JEL classification: F3, G2.

*The views expressed are those of the authors and do not necessarily reflect those of the Federal Reserve Board and System, Bundesbank, European Central Bank or the Eurosystem.

1. Introduction

Starting with the seminal contributions of Solnik (1974) and Adler and Dumas (1983, 1984), the international asset pricing literature has studied extensively the implications of exchange rate risk and incomplete markets on portfolios (e.g. Lewis (1999)) and consumption fluctuations (e.g. Cole and Obstfeld (1991), Baxter and Jermann (1997)). A fundamental assumption in this literature is the arm's-length transactions between borrowers and investors, with infinitely elastic demand. An influential recent literature highlights the important role of financial intermediaries for asset prices and portfolios, implying that asset demand is much more inelastic. These intermediaries, facing different risks and frictions, can segment domestic and international asset markets rendering them incomplete (Gabaix and Maggiori (2015),Koijen and Yogo (2019), Koijen et al. (2017), and Gabaix et al. (2025)). The consensus on asset demand being much less elastic and responding less to price changes rests on exogenous asset supply in the short run.

We build on this literature and expand its insights to an international setting focusing on currency risk and relaxing the exogenous asset supply assumption. We use confidential data on the universe of Euro Area (EA) and the U.S. investors international portfolio holdings and prices at the security-level from the European Central Bank SHS and the Federal Reserve TIC databases. For the SHS data, the Security Holdings Statistics come from a harmonized effort of joint collection from national central banks, which started in 2013. For the U.S., we use the confidential portion of the Treasury International Capital, a dataset that emanates from official reporting which started at the fall of Bretton Woods and has been regular at quarterly level in 2003. Both are administrative datasets with universal coverage of EA and U.S. investors international portfolios relative to less coverage from the commonly used commercial datasets such as Morningstar or Factset. To the best of our knowledge there is no other study estimating demand and supply elasticities based on official data covering international investment universe of EA and U.S. investors.

We start with estimating price elasticities of demand using exogenous variation in bond-specific currency wedges, namely Uncovered Interest Parity (UIP) and Covered Interest Parity (CIP) deviations for each bond. We focus on bonds with residual maturity of 1-5 years as in the longer horizons the currency wedges tend to disappear. The identification strategy is enabled by data on heterogeneous investors, where we do a separate estimation

for each type of investor (bank, nonbank, insurance, other). We infer investor-specific exogenous demand from other investors demand, that is, from the excess portfolio share of each security relative to an equal-weighted portfolio. Once we estimate these demand elasticities and show the reallocation of portfolios as a response to exogenous changes in currency wedges, we turn to the supply elasticities. In the estimation of the supply elasticity, different than the estimation of the demand elasticity, we regress the change in the amount outstanding from t to $t+1$, the new issuance, on the instrumented currency wedges in time t, allowing new issuance to adjust. Since the issuance data is only observed in SHS and not in TIC, we only undertake these estimation for the Euro area investors.

Our results are as follows. We find that U.S. investors across the board reallocate away from dollar and local currency denominated emerging market (EM) bonds when currency wedges increase, indicating higher risk of local currency depreciation vis-a-vis the investor currency. In contrast, EA insurance companies and nonbanks respond to the same increase in local currency risk premia by increasing their exposure to local currency bonds, whereas EA banks exhibit similar behavior to U.S. investors, rebalancing away from both local currency bonds and investor currency bonds. We condition on issuer$\times$time, bond-specific rating and maturity fixed effects. Our interpretation of these results is that U.S. investors' and EA banks' rebalance based on country risk rather than currency risk. This in turn translates into an unwilligness to absorb any new issuance. EA nonbanks and insurance companies on the other hand, absorbs the currency risk at a higher premia. The behaviour of EA insurance companies and nonbanks can also be interpreted as inelastic/ sticky investor demand as they hold on to local currency securities, even when both UIP and CIP tick up suggesting higher currency risk.

We next turn to the estimates of the supply elasticity. Our hypothesis is that, the issuer should internalize the investor behavior. Indeed, we find that an increase in the currency wedges causes a decrease in the growth rate of the amount outstanding by the issuer of that currency bonds, and also a decrease in the bonds denominated in investor currency. This results holds also when we narrow the sample to include only securities denominated in local currency, thereby confirming that this is indeed a reduction in the issuance and not a compositional change. A direct interpretation of our results is that when it becomes more expensive for borrowers to finance new debt, in any currency, they let the amount outstanding shrink, consistent with an inward shift of the longer-run supply curve (as

opposed to constant supply in the short-run). The higher cost of borrowing, both in investor and in issuer currency, may lead the issuer to take on more of the currency risk from investors, by borrowing less in local currency,what we call "currency risk transfer".[1]

Quantitatively our supply elasticity estimates are substantial: we estimate that EMs would on average reduce net issuance of local currency debt by roughly 0.26 percent of GDP in response to an unexpected exogenous widening of the currency wedges equivalent (8 bps) to an increase in spreads on an investment-grade sovereign security by a one standard deviation increase in the VIX (as estimated by Gilchrist et al. (2022)). These results suggest that the supply of EM bonds is very elastic to global investors pricing of EM currency risk.

We perform the same analysis for advanced economy (AE) bonds but do not find significant results. A primary reason for that is our instrument is weaker for AE bonds and we can trace this to the underlying economic arguments. The instrument is relevant, capturing changes in investors demand, through exogenous changes in arbitrage deviations, when the bond default and currency depreciation risk are proportional to bond issuance, and to demand outstanding. This case applies well to EM given the shallow financial markets. For AE this proportionality is absent given the liquidity in secondary markets. To make a concrete example, the supplier of synthetic PEN charges the investors more in order to absorb the higher demand for PEN. However there does not need to be a higher charge to absorb demand for Japanese bonds in yen or U.K bonds in pounds.

Our identification builds on the literature that constructs instruments based on plausibly exogenous demand pressure generated by residual market participants either via mutual fund flow Coval and Stafford (2007), Edmans, Goldstein and Jiang (2012), Lou (2012), Van der Beck (2022), Zhou (2024)), or via flows from other investors arising from investment mandates, as in Koijen and Yogo (2019). We extend this instrumentation approach along three dimensions. First, when estimating the response of investor-specific asset demand to excess currency returns, bond-specific estimates of UIP and CIP, we instrument the excess returns through a Bartik (1991)-style shift-share instrument constructed through the predicted residual aggregate demand inflows, which serve as exogenous shifts. Second, we introduce the adjustment in the supply: this is crucial for correctly identifying and

1 Note that if the issuer keeps the total outstanding amount the same by decreasing local currency issuance and increasing investor currency issuance, this action would amplify the currency risk transfer from investors to borrowers.

attributing movements in portfolio flows to demand and supply. Third, we introduce investors heterogeneity, in terms of their inelastic demand, across bonds issued in different currencies, and hence in their portfolio adjustments.

Our results suggest that issuers have incentives to internalize the investor demand since certain investors' unwillingness to absorb any issuance acts as a discipline device on debt issuance. We write down a typical default model with optimal debt issuance by enriching the model with heterogeneous investors. Our model embeds this unified view of demand and supply elasticity and investigates the optimal issuance under risk of default à la Eaton and Gersovitz (1981). The model has a dual role: it provides a microfoundation to our econometric specification. And, through simulated data, we show that it can replicate the empirical estimates. The model features international financial intermediaries— heterogeneous in their intermediation costs which can be linked to the risk attitudes of their clientele/or frictions—, optimally choose their exposure to different bonds issued by different countries and in different currencies. Optimal portfolio demands, coupled with market clearing conditions, lead to arbitrage deviations under segmented markets. Issuance policy in EM is decided optimally by a benevolent government, that can default strategically on foreign currency bonds, and internalizes the demand elasticities of different international investors. We show that the model equilibrium conditions can be mapped into the reduced form equations that we use in our estimation strategy. We then use simulated data to show under which conditions the model regressions replicate the empirical counterparts.

Relation to literature. In addition to the aforementioned papers, our paper relates to papers that study optimal issuance decisions by governments in conjunction with the currency denomination (see Ottonello and Perez (2019)) or with sticky prices (see Bianchi, Ottonello and Presno (2023)). Our approach intends to merge those two approaches, both theoretically and empirically. Similar efforts have been undertaken by Moretti et al. (2024).

Our paper also contributes to an expanding literature that employs highly disaggregated securities data to study various aspects in international finance. Most closely, we are related to papers using security-level data; Fang, Hardy and Lewis (2022), Faia, Salomao and Ventula Verghazy (2022), Faia, Lewis and Zhou (2024), Bertaut, Bruno and Shin (2021), Bertaut et al. (2024*b*), Bertaut et al. (2024*a*). We are also closely related to the

recent paper by Gabaix et al. (2025), who also study risk transfer, in a domestic context, namely the change in exposure to market risk on the part of households.

Our results also have implications on the means for sovereign debt repayment enforcement. To account for what makes governments repay their debt Eaton and Gersovitz (1981) propose reputational mechanisms and Bulow and Rogoff (1989) show that reputation alone can't be sufficient and requires additional forms of punishment. The extreme assumptions needed to enforce repayment in the Eaton and Gersovitz (1981) are largely due to the fact that international investors are assumed to be infinitely elastic and accommodate any debt issuance in primary markets. Already Broner, Martin and Ventura (2010) noted that allowing for the possibility of debt to be traded in secondary markets reduces the need for extreme assumptions on enforcement, as the market discipline itself acts as an enforcement device. Our empirical results show that indeed this is the case: government do adjust their issuance when inelastic investors' demand declines where they transfer risk swiftly to the issuer (see Gabaix et al. (2025)). Issuer responds with a sizeable decline in issuance. Our model shows that simply allowing for investors to have time-varying risk taking capacity in a model with sovereign default, acts as a simple but powerful enforcement mechanism that allows to account for the data, contrary to models where currency or credit distress is reflected only in the changes of the spread. These models cannot account for both changes in spreads and international portfolio investment, whereas our model can match these patterns.

Outline. The paper is structured as follows. Section 2 describes the institutional background and the data, Section 3 details the empirical strategy, highlighting the main results. Section 4 provides a description of the theoretical model with heterogeneous international investors. Section 5 concludes.

2. Data, Measurement, and Descriptive Statistics

2.1. Description

We provide a brief description of the institutional setting, data, and acronyms we will use consistently in the text. A longer description of the data is provided in Appendix A.

The underlying criterion in the choice of the country sample and of the reference

period is to ensure the maximum degree of comparability of our estimates across the two datasets employed in the analysis. The datasets are the European Central Bank's Securities Holdings Statistics (henceforth, SHS), with data collection starting in 2013Q4, and the U.S. Department of the Treasury' Treasury International Capital (henceforth, TIC), available since 2003. Our reference period is 2014 through 2022. Appendix B offers a detailed description of the algorithm we use to select the countries included in our sample. We focus exclusively on countries for which forward, swap, and spot exchange rates and exchange rates expectations are available at least at quarterly frequency from market data providers throughout the reference period; in which there are unified foreign exchange markets at the end of each quarter and official exchange rates are fully floating or subject to managed floats following the classification in Ilzetzki, Reinhart and Rogoff (2019); in which a positive fraction of total sovereign bond issuance is denominated in euro, in U.S. dollar, and in local currency throughout the reference period; in which the investors covered in each of our two datasets hold at least the equivalent of one billion in investor currency in face value of outstanding sovereign debt throughout the reference period. This selection criteria allow us to construct reliable measures of security-level UIP and CIP deviations and portfolio holdings that are unaffected by capital controls.

The resulting sample of countries consists of 13 EM issuers: Brazil, Chile, Colombia, India, Israel, Malaysia, Mexico, Poland, Russia (excluding 2014Q4-2015Q4, 2022Q1-2), South Africa, South Korea, Thailand, Turkey (until 2018Q2); and 8 AE issuers: Australia, Canada, Switzerland (after 2015Q1), United Kingdom, Japan, Norway, New Zealand, Sweden. Notice how the sample of advanced economy issuers does not include the United States and the euro area countries since we intend to study the investment behavior of residents in this area, and not their issuance behavior.

Together with portfolio holdings data, in our datasets we observe several security characteristics, issuer country, currency of denomination, maturity, and ratings. These characteristics are crucial controls of our security-level econometric specifications.

Institutional Setting in the EA and in the U.S. The heterogeneous set of investors in the two datasets we employ comprises entities that are not only characterized by varying preferences for investment opportunities, but also subject to different constraints in the forms of regulatory requirements and statutory mandates. Needless to say, preferences and constraints contribute to the composition of the portfolios observed in the data for

each investor. For example in the EA pension funds are subject to the stricter regulations, summarized in the Solvency II Directive, and those are meant to protect the type of clientele served by those intermediaries, which is more risk averse and has long term goals. Those institutional investors differ not only in the composition of their portfolio of assets. On the liability side, a defining feature of pension funds' financing structure is their access to characteristically long-term liabilities, while banks and mutual funds rely on more volatile short-term liabilities, an aspect which is broadly shared across the EA and and the U.S. This too affects the overall risk and the risk-bearing capacity of different institutional investors.

As far as banks are concerned, the Basel Committee on Banking Supervision (BCBS) is responsible for setting the standards for internationally active banks domiciled in the 28 countries that are members of the Committee. Key elements of the Basel III regulation, whose terms were first published in late 2010 and which are relevant for our sample period, are risk-weighted capital requirements. These requirements have a common minimum component across the EA and the U.S., consisting of the Common Equity Tier 1 (CET1) and the Additional Tier 1 (AT1), which implies a common equity target no lower than 6 percent of risk-weighted assets. There are also surcharges that national regulators can impose, such as bank-specific stress capital buffers, the Pillar 2 requirement assigned by the ECB in the EA, and the capital surcharge for global systemically important banks (G-SIBs) imposed by the Federal Reserve Bank.

Section 3 explains how these differences in mandates and regulatory frameworks affect the construction of our instruments, and, in Section 4, we capture these differences by embedding heterogeneous investors in our theoretical model.

EA Data. To study euro area investors' portfolio adjustment, we use high-quality confidential security-level data collected in the European Central Bank's Securities Holdings Statistics (SHS), a harmonized security-by-security collection of direct portfolio holdings of investors domiciled in the EA for a vast assortment of security classes, including but not limited to government bonds, equities, mutual fund shares, covered bonds. The consistent harmonized data collection process started in the last quarter of 2013 and continues to the present day. Data are quarterly and are reported following the principle of residence of issuer and investor countries. Our sample covers 2014Q1 to 2022Q2.

Importantly, the data collection process is the outcome of a clearly legally regulated

and enforced mandatory reporting protocol, whose administrative details we describe in Appendix A. Several unique characteristics of this dataset are pivotal for our analysis.

First, the data records the holder of each security by country of domicile and by investment sector. Table A1 provides a precise outline of the subsectoral coverage of the SHS and of our classification of each subsector into one of the four main sectors that form the basis of our analysis: monetary financial institutions (MFI) (excluding monetary authorities such as the European Central Bank and euro area national central banks); insurance corporations and pension funds (ICPF), nonbank financial intermediaries (NBFI) (including mutual funds and hedge funds), and a residual category of 'other investors' (OTH), which consists of households, non-financial corporations, and the government sector. For short, we shall interchangeably refer to MFI as 'banks', ICPF as 'insurance', NBFI as 'nonbanks', and OTH as 'households' throughout the paper, a reference to the representativeness of these entities within their respective category. This classification follows the differences across sectors in terms of their core investment mandates.

U.S. Data. In order to study U.S. investors' portfolios, we rely on another high-quality confidential security-level dataset assembled and maintained by the U.S. Department of the Treasury, the Treasury International Capital (TIC) survey. The TIC collects annual detailed position data on holdings of long-term and short-term securities by U.S. resident custodians, broker-dealers, and institutional end-investors who hold foreign securities on their own behalf or for U.S.-resident clients. As in the case of SHS, reporting and filing of the positions data is mandatory and compliance is enforced by the U.S. government. While the survey is available on an annual basis since 2003, we focus on annual data from 2014 to 2022 inclusive to be able to compare to EA investors. The individual security level data provides a wealth of information that we leverage to construct a detailed security-level dataset that consists of several security characteristics, as in the case of the EA.

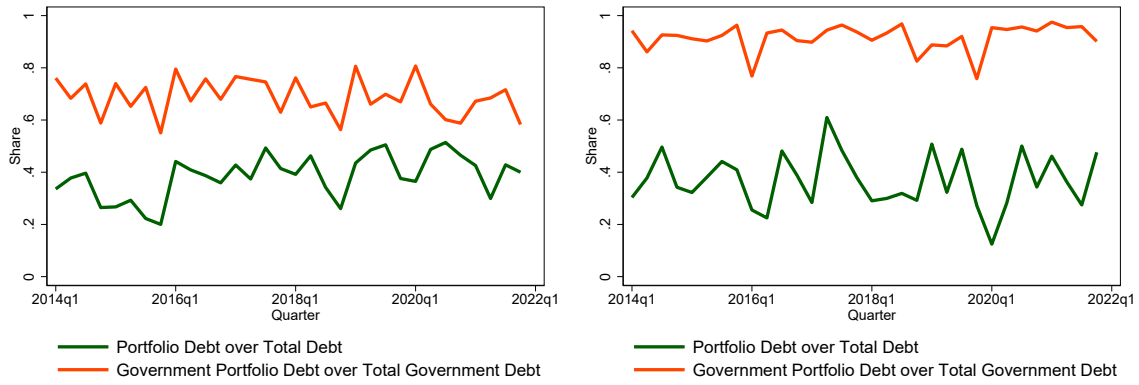
The International Securities Identification Number (ISIN) by which each security is uniquely identified links the holder to the immediate issuer of the security, and SHS contains also information about outstanding amounts per security. In Section 3, we will exploit such micro data information on lenders and as well as borrowers to estimate demand and supply elasticities.

2.2. International Portfolios in Macro and Micro Data

In this section we evaluate international portfolios through the lens of both public macroeconomic statistics and our confidential micro data, particularly for what relates to the asset class (portfolio versus other debt), issuer type (government versus corporate and bank debt), and investor composition (nonbank versus other investors).

We start by examining aggregate statistics available from the IMF's Balance of Payments Statistics. The analysis of aggregate data allows us to benchmark the security level datasets, from the perspective of the borrower, which we use as our primary source. Figure 1, Panel (a), shows that portfolio debt flows captures close to half of all debt flows going into EM, regardless of investors (green line). We know that most of this is borrowed by the sovereigns of the EMs (e.g. Adjiev et al. (2022); Hardy and Lewis (2023)). Thus, focusing only on the government debt of the EM, almost 80 percent is in portfolio debt flows (orange line). Panel (b) plots the same data for AE, where governments exclusively borrow via bonds.

Figure 1
Debt in portfolio flows as a share of outstanding nonresident debt flows.
See Appendix C for detailed notes to this figure.



(a)
EM Debt in Portfolio Holdings

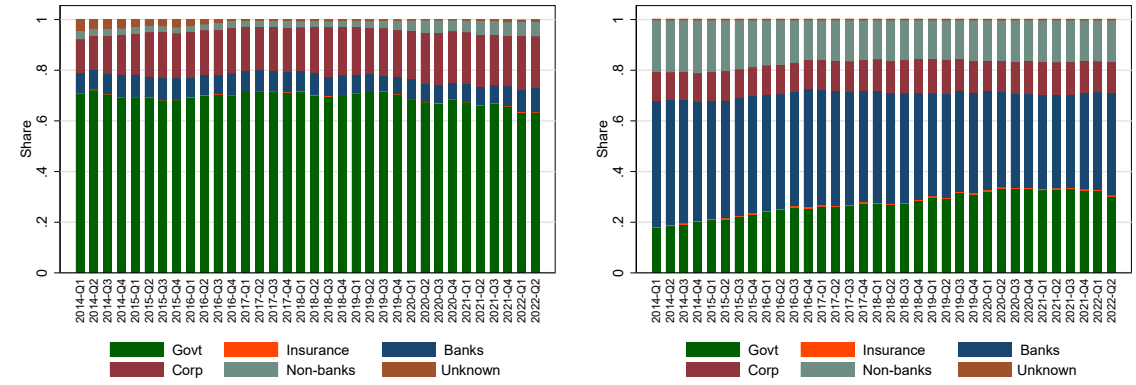
(b)
AE Debt in Portfolio Holdings

In Figure 2 we leverage our micro data to zoom in on the composition of the portfolios of EA and U.S. investors, by issuer types. Issuer types in the figure include governments, insurance companies, banks, nonfinancial corporations, and others. The figure, divided into four panels, shows the share of debt securities issued by each issuer in the portfolios of the investors in our datasets. The two upper panels highlight how most of the holdings

of EA investors in EM securities are in sovereign bonds (Panel (a)) but in AE securities they are mainly in banks (Panel (b)). For U.S. investors, while also most of their holdings in EM securities are in sovereign bonds (Panel (c)), when investing in AE (Panel (d)) they tend to invest mostly and in roughly equal shares in corporates and banks.

Given the prominence of EM sovereign bonds in investor portfolios, we focus mostly on these in data and in our model.

Figure 2
Issuer share in the total portfolio holdings of investors, by country sample
See Appendix C for detailed notes to this figure.

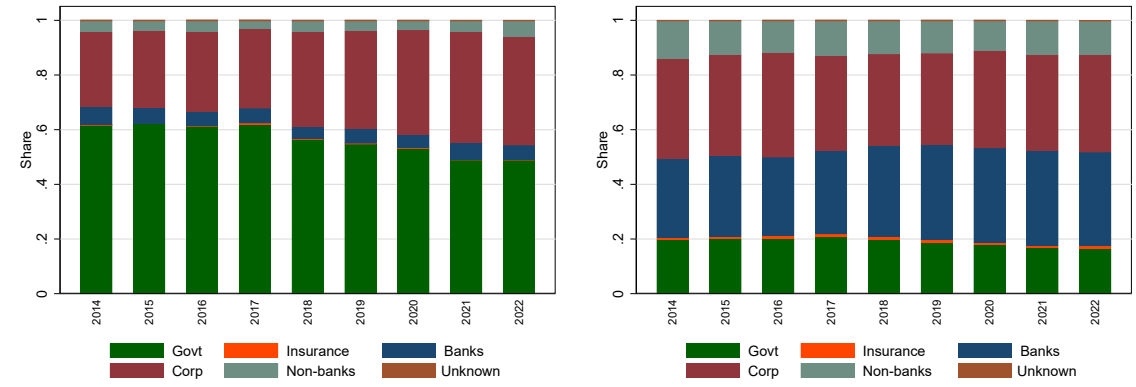


(a)

SHS: EA Holdings in EM Bonds, by Issuer Type

(b)

SHS: EA Holdings in AE Bonds, by Issuer Type



(c)

TIC: U.S. Holdings in EM Bonds, by Issuer Type

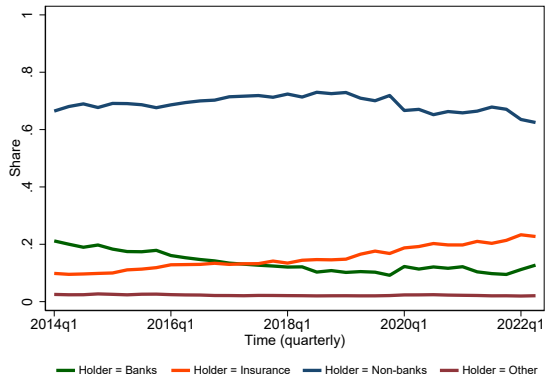
(d)

TIC: U.S. Holdings in AE Bonds, by Issuer Type

Next, we examine the degree of heterogeneity of investors who are active in sovereign debt markets in EM and AE. To this purpose, Figure 3 depicts the relative importance of the four investor types: banks, nonbanks, insurance and other. Regardless of the issuer country, it is evident from all four panels how EA (upper panels) and U.S. (lower

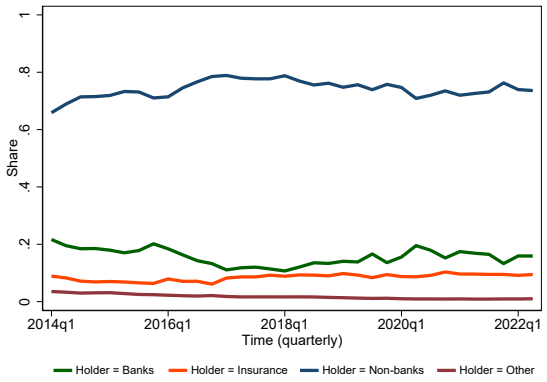
panels) nonbanks (i.e., mainly mutual funds and hedge funds) hold the lion's share of total sovereign debt issuance, followed by banks.

Figure 3
Investor shares in sovereign bonds, by country sample
See Appendix C for detailed notes to this figure.



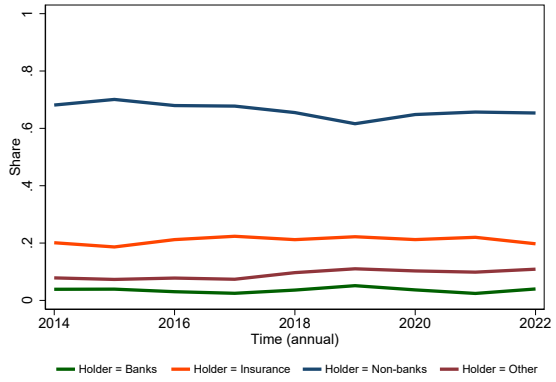
(a)

SHS: EA Holdings in EM Sovereign Bonds, by Investor Type



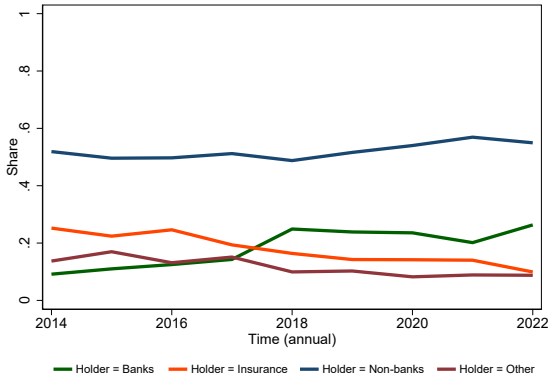
(b)

SHS: EA Holdings in AE Sovereign Bonds, by Investor Type



(c)

TIC: U.S. Holdings in EM Sovereign Bonds, by Investor Type



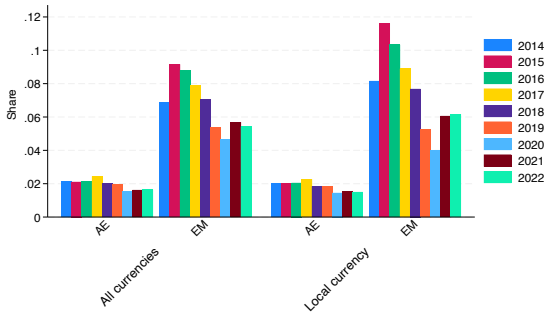
(d)

TIC: U.S. Holdings in AE Sovereign Bonds, by Investor Type

Lastly, in Figure 4 we illustrate the coverage of our final TIC and SHS datasets, by issuer country group and by currency of debt denomination. To do so, we divide the holding amounts recorded in TIC for U.S. (Panel (a)) and EA (Figure (b)) investors by the total outstanding amounts (that is, held by domestic and foreign investors), by issuer country group and by currency of debt denomination. For debt denominated in all currencies, in TIC our coverage hovers around 2 percent for AE and 6-9 percent for EM. In SHS, these values are about 10-12 percent for AE and 20-25 percent. When narrowing down to only debt denominated in local (issuer) currency, in TIC our coverage still hovers around 2 percent for AE and 4-12 percent for EM. In SHS, these values are about 10-12

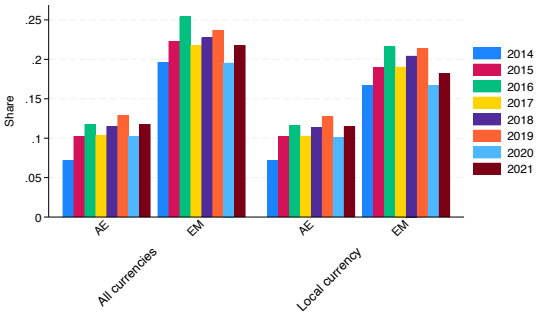
and 18-20 percent. The relatively small coverage for advanced economies is due to the fact that the bulk of the investor base for the sovereign debt of these countries is domestic, consistent with home bias in assets.

Figure 4
Coverage of TIC and SHS datasets over total sovereign debt, by issuer country group and by currency of debt denomination.
See Appendix C for detailed notes to this figure.



(a)

Share of TIC holding amounts in total externally held amount outstanding, by country sample and currency of denomination



(b)

Share of SHS holding amounts in total externally held amount outstanding, by country sample and currency of denomination

3. Empirical Strategy

Our identification builds on the recent methodologies that construct instruments based on plausibly exogenous demand pressure generated by residual market participants either via mutual fund flow Coval and Stafford (2007), Edmans, Goldstein and Jiang (2012), Lou (2012), Van der Beck (2022), Zhou (2024)), or pension fund flow (Jansen (2025)), or via flows from other investors arising from investment mandates, as in the asset demand system approach of Koijen and Yogo (2019). The main tenet behind this methodology is that investors' demand of portfolio shares are not infinite elastic, as traditionally assumed in the asset price literature that studies investors' behavior through the stochastic discount factors and the implied premium that they demand. To estimate elasticity the underlying modeling framework assumes that demand are derived by blending a traditional mean-variance portfolio optimization approach with an IO approach, where each investors takes into account and reacts to residual demand through market clearing conditions. The approach has several realistic implications: shocks do not induce only fluctuations in asset returns and premia, but induced adjustment in portfolio shares, which in turn affect

prices through market equilibrium conditions. Investors' heterogeneity matters as trade occurs to the extent that each faces different shocks, prudential constraints or frictions. Furthermore, large investors can act as strong conduit of large shocks into asset prices. All those implications make the methodology particularly well suited to study the dynamic of portfolio holdings adjustment, jointly with asset prices.

So far this literature has mostly focused on domestic markets and assumed that asset supply is fixed and that asset price movements were due to changes in investors' asset demand, combined with market clearing conditions. The assumption that asset supply is fixed in the short run is very reasonable. However, asset prices, particularly those that determine international adjustment, may heavily depend also on supply.

Our key contribution consists of extending the inelastic asset demand system approach, described above, by allowing for an endogenous supply response. We capture this combined demand and supply elasticities in an empirical three stage approach. We then also present a model, characterized by microfounded and optimizing heterogeneous investors demand and a benevolent government that optimally decides bond issuance, and show that this can provide a structural interpretation of our empirical approach. approach. The first two stages are devoted to identify the investors' demand elasticities, and as investors' are heterogeneous we rely on a Bartik (1991) shift-share exposure measure to distribute exogenous variation in aggregate demand vis-a-vis fixed weights. The third stage is devoted to estimate the supply elasticities.

More specifically, we instrument the arbitrage deviations with the predicted residual aggregate demand, weighted by the initial excess portfolio share. This is akin to a Bartik (1991) exposure of each security to the aggregate demand shocks. Demand elasticities are estimated as the response of the portfolio share of each investor in each security to the instrumented return differentials, controlling for various security characteristics available in our datasets, such as rating and maturity. Finally, the supply elasticities are the estimates of the bond issuance to instrumented return differentials, which from the point of view of the issuer proxy the excess returns requested by investors.

3.1. Estimating the Short-Run Price Elasticity of Demand

In each period $t = 1, \ldots, T$, there are B sovereign securities indexed $b = 1, \ldots, B$ and I investor sectors indexed $i = 1, \ldots, I$. Denote as *residual market participants* the set of investors $-i \in I \setminus i$, for all $i \neq I$, and by $D_{b,i,t}$ the face value of holdings of security b by sector i in period t. Define B_{-i} as set of securities in the *investment universe*, i.e. lying inside of the *investment mandate*, of $-i$. Specifically, let $B_{-i} = \{b \in B \mid \exists j \neq i \in I \, (D_{b,j,t} > 0) \, \exists t \in T\}$. In words, we define B_{-i} as the set of securities which are ever held by at least one of the sectors that are not sector i. For example, if banks are the excluded sector i, and none of the other sectors ever holds security $s \neq b$ over the sample, then s is not included in B_{-i}.

Given the definitions above, sector i's portfolio share in security b at time t can be characterized as the following share

$$w_{b,i,t} = \frac{D_{b,i,t}}{\sum_{b=1}^{B_{i,t}} D_{b,i,t}}, \tag{1}$$

where $B_{i,t}$ denotes the number of securities in which sector i invests at time t.

For all investor sectors $i \in I$ and securities $b \in B$ we compute the *initial* predicted exposure of residual market participants $-i \in I \setminus i$ to security b. We measure such exposure as the period-0 difference between the *actual* portfolio share and the *counterfactual* portfolio share from an equal-weighted benchmark portfolio, where period 0 is the first time security b is ever held by at least one of the sectors in $-i$. The resulting net share is the initial predicted excess portfolio share of security b in the portfolio of $-i$, namely

$$w_{b,-i,0} = \frac{\sum_{j \neq i}^{I} D_{b,j,0}}{\sum_{b=1}^{B_{-i,0}} \sum_{j \neq i}^{I} D_{b,j,0}} - \frac{1}{|B_{-i}|}, \tag{2}$$

where $|B_{-i}|$ denotes the cardinality of the investment universe. In other words, $w_{b,-i,0}$ is the initial portfolio weight that b commands over an average security, which would receive equal weight in an equally-weighted portfolio composed by all securities in which $-i$ *can* invest. Denote the currency wedge on security b with residual time to maturity τ at time

t by $x_{b,t,t+\tau}$. Up to a log-linear approximation, we define the following wedges, which we will refer to throughout the analysis

$$x^{UIP}_{b,t,t+\tau} = r_{b,t,t+\tau} - r^h_{b,t,t+\tau} - \frac{1}{\tau}\left(s^e_{t,t+\tau} - s_t\right), \quad h \in \{EA, US\} \tag{UIP}$$

$$x^{CIP}_{b,t,t+\tau} = r_{b,t,t+\tau} - r^h_{b,t,t+\tau} - \rho_{t,t+\tau}, \quad h \in \{EA, US\} \tag{CIP swaps-based}$$

where $r_{b,t,t+\tau}$ $\left(r^h_{b,t,t+\tau}\right)$ denotes the return in local (foreign/investor home) currency that accrues to the holder of the security at maturity, s_t is the spot exchange rate in units of the foreign currency, $s^e_{t,t+\tau}$ is the expected value of the spot exchange rate at maturity. The term $\rho_{t,t+\tau}$ is the swaps-based forward premium computed by Du, Tepper and Verdelhan (2018) for a swap contract with maturity τ. In Appendix D we show how we compute a measure of the forwards-based CIP wedge, and illustrate our results when this wedge is instrumented for.

We instrument for a generic wedge $x_{b,t,t+\tau}$ by using the predicted residual *aggregate* excess demand for security b

$$z_{b,-i,t} = w_{b,-i,0} \frac{\sum_{b=1}^{B_{-i,t}} \sum_{j \neq i}^{I} D_{b,j,t}}{\sum_{b=1}^{B_{-i,0}} \sum_{j \neq i}^{I} D_{b,j,0}}, \tag{3}$$

Notice how excess portfolio share $w_{b,-i,0}$ defined in (2) is time-invariant at the security level, such that it encapsulates all constant security-level attributes (e.g., liquidity, pledgeability, etc...), and nets out diversification inflows into security b.

In practice, the product between the time-constant security-specific excess portfolio share $w_{b,-i,0}$ and the time-varying face value of all holdings of sovereign securities held by residual market participants, i.e. their *nominal wealth* $\sum_{b=1}^{B_{-i,t}} \sum_{j \neq i}^{I} D_{b,j,t}$, appropriately normalized by initial nominal wealth $\sum_{b=1}^{B_{-i,0}} \sum_{j \neq i}^{I} D_{b,j,0}$, serves as an instrument $z_{b,-i,t}$ that shifts the price of security b by changing the effective (i.e., net of $-i$'s predicted holdings) supply of security b faced by investor i. In other words, the instrument captures the predicted inflow into security b, as residual aggregate demand shifts are *apportioned* to the unit of observation, b. Such identification scheme corresponds to identification "through exogenous shifts" in the language of Borusyak, Hull and Jaravel (2025) and corresponds to the apportioning formula developed in Appendix A.5 therein.

Before proceeding, let us provide a formal analysis of instrument validity. As far

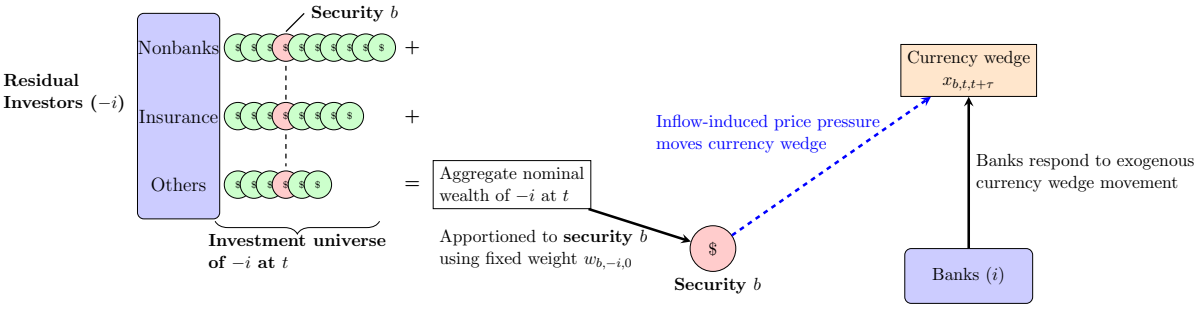
as instrument relevance is concerned, we envisage two separate mechanisms through which the currency wedges are affected. First, the shift in effective supply coupled with downward-sloping demand curves causes the yields in the currency of denomination to increase. Second, for securities issued in a currency other than the investor's home currency, the demand pressure generated by the shock requires the trading desks of financial intermediaries to adjust their positions in currency markets to supply the currency of denomination of the securities, subject to liquidity, leverage, and regulatory frictions which limit their risk-taking capacity, and therefore quantities affect the pricing of currencies as intermediaries demand compensation to take the other side of the trade. These frictions have been extensively documented (see, for example, Chaboud, Rime and Sushko (2023) for a comprehensive review) and modeled, for example in Faia (2007), Gabaix and Maggiori (2015), and Greenwood et al. (2023). As far as instrument exogeneity is concerned, it is satisfied for two separate reasons. Firstly, the initial excess portfolio shares $w_{b,-i,0}$ are constant and do not depend on aggregate shocks which can contemporaneously affect the nominal wealth of the residual market participants and the portfolio share commanded by security b in the portfolio of the investment sector of interest. Secondly, as per the main identifying assumptions in Koijen and Yogo (2019), we assume that the investment universe of investors in $-i$ is exogenously given and that the nominal wealth distribution among investors in $-i$ at t is exogenously given by the assets they hold as per their investment mandate. Lastly, the exclusion restriction is plausibly met to the extent that aggregate demand shifts of investors $-i$ affect asset demand of sector i only through their price impact, that is *exclusively* through the effect they have on the currency wedges.

To fix ideas, we further explain the identification strategy by way of a simple example. Suppose a given security is held by banks, nonbanks, insurance companies, and others. Suppose the investor sector of interest are banks, such that banks are i, and the remaining sectors belong in $-i \in I \setminus i$. Sectors in $-i$ are invested *not only* in the given security, but also in other securities, according to their investment mandate. Summing the face value of all securities they are invested in across securities and across all investors in $-i$ provides a notion of nominal wealth in each period, or differently put, assets under management (AUM) valued at face value instead of marked to market. As per the main assumptions in Koijen and Yogo (2019), our strategy takes the time-varying distribution of nominal wealth across members of $-i$ and their investment mandate as given, and in each period

it generates a *counterfactual* inflow of capital into the given security held by banks, that has nothing to do with true trades of $-i$. Figure 5 provides a graphical illustration of this example.

Figure 5

Identification Scheme



The conditions for instrument validity having been clarified, we run the following sector-level regressions:

$$x_{b,t,t+\tau} = \pi_i z_{b,-i,t} + \nu_t + \xi_c + \phi_{t,c} + \vartheta_m + \theta_r + \varepsilon_{b,t}, \tag{4}$$

$$\log(w_{b,i,t}) = \beta_i x_{b,t,t+\tau} + \nu_t + \xi_c + \phi_{t,c} + \vartheta_m + \theta_r + \eta_{b,i,t}, \tag{5}$$

$\forall i$, where ν_t, ξ_c, $\phi_{t,c}$, ϑ_m, and θ_r are time, issuer country, time-by-issuer country, maturity, and rating fixed effects, respectively. The security level shock is denoted by $\varepsilon_{b,t}$ and the latent demand for security b on the part of sector i is denoted by $\eta_{b,i,t}$. Coefficient β_i represents the *semi-elasticity* of interest.

To obviate the problem of the small number of clusters, following Davidson and MacKinnon (2010) and Finlay and Magnusson (2014), we employ the wild restricted efficient (WRE) bootstrap to construct the Anderson-Rubin (AR) 95 percent confidence intervals around our coefficient estimates, following the guidance in Andrews, Stock and Sun (2019). Such confidence intervals are always robust to weak identification and efficient in our just-identified IV design. Since our clusters have very large size, we rely on the results in Canay, Santos and Shaikh (2021), who find that wild bootstrap-based tests have very good properties in settings in which the cluster size is large, for as few as five clusters (we have 9 clusters in the U.S. sample, 34 in the EA sample).

3.2. Results on Investors' Demand Elasticities

Our baseline results are presented in Tables 1 through 4. For clarity, we divide our results between those based on the SHS dataset and those based on the TIC dataset. We will interchangeably refer to the former as 'EA results' and to the latter as 'US results'. Each column in the tables represents a different sample of securities, EM sovereign bonds in the first two columns from the left and AE ones on the last two columns from the left. Within each country sample, the first column shows results for securities denominated in both the holder's home currency (the euro in the SHS data, and the USD in the TIC data) and the local currency, whereas the second column narrows the sample down to include only those securities denominated in local currency. We restrict our focus to the short and the medium run, and hence only consider securities with 1 through 5 years of residual maturity.

Overall, we uncover significant differences across EA and U.S. investors in their local currency versus dollar and euro bond investments and between emerging markets and advanced countries. Let us then move to comment on the results for individual investors and issuers and discuss their implications.

EA investors. Table 1 shows the estimated elasticities for EA investors in response to an exogenous fluctuation in the UIP wedge. A 1bps increase in the UIP wedge, hence an increase in borrowing costs for the issuer, leads to on average to a 0.58 percent increase in the portfolio share of insurance companies, a 2.1 percent increase portfolio share of mutual funds, and a 1.4 percent reduction in the portfolio share of banks.

However, as noted, there is significant heterogeneity in the elasticities across investors' types. Insurance companies and nonbanks buy up assets, whose unhedged return increases (estimates shown in the second column) whenever the UIP widens. The incentive to increase the exposure in EM bonds is however less pronounced for bonds denominated in local currency (second column), a sign of aversion to currency risk. Banks, on the other side, tend to shed away EM bonds whose UIP deviation widens, although no significant rebalancing is observed when local currency bonds are involved. To summarize, EA-based insurance companies and investment funds buy both euro-denominated and local currency EM bonds under higher UIP deviations, whereas EA banks, like U.S. investors, invest out

of EM bonds whose UIP wedge increases, regardless of the currency of issuance on the bond.

The results on EA insurance companies and nonbank investment funds are especially interesting when those investors are confronted with higher CIP deviations, that indicate higher hedging costs (or more expensive synthetic euros than cash euros). Table 3, for instance, shows the estimates for the specification linking the investors' rebalancing to the CIP deviations for EA investors. Insurance companies, nonbanks, and banks buy securities whose hedging cost unexpectedly ticks up.[2]. Compared to nonbanks, insurance companies exhibit a very sticky demand, in line with other papers (see Koijen et al. (2017) or Bertaut, Bruno and Shin (2021)), that documented a less active rebalancing for those investors.[3] Overall our results point to significant currency risk transfer between heterogeneous investors, without any particular investor bearing the currency risk over the short-run.

US investors. Table 2 shows results for US investors, that exhibit a more homogeneous behaviour. A widening of the UIP wedge generally induces portfolio rebalancing away from emerging market sovereign bonds for all investors. Such broad-based and statistically significant rebalancing is more pronounced for nonbanks than for other investors. As column (1) of the table reveals, all investor types in the U.S. rebalance away from EM dollar-denominated and local currency denominated bonds when the UIP wedge widens.

Noteworthy is the similarity of the rebalancing behaviour of banks across both sides of the Atlantic. This is likely explained by the fact that, following the 2007-2008 financial crisis, regulators in both areas tightened banks' regulations in similar ways, as documented in the regulatory framework of the banking sector explained in Section 2.

When we examine the response of changes in the portfolio shares of US investors in response to CIP deviations (Table 4), results are largely insignificant. A primary reason for that is that the instrument is weak and we can trace this to the underlying economic arguments. The instrument is relevant capturing changes in investors demand, through exogenous changes in arbitrage deviations, when the bond default and currency depreciation risk are proportional to bond issuance, and to demand outstanding. This

2 It should be noted that our instrument in this case is marginally weak for banks, with an effective F-statistic of 10.462

3 Other authors, for example Kubitza, Sigaux and Vandeweyer (2024), have documented more active behaviour of insurance funds. However it shall be noted that their focus was on dollar denominated assets, while ours is on local currency denominated bonds.

case applies well to EME. For AE this proportionality is absent also since dollar assets can be quickly liquidated in secondary markets, due to the persistent high demand of dollar assets.

Table 1

EA: UIP wedge

Dependent variable: Portfolio share, $\log(w_{b,i,t})$	EM + Local & EUR	EM + Local	AE + Local & EUR	AE + Local
Panel A: Insurance				
$x^{UIP}_{b,t,t+\tau}$	0.583**	0.128**	-1.682	-0.959
	[0.272,0.623]	[-0.119,0.190]	[-18.347,-0.856]	[-Inf,+Inf]
Observations	3050	2428	3643	3541
Effective F-statistic	89.526	81.182	2.265	0.632
Panel B: Nonbanks				
$x^{UIP}_{b,t,t+\tau}$	2.074**	1.393**	4.969	6.421
	[0.973,2.736]	[0.716,1.652]	[0.123,14.867]	[0.211,20.952]
Observations	6209	5579	5756	5639
Effective F-statistic	24.676	43.654	1.719	1.227
Panel C: Banks				
$x^{UIP}_{b,t,t+\tau}$	-1.417**	1.313	44.521	-128.256
	[-2.175,-0.945]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	1987	1364	2414	2312
Effective F-statistic	31.804	2.064	0.357	0.052
Panel D: Other				
$x^{UIP}_{b,t,t+\tau}$	5.408	1.070	-0.664	-0.279
	[-Inf,+Inf]	[0.259,2.127]	[-17.317,1.472]	[-14.168,1.811]
Observations	1678	1054	3856	3766
Effective F-statistic	0.404	4.495	2.976	2.701
Quarter FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Quarter x Issuer Country FE	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes
Maturity FE	Yes	Yes	Yes	Yes

Notes: Two stars next to the coefficient estimate denotes statistical significance at the 5 percent significance level. The 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 999 wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010). The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039.

Table 2

US: UIP wedge

Dependent variable: Portfolio share, $\log(w_{b,i,t})$	EM + Local & USD	EM + Local	AE + Local & USD	AE + Local
Panel A: Insurance				
$x^{UIP}_{b,t,t+\tau}$	-1.888**	6.137	-2.300	-1.714
	[-39.992,0.996]	[1.660,16.447]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	1820	1077	1259	1202
Effective F-statistic	12.793	2.581	0.416	1.207
Panel B: Nonbanks				
$x^{UIP}_{b,t,t+\tau}$	-2.163**	5.692	-0.668	0.350
	[-6.708,-1.336]	[0.939,11.868]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	3280	1894	1491	1407
Effective F-statistic	23.886	0.889	0.623	3.058
Panel C: Banks				
$x^{UIP}_{b,t,t+\tau}$	-1.592**	3.776	-44.126	2.109
	[-3.502,-1.196]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	759	309	765	703
Effective F-statistic	13.163	0.190	0.025	1.278
Panel D: Other				
$x^{UIP}_{b,t,t+\tau}$	-2.105**	3.920	-93.099	-4.848
	[-7.584,-1.191]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	2099	731	1043	968
Effective F-statistic	13.630	0.948	0.000	0.658
Year FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Year x Issuer Country FE	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes
Maturity FE	Yes	Yes	Yes	Yes

Notes: Two stars next to the coefficient estimate denotes statistical significance at the 5 percent significance level. The 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 512 wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010). The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039.

Table 3

EA: CIP wedge (swaps-based measure)

Dependent variable: Portfolio share, $\log(w_{b,i,t})$				
	EM + Local & EUR	EM + Local	AE + Local & EUR	AE + Local
Panel A: Insurance				
$x^{CIP}_{b,t,t+\tau}$	0.371**	0.107**	-5.291	-1.932
	[0.188,0.404]	[-0.103,0.166]	[-13.628,-2.214]	[-13.791,-0.706]
Observations	3050	2428	3643	3541
Effective F-statistic	68.095	94.024	3.106	1.814
Panel B: Nonbanks				
$x^{CIP}_{b,t,t+\tau}$	1.168**	1.417**	23.913	20.405
	[0.653,1.211]	[0.683,1.561]	[0.502,28.531]	[0.621,19.958]
Observations	6209	5579	5756	5639
Effective F-statistic	122.972	50.903	1.386	2.080
Panel C: Banks				
$x^{CIP}_{b,t,t+\tau}$	1.775	-10.547	-80.983	-107.407
	[0.757,2.142]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	1987	1364	2414	2312
Effective F-statistic	10.462	0.038	3.357	2.497
Panel D: Other				
$x^{CIP}_{b,t,t+\tau}$	-3.170	6.467	-1.540	-0.580
	[-Inf,+Inf]	[-Inf,+Inf]	[-16.646,3.144]	[-16.457,3.441]
Observations	1678	1054	3856	3766
Effective F-statistic	6.696	0.199	5.010	5.121
Quarter FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Quarter x Issuer Country FE	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes
Maturity FE	Yes	Yes	Yes	Yes

Notes: Two stars next to the coefficient estimate denotes statistical significance at the 5 percent significance level. The 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 999 wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010). The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039.

Table 4

US: CIP wedge (swaps-based measure)

Dependent variable: Portfolio share, $\log(w_{b,i,t})$				
	EM + Local & USD	EM + Local	AE + Local & USD	AE + Local
Panel A: Insurance				
$x^{CIP}_{b,t,t+\tau}$	8.077	5.603	5.242	4.569
	[-Inf,+Inf]	[2.124,19.100]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	1820	1077	1259	1202
Effective F-statistic	0.448	9.846	0.291	0.424
Panel B: Nonbanks				
$x^{CIP}_{b,t,t+\tau}$	-10.490	-47.602	4.476	-2.337
	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	3280	1894	1491	1407
Effective F-statistic	0.805	0.029	0.060	0.164
Panel C: Banks				
$x^{CIP}_{b,t,t+\tau}$	-2.916	-7.361	-31.898	-16.326
	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	759	309	765	703
Effective F-statistic	4.171	0.047	0.192	0.131
Panel D: Other				
$x^{CIP}_{b,t,t+\tau}$	-6.740	7.080	10.049	9.058
	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	2099	731	1043	968
Effective F-statistic	0.973	0.786	0.120	0.326
Year FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Year x Issuer Country FE	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes
Maturity FE	Yes	Yes	Yes	Yes

Notes: Two stars next to the coefficient estimate denotes statistical significance at the 5 percent significance level. The 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 512 wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010). The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039.

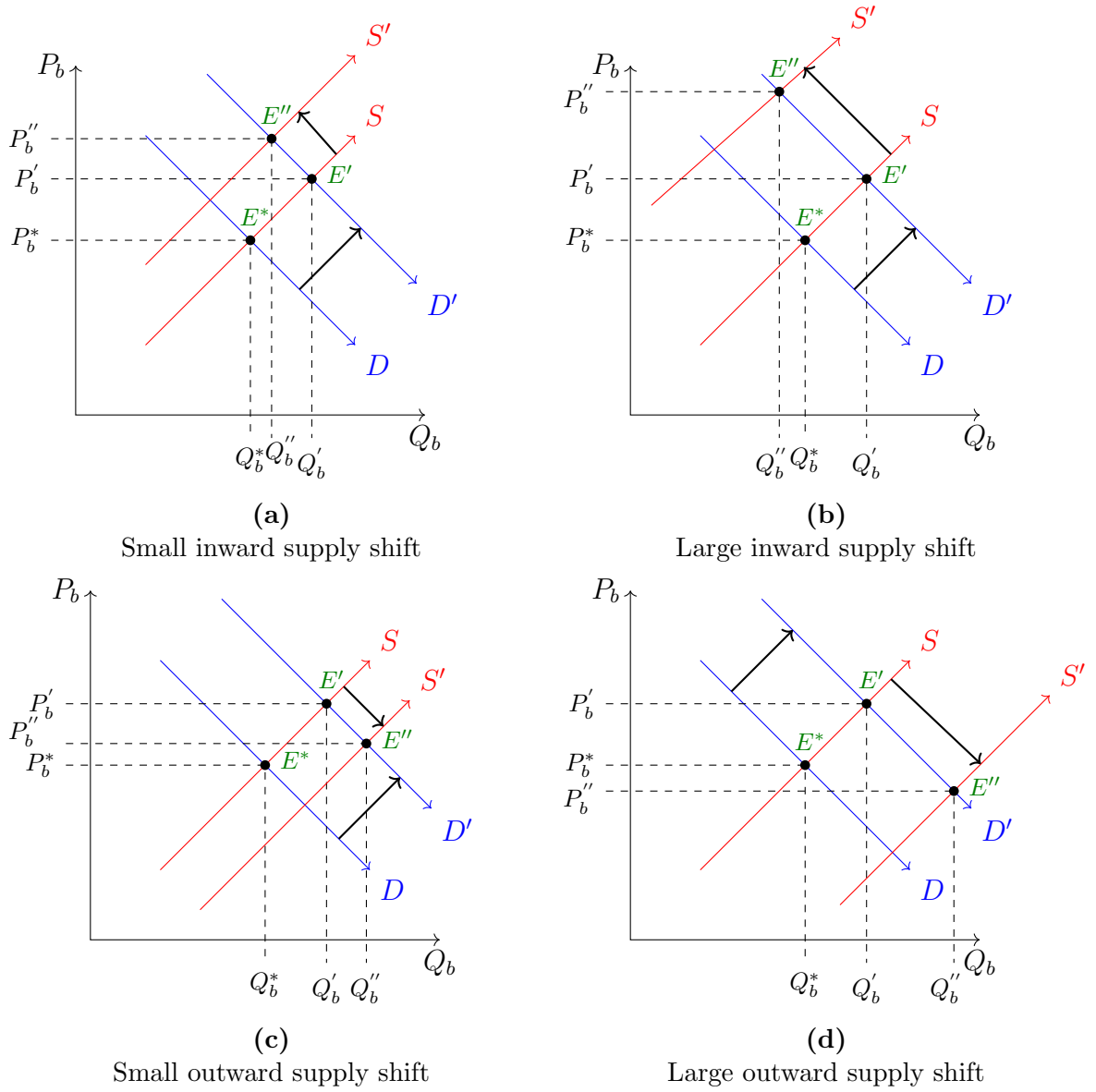
3.3. Estimating the Long-Run Price Elasticity of Supply

This section explains the empirical strategy we implement to compute what we label the *long-run* price elasticity of supply. Such elasticity should be understood as the percentage point change in the growth rate of outstanding amount, after the issuer of security $b \in B$ observes the demand shift originated from an exogenous one basis point increase in the price of the security. Hence this is the security-specific currency wedge.

As we show in Figure 6, there are four possible representative cases. Supply can shift at varying degrees, inward or outward, from S to S' following a given demand shift from D to D'. In each case the equilibrium, which results from the demand and supply adjustment (hence the name *long-run* elasticity), can entail any price-quantity tuple

$E'' = \left(P_b'', Q_b''\right)$, where E denotes the equilibrium set and the primes indicate the sequence of the adjustment iterations. Note that the shape of the demand and supply schedules, shown in the panels, is arbitrarily chosen for illustrative purposes, on account of the fact that our elasticity results are valid in a *local* approximation around the equilibrium.

Figure 6
Possible Supply Reactions to an Outward Demand Shift



(a)
Small inward supply shift

(b)
Large inward supply shift

(c)
Small outward supply shift

(d)
Large outward supply shift

Next we clarify how we recover the average response of the supply in the data. We do so by tracing out the price path that links the empirical counterparts of E and E'', by relying on a counterfactual equilibrium E'.

For all $t \in T$ the initial crossing of supply and demand for security b is denoted in all panels of Figure 6 by equilibrium E^*. Our instrument shifts the demand curve to some

$E^{'}$ (the short-run adjustment). In response the government adjusts its issuance, thereby changing the supply. The point E'' indicates the new equilibrium along the new demand curve (the long-run adjustment).

To implement such sequence of events, we leverage information on outstanding amount $Q_{b,t}$ for each security and quarter. We use this information to construct the specification for the second stage, which reads as follows:

$$\Delta \log (Q_{b,t+1}) = \kappa x_{b,t,t+\tau} + \nu_t + \xi_c + \phi_{t,c} + \vartheta_m + \theta_r + \eta_{b,i,t}. \tag{6}$$

To maximize statistical power, we use the set of securities held by EA nonbanks since it represents the largest and most representative high frequency sample at our disposal. The left-hand side of the equation is the growth rate in the outstanding amount from t to $t+1$. The parameter κ denotes the semi-elasticity. Our results show that a 1bps increase in the security-specific UIP (CIP) wedge implies a reduction of about 0.15 (0.08) percentage points in the growth rate of the outstanding amount, for the sample of securities denominated either in euros or in local currency (the first column of Tables 5 and 6). When we focus on the local currency bonds (columns (2) of Tables 5 and 6), a 1bps increase in the security-specific UIP or CIP wedge reduces the growth rate of outstanding amount of 0.1 percentage points. Although the shock to the currency wedge is generated using the predicted capital inflow by EA investors, the ensuing rebalancing, of *all* global holders of the securities in the estimation sample, allows us to engineer a global demand shock. Our estimates imply that following an increase in the cost of debt, due to the increase in the UIP wedge, government reduce their debt issuance. Overall, the estimates are in line with the adjustment we conjectured in Figure 6.

To understand further the relevance of our estimates let us consider their implications in the case of a shock to the VIX, a typical global factor. Gilchrist et al. (2022) estimate that this shock widens the spread on an investment-grade EM sovereign security by 8 bps. We can then use this number to approximate a realistic increase in the UIP wedges. We computed, in each quarter, the reduction in total EM local currency amount outstanding (in USD), as percent of total EM GDP at current USD, following the same widening in the UIP and CIP wedges and using the estimated elasticities in Tables 5 and 6. After averaging

the resulting numbers over the period 2014Q1-2022Q2[4] we find that EM governments would on average reduce net issuance of local currency debt by approximately 0.26 percent of GDP.

Table 5

Supply: UIP wedge

Dependent variable: Change in amount outstanding, $\Delta \log(Q_{b,t+1})$				
	EM + Local & EUR	EM + Local	AE + Local & EUR	AE + Local
$x^{UIP}_{b,t,t+\tau}$	-0.151**	-0.101**	0.604	0.745
	[-0.239,-0.066]	[-0.145,-0.046]	[0.166,2.227]	[0.185,3.118]
Observations	5989	5385	5476	5361
Effective F-statistic	23.775	42.995	2.130	1.655
Quarter FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Quarter x Issuer Country FE	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes
Maturity FE	Yes	Yes	Yes	Yes

Notes: Two stars next to the coefficient estimate denotes statistical significance at the 5 percent significance level. The 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 999 wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010). The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039.

Table 6

Supply: CIP wedge (swaps-based measure)

Dependent variable: Change in amount outstanding, $\Delta \log(Q_{b,t+1})$				
	EM + Local & EUR	EM + Local	AE + Local & EUR	AE + Local
$x^{CIP}_{b,t,t+\tau}$	-0.080**	-0.101**	2.492	2.223
	[-0.106,-0.036]	[-0.136,-0.040]	[0.604,4.927]	[0.559,3.808]
Observations	5989	5385	5476	5361
Effective F-statistic	122.780	48.045	2.897	3.890
Quarter FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Quarter x Issuer Country FE	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes
Maturity FE	Yes	Yes	Yes	Yes

Notes: Two stars next to the coefficient estimate denotes statistical significance at the 5 percent significance level. The 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 999 wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010). The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039.

4. Model of International Asset Demand and Supply

Our empirical results have the following implications. First, global investors exhibit different elasticities, a fact that may capture different frictions or ability to process risk. This ultimately maybe due to either different regulation or different risk-attitudes of the institutional intermediaries' clientele. Second, the empirical results show that issuance also changes in response changes in asset demand from heterogenous investors. Therefore we aim to build up a model that captures the most salient features of the data: we will then use the model simulated data to replicate the empirical results.

4 We apply the exceptions detailed in Appendix, Table A2

We write down an optimization problem of investors that invest in domestic and international securities and face a simple financial intermediation cost, that may encompass regulation or different risk-attitudes of the clientele. The resulting optimizing conditions lead to a UIP-wedge that depends on the heterogenous frictions. We can also extend this optimization problem by allowing for the choice of currency risk coverage: in this case the investors' optimizing conditions lead to CIPs (see Appendix F). Next, we model endogenous issuance through a Ramsey planner that chooses the optimal amount of debt in local and foreign currency to maximize aggregate welfare. To capture the response of the Ramsey planner to the investors' demand, its maximization is constrained by the resource constraint and by the heterogeous investors' demand, summarized by their UIP. Including the investors' demand among the constraints arises as a natural outcome in model of optimal issuance with the possibility of strategic default a' la Eaton and Gersovitz (1981). In there the default mis-incentives are disciplined by the investors' response or the premium that they require to hold risky bonds. This literature typically entertain the possibility that foreign investors are homogenous and do not face frictions. We extend that literature to include those possibilities. The risk transfer stemming from the investors' costs leads to sticky portfolio demands at a higher cost, which is akin to a form of punishment for the risk of default along the lines of Bulow and Rogoff (1989).

The government of a small open economy can issue debt in local and foreign currency. It chooses the sequence of debt in foreign currency, $\{b_t^\star\}_{t=0}^\infty$, and the debt in local currency, $\{b_t\}_{t=0}^\infty$, the sequence of periods that it defaults, $\{d_t\}_{t=0}^\infty$ to maximize the utility of the households in the economy subject to the budget constraint and by taking the price schedule determined by international investors as given. Income or production in the economy, y, is subject to random shocks that follow an AR(1) process. Hence the government chooses the sequence $\{c, b', b^{*\prime}\}$ to solve:

$$\max_{\{c_t, b_{t+1}, b^*_{t+1}\}_{t=0}^\infty} \sum_{t=0}^{\infty} \beta^t u(c_t), \tag{7}$$

subject to the budget constraint in equation (8)

$$c = y + q(b', b^{*\prime}, e', y, \gamma)b' - b + eq^*(b', b^{*\prime}, e', y, \gamma^*)b^{*\prime} - eb^*. \tag{8}$$

The price schedule for the local currency bond in equation (9) and for the foreign currency bond in equation (10) are defined below

$$q(b', b^{*\prime}, e', y, \gamma) = \frac{1 - \delta(s')}{1 + r} - \frac{e}{E(e')}\gamma b', \tag{9}$$

$$q^*(b', b^{*\prime}, e', y, \gamma^*) = \frac{1 - \delta(s')}{1 + r^*} - \gamma^* b^{*\prime}. \tag{10}$$

The price schedules at which the international investors buy local currency and foreign currency debt arise from market clearing for the debt issuance b' and $b^{*\prime}$ of different investor types as shown in the investor optimization problem below. The investors face investment costs for the local and foreign currency bonds that affect the investor pricing via the aggregate investment cost parameters γ and γ^*. Note that the debt price schedules depend on the total debt issuance in both currency denominations and the exchange rate: the reason is that changes in those affect the government default region and, hence, the default probabilities.

The government decision can be divided into two stages: the default decision, given the forecast that the government makes of the value from default and repayment, and the debt issuance decision, conditional on repayment. Next, we describe each of them sequentially.

Strategic Default. The government can default, and if it does so, it defaults on all of its debt. It repays if the maximized value from repayment, V^R, is bigger than that of default, V^D, conditional on the aggregate states, $s = [y, b, b^*, e, \gamma, \gamma^*]$, hence

$$d = \begin{cases} 0, & \text{if } V^R(s) \geq V^D(s) \\ 1, & \text{otherwise.} \end{cases}$$

The values of repayment and default can be derived as follows. If the government decides to repay, the economy consumes its endowment and borrowed resources, less the repayment of existing borrowing and obtains the discounted future value. If the government decides to default, it faces a default cost and is only able to consume y^d. Additionally, it is

excluded from financial markets and re-enters only with probability θ in the next period with a zero debt position. Hence:

$$V^R(y, b, b^*, e, \gamma) = \max_{b', b^{*\prime}} u(y + qb' - b + \tag{11}$$
$$eq^* b^{*\prime} - eb^{*\prime}) + \beta \int_{y', e', \gamma'} V^0(y, b', b^{*\prime}, e', \gamma') f(\gamma' \mid \gamma) f(y' \mid y) f(e' \mid e) de' dy' d\gamma',$$

where $V^0 = \max\{V^R, V^D\}$. The value of default is

$$V^D(y; y^d) = u(y^d) + \beta \int_{y', e', \gamma'} [\theta V^0(y', 0) + (1-\theta) V^D(y', 0)] f(\gamma' \mid \gamma) f(y' \mid y) f(e' \mid e) de' dy' d\gamma'. \tag{12}$$

The default probability is given by δ over the default set $D(s) = [s : V^R(s) < V^D(s)]$. In this default probability, the government takes into account the expected future realization of income. Given this relationship, the probability of default is given by

$$\delta(s') = \int_{D(s)} f(\gamma' \mid \gamma) f(y' \mid y) f(e' \mid e) de' dy' d\gamma'. \tag{13}$$

International Investors. The government borrows from representative international investors (we use an index i to denote investor types). The investors choose how much to invest in the asset by maximizing profits, π^i, facing investment costs $\Gamma^i(\gamma^i, b') = \frac{\gamma^i}{2}(\frac{b'^2}{E(e')})$ on local currency bonds and $\Gamma^i(\gamma^i, b^{*\prime}) = \frac{\gamma^{*i}}{2} b^{*\prime 2}$ on foreign currency bonds. Those costs may capture the degree of investor risk aversion or regulation. As such, those costs may differ across investors and currency denominations. Some investor types may have stronger regulation constraints or more risk-averse clientele and face larger investment costs for local currency debt relative to the adjustment costs for foreign currency debt.[5] The index i indicates the investor type, which we distinguish according to the adjustment costs they face. The international investors act in competitive markets and take the government default probability as given. To maximize their profits in foreign currency, they choose the amount to invest, $b^{i\prime}, b^{*,i\prime}$

$$\pi^i = \max_{b^{i\prime}, b^{\star,i\prime}} \left[\frac{1-\delta}{1+r} \frac{b^{i\prime}}{e} + \frac{1-\delta}{1+r^*} b^{*,i\prime} - \frac{q}{e} b^{i\prime} - q^* b^{*,i\prime} - \Gamma(\gamma^i, b^{i\prime}) - \Gamma(\gamma^{*i}, b^{*,i\prime}) \right]. \tag{14}$$

Note that since this is a small open economy the risk-free dollar reference rate is the same

5 Foreign currency denotes debt from the perspective of the issuer, which corresponds to local currency, e.g., euro or dollar, for international investors.

for either of the two currency denominations. Furthermore, the default rate applies to the entire debt issuance, hence, it applies equally to both the local currency and the foreign currency bonds. The first order condition for local and foreign currency debt reads as follows:

$$q = \frac{1-\delta}{1+r} - \frac{e}{E(e')}\gamma^i b^{i\prime}; \quad q^* = \frac{1-\delta}{1+r^*} - \gamma^{*i} b^{*,i\prime}. \tag{15}$$

The above relations can be inverted to find the optimal demand of local currency bonds from each investor: $b^{i\prime} = \frac{E(e')}{e}\frac{1}{\gamma^i}\left(\frac{1-\delta}{1+r} - q\right)$ and $b^{*,i\prime} = \frac{1}{\gamma^{*i}}\left(\frac{1-\delta}{1+r^*} - q^*\right)$. The parameter γ^i determines how the investment cost affects the investor pricing of debt. Imposing arbitrage on the returns, or else bond prices, of the domestic and foreign currency denominated bonds, also leads to an expected UIP:

$$\begin{aligned} UIP = q^{*,rf} - q\frac{E(e')}{e} &= \frac{1}{1+r^*} - \left(\frac{1-\delta}{1+r} - \frac{e}{E(e')}\gamma b'\right)\frac{E(e')}{e} \\ &= \frac{1}{1+r^*} - \frac{1-\delta}{1+r}\frac{E(e')}{e} + \gamma b'. \end{aligned} \tag{16}$$

The above relation also aligns well with the one we estimate in the data as it includes proxies that capture the issuer risk of default, which in the data are proxied by issuer fixed effecta and security maturity and rating.

Market Clearing. There are two investor types, whose masses are m_1 and m_2 in the model. Within each investor type, there is a continuum of individual investors. There is a market clearing for debt in each denomination. The market clearing for local currency debt is

$$\int_0^1 b^{1,i\prime}(q, e, \gamma^1)di + \int_0^1 b^{2,i\prime}(q, e, \gamma^2)di = m^1 b^{1\prime}(q, e, \gamma^1) + m^2 b^{2\prime}(q, e, \gamma^2) = b, \tag{17}$$

and for foreign currency debt

$$\int_0^1 b^{*,1,i\prime}(q^*, e, \gamma^{*1})di + \int_0^1 b^{*,2,i\prime}(q^*, e, \gamma^{*2})di = m^1 b^{*,1\prime}(q^*, e, \gamma^{*1}) + m^2 b^{*,2\prime}(q^*, e, \gamma^{*2}) = b^*, \tag{18}$$

where b and b^* are the supply of each debt type, that are optimally chosen by the government and that the individual investors take as given. To arrive at the aggregate demand for local and foreign currency debt, the government takes as given the optimal debt pricing by all investors i. Combining the individual pricing functions with the market

clearing in equation (17) and (18) delivers the following equation, also shown in the government's issuance decision above

$$b' = \frac{1-\delta}{1+r}\frac{E(e')}{e}\Big(\frac{1}{\gamma^1}+\frac{1}{\gamma^2}\Big) - \frac{E(e')}{e}\Big(\frac{1}{\gamma^1}+\frac{1}{\gamma^2}\Big)q \tag{19}$$

$$b^{*\prime} = \frac{1-\delta}{1+r^*}\Big(\frac{1}{\gamma^{*1}}+\frac{1}{\gamma^{*2}}\Big) - \Big(\frac{1}{\gamma^{*1}}+\frac{1}{\gamma^{*2}}\Big)q^* \tag{20}$$

The two equations summarize the investors demand that clear the asset market. Their elasticity to prices also depends on cross-elasticities and reads as follows: $\gamma = \frac{1}{\frac{1}{\gamma^1}+\frac{1}{\gamma^2}}$ and $\gamma^* = \frac{1}{\frac{1}{\gamma^{*1}}+\frac{1}{\gamma^{*2}}}$.

Exchange rate process. To close the model we need to determine the exchange rate. To keep the model parsimonious exchange rates are determined a no arbitrage condition on risk-free rates, which are then determined through an affine structure.[6] Eventually the exchange rate is determined by the following arbitrage conditions: $\frac{e'}{e} = \frac{m'^*}{m'}$. This requires to specify the process for the stochastic discount factor which we model as an affine for which we follows Lustig, Roussanov and Verdelhan (2011). The risk-free discount rates are determined based on one common global risk factor ω, according to the following affine representation:[7] $-log(m') = \tilde{\delta} + \left(\psi + \frac{\lambda^2}{2}\right)\omega + \lambda\omega^{\frac{1}{2}}\epsilon'_\omega$, $-log(m'^*) = \left(1 + \frac{\lambda^{*2}}{2}\right)\omega + \lambda^*\omega^{\frac{1}{2}}\epsilon'_\omega$.

4.1. Model calibration and simulation

The main parameters of the model are calibrated to target US and emerging market data for the EM countries in the empirical sample as shown in Table 7. The parameters linking investment friction and the UIP, as well as the government's debt issuance decision, are used to replicate the empirical results in Section 3. We focus in this section on matching the results for UIP deviations since the results from the demand estimation using CIP deviations based on the U.S. data did not produce strong first stage results (see Table 4).

The calibrated parameters are set as follows. The parameters for the income process match the cyclical component of USD real GDP by EM countries in our sample for the first quarter of 2005 until the fourth quarter of 2019, leaving out the Covid-19 period. The income in the default states is set at 0.8 of mean income to match a low maximum default

6 An alternative would be to include a forex market, but that would require extending the model along other dimensions which present unnecessary complications.

7 ω follows a squared root process as in Cox, Ingersoll and Ross (1985) in line with $\omega' = (1-\xi)\tau + \xi\omega + \sigma_\omega\omega^{\frac{1}{2}}\epsilon'_\omega$ where ϵ_ω is distributed independently and normally with mean zero and variance one.

probability, in line with rating-implied historical default frequencies of the countries in our sample during our reference period 2014-2022. The parameters governing the global risk shock ω, which determines the foreign interest rate and exchange rate process, are based on 1-year US sovereign bonds over the sample period. The parameters governing the relationship between US sovereign yields and EM sovereign risk-free yields are obtained from the estimates of panel regressions of EM yields on US yields for the sample of EM countries, which include country fixed effects. The differential pricing of local and foreign currency risk is chosen so as to target the average expected exchange rate depreciation and the average risk-free UIP deviation of EM yields relative to US sovereign yields, over the sample period. Calibration parameters are summarized in 7.

We then simulate a series of shocks to the parameter capturing intermediation frictions $\gamma = \left(\frac{1}{\gamma_1} + \frac{1}{\gamma_2}\right)$ that follows a Markov process. After each shock the new parameter is $\tilde{\gamma} = \left(\frac{1}{\gamma_1} + \frac{1}{\tilde{\gamma}_2}\right)$, where $\tilde{\gamma_2} > \gamma_2$. The transition probabilities for the Markov process are set to match the persistence and the standard deviations of the estimated residuals from the UIP between EM countries and US 1-year sovereign yields regressed on its lag. The transition probabilities $\pi_{1,1}$ and $\pi_{2,1}$ are obtained from discretizing the AR(1) process for the UIP using the Tauchen (1986) method and based on the two abovementioned parameters over two grid points. The value for the intermediation cost for foreign currency bonds is set to be zero; the shock to the investment cost parameters of the two types of investors increases the aggregate intermediation cost on local currency bonds from 0.02 to 0.0425. This magnitude of intermediation cost yields reasonable UIP deviations in the simulated data that aligns with average UIP deviations found in the data. The government endogenously chooses the amounts to borrow in each currency, $b^{*\prime}$ and $b^{\prime}$, and the timing of the default, taking prices for the foreign and local currency bonds as given.

The model is simulated with 100 issuing countries subject to different income and global risk factor shocks for 10,000 periods. The first 20 generated observations for local and foreign currency securities of each issuer are dropped. The remaining observations are used to estimate the following UIP specification: $x_{b,t}^{UIP} = q_t^{rf,*} - q_{b,t}\frac{E(e_{t+1})}{e_t}$, where q^* is the foreign currency risk-free bond price, q the local currency bond price and e the exchange rate. The aggregate intermediation friction, γ, serves as the instrument $z_{b,t}$ for the UIP deviation. For foreign currency bonds, the UIP represents only the yield differential. This

part of the model estimation procedure corresponds to the first stage of our empirical analysis.

Table 7

Parameter		Value	Target
Persistence y	ρ_y	0.822	USD real GDP cycle component
Std. dev. y	σ_y	0.011	for EM countries 2005q1-19q4
Income in default	y_{def}	0.825	Low average default probability
Time discount factor	β	0.95	Standard coefficient
Prob. reentering fin. markets	θ	2.55%	Match avg. time excluded from financial markets of 9.8 years (Uribe and Schmitt-Grohé, 2017)
Parameters governing exchange rate and interest rate process			
Mean interest rate	ξ	0.0098	1-year US sovereign bond in
Uncond. variance global factor	σ_ω^2	0.0079	sample period 2014-22
Intercept for. and dom. int. rate	$\tilde{\delta}$	0.0369	Relationship US sovereign yield
Slope for. and dom. int. rate	ψ	0.594	and EM sovereign risk-free yields
Local currency risk	λ	2.053	Avg. exchange rate depreciation
Foreign currency risk	λ^*	3.578	Avg. risk-free UIP deviation of EM rel. to US sovereign yields
Parameters governing the Markov process for the aggregate investment friction			
Symmetric transition matrix	$\pi_{1,1}$	0.9631	Evolution of UIP deviation
of friction parameter γ	$\pi_{2,1}$	0.0369	of EM countries

Source: IMF International Financial Statistics, Bloomberg, Refinitiv Datastream.

Notes: The parameters target data during the sample period used for the empirical regressions. The UIP deviations are calculated using one-year sovereign yields and one-year ahead exchange rate expectations. The risk-free rates are obtained by subtracting sovereign credit default swap rates from sovereign yields. The mean reversion parameter of interest rates is estimated by shifting interest rates upwards following Orlando, Mininni and Bufalo (2019) to ensure that interest rates are positive.

To replicate in the model the second stage featured in our empirical analysis, we regress the logged portfolio shares on the predicted UIP deviation from the first stage. The portfolio share, w, is defined as the share of each security in the total portfolio of international investors. In this regression, likewise in the data, we control for time fixed effects, ν_t, that capture common factors affecting all securities, issuer fixed effects, ξ_c, and

other time-varying issuer characteristics and country specific shocks which are summarized in the default probability and global risk factor, represented by $\phi_{c,t}$.

$$x_{b,t} = \pi z_{b,t} + \nu_t + \xi_c + \phi_{c,t} + \varepsilon_{b,t} \qquad \text{(First Stage)}$$

$$\log\left(w_{b,t}^{loc.curr.}\right) = \beta x_{b,t} + \nu_t + \xi_c + \phi_{c,t} + \eta_{b,t} \qquad \text{(Second Stage Demand)}$$

To implement in the model the last stage of our empirical analysis, namely the supply curve estimation, we estimate a specification similar to the one of the second stage, but where the dependent variable is replaced by the log change in the amount issued by the government next period, relatively to the previous period, for each security $\Delta log(Q_{b,t+1})$. The regressor obtained from the first stage remains the same. The specification then reads as follows

$$\Delta \log\left(Q_{b,t+1}\right) = \kappa x_{b,t} + \nu_t + \xi_c + \phi_{c,t} + \eta_{b,t} \qquad \text{(Second Stage Supply)}$$

Results for this estimation procedure are reported in Table 8. Column (1) of the table shows the results of the demand curve estimates, namely the changes in the portfolio shares in response to a UIP shock. The estimates shown in column (1) align, in sign and magnitude, with the estimates obtained in the data for US investor portfolio shares in response to changes in the UIP. Table 8 reports the estimated coefficient from the supply estimates. The estimate reported in column (2) also aligns well with the empirical estimates of the changes in issuance following adjustments in the portfolio of euro area investors, in response to UIP shocks.

Table 8

Foreign & Local currency		
	Dependent variable	
	$\log(w_{b,t})$	$\Delta \log(Q_{b,t})$
	(1)	(2)
UIP	-2.024**	-0.200**
	[-5.179,-1.012]	[-4.266,-0.015]
Observations	1996000	1996000
Effective F-statistic	595	595
Time characteristics	Yes	Yes
Security characteristics	Yes	Yes

Notes: Two stars next to the coefficient estimate denotes statistical significance at the 5 percent significance level. The 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 999 wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010). The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039.

To summarize, the model based regressions replicate well the empirical counterparts, despite the model simplicity. Most importantly, through the lens of the model we can account for the mechanisms underlying the adjustment process. Unexpected changes in arbitrage deviations exogenously shift the portfolio of investors. In turn, governments adjusts their issuance decisions to accommodate changes in international investors' demand.

5. Conclusion

We present and quantify a unified view of the implications of international arbitrage deviations for investors' demand and issuer's supply decisions. Three are our main novelties. First, we estimate demand and supply elasticities for securities held in the portfolios of Euro Area and the U.S. investors. Given our use of confidential data from the ECB and the FED, we cover the universe of investors and their portfolios. Second, our identification strategy can be micro-founded with a dynamic general equilibrium model with optimizing heterogeneous investors' demand decisions and benevolent government issuing decisions. And, third, we extent the asset demand system approach to international assets issued in different currencies, taking into account the endogenous response of supply by the issuer.

Intuitively our approach can be summarized as follows. Exogenous changes in yields differentials for different currency assets, due to either macro shocks or regulatory shocks, trigger a portfolio relabance for all investors, with consequences for the market equilibrium. This induces time-varying changes in investors' demand elasticities, which in turn force government to change their debt issuance.

What we find when we zoom the microscope on investors' heterogeneity is that not all investors respond to arbitrage deviations in the same way, with some of them being shock absorber and some being shock propagators. Differences arise also across the Atlantic. Specifically, we find that all investment sectors in the US rebalance away from EM bonds when the UIP wedge widens, while euro are insurance companies and investment funds weigh in to arbitrage away these uncovered deviations.

Our results have broader implications in terms of two set of distinct but related class of models. On the one side, incomplete markets models studying investors' behavior based on consumers' SDF were used to microfound and study the implications of arbitrage deviations. On the other side, models of optimal sovereign debt issuance were used to study how the incentives for strategic default can affect the premia received by fully elastic investors. We bring together those two traditions, empirically and theoretically, obtaining realistic results especially for EM sovereign bonds. These bonds are mostly traded in secondary international markets by institutional investors facing modern clientele protection mandates, sovereign distress emerges as the interplay of shocks to the investors, which then internalized by the issuing country. These patterns imply changes in risk premia and quantity traded are determined by the combination of investor demand and issuer supply.

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Internet Appendix

A. Securities Holding Statistics from the Euro Area

The Securities Holdings Statistics by sector (SHS) are collected on a security-by-security basis and provide information on securities held by all institutional sectors of euro area investors (with the exception of monetary authorities), broken down by instrument type, issuer country and further security- and sector-specific classifications. These data can be combined with other security-specific-information, e.g. on the currency denomination, rating and maturity. Those are particularly relevant when focusing on emerging market economies as the selection of duration and rating is typically different compared to advanced economies. Moreover, the holdings data can be matched with data on prices and returns allowing us to also decompose the changes in the shares in its various components: valuation, exchange rate changes and transactions.

In what follows we provide a general description of the framework underlying the securities data.

Securities holdings statistics. General Framework The legal basis for collecting SHS data is laid down in Regulation ECB/2012/24, which is further complemented by Guideline ECB/2013/7. Note that the dataset is gathered through a harmonized collection across the central banks of the euro area. To this purpose the second regulation sets out the procedures to be followed by national central banks when reporting to the ECB. The harmonized data have been collected in full since the fourth quarter of 2013[8]. The data, which is at security level, contains the break down by asset type (debt versus equity, including fund shares; debt is further broken down by type of issuer, such as government, non financial corporations, etc.).

The main breakdown of the data is by type/sector of investors (see Table A1). There are in total 22 different type of investors. We focus in particular on debt securities held by banks, insurance companies and pension funds, non-bank financial intermediaries (such as investment funds) and other investors (government, non-financial corporations, households). A key aspect lies in the fact that the data contains both investment in securities issued domestically and abroad: this feature, rarely present in holdings data, allows us to compute the portfolio shares for each investors over their total investment. This aspect is crucial if one wishes to gauge the importance of certain type of investment,

8 Between the first quarter of 2009 and the fourth quarter of 2013, reporting agencies were not obliged to report the data, but many did.

such as that in emerging market securities, relatively to other. Finally, and in relation to the investor characterization note that the securities include holdings by investors residing in the euro area and non-resident investors' holdings of euro area securities that are deposited with a euro area custodian.

The holding information is complemented with the Centralised Securities Database (CSDB) that contains information such as price, issuer name and outstanding amount, precise debt type and issuer information for over six million outstanding debt securities, equities and investment fund shares.

To ensure good data quality, SHS data are regularly checked against comparable data sources, which include the integrated euro area financial and non-financial accounts (EAA), balance of payments and international investment positions statistcs (BoP/IIP), Monetary and Financial Institutions (MFI) balance sheet statistics, insurance corporations and pension fund statistics, investment fund statistics and securities issues statistics, as well as with consolidated banking data.

B. Country sample selection

The empirical analysis and descriptive statistics use narrow samples of emerging market economies and advanced economies. The narrow sample captures countries that are relevant investment destinations for euro area investors, countries for which UIP and CIP can be computed based on data availability and countries for which UIP and CIP deviations are not expected to be large since their exchange rates float freely and there are unified exchange markets at the end of each quarter. In order to arrive at the final sample (see table A2), the following steps are implemented.

- Compute the average holding of government bonds issued by countries held by euro area lenders across all quarters.
- Remove all countries below an average holding of 1bn EUR and keep all countries with both exchange rate forwards or exchange rate expectations.
- **AE sample:** Remove countries with fixed ex-rate (DK), countries that borrow mostly in USD (SG, HK), and countries for which there is no benchmark 1Y local currency bond in Refinitiv or Bloomberg (IS) and remove the U.S.
- **EM sample:** Keep all countries with floating or managed floats (category 3 & 4 of

Table A1

Coverage of Holder Sectors and Underlying Subsectors in the SHS

Holder Sector	**Subsectors (identifier code)**
ICPF	- Insurance corporations (S_128). - Pension funds (S_129). - Other insurance corporations and pension funds (S_12QU).
NBFI (= OFI)	- Other financial intermediaries plus financial auxiliaries plus captive financial institutions and money lenders excluding financial vehicle corporations (S_125W). - Financial vehicle corporations (S_125A). - Non-MMF investment funds (S_124).
MFI	- Deposit taking corporations except central banks (S_122). - Money market funds (MMF) (S_123).
OTH	- Non-financial corporations (S_11). - Households excluding non-profit institutions serving households (S_14). - Non-profit institutions serving households (S_15). - Other households and non-profit institutions serving households (S_1MU). - Central government (S_1311). - State government (S_1312) . - Local government (S_1313). - Social security funds (S_1314). - Other general government (S_13U).

the classification in Ilzetzki, Reinhart and Rogoff (2019, 2022)) and unified exchange markets at the end of each quarter by extending the latest value into the future. Russia is excluded for 2022q1 and 2022q2 even though data for the classification of the exchange rate regime and unified exchange market was not yet available.

Table A2

Country sample for descriptive statistics and UIP/CIP regressions. Countries in gray were removed due to the step-wise sample creation described above.

	Data on forwards, expectations	Final sample
EME	AR, BR, CL, CN, CO, CZ, EG, HR, HU, ID, IL, IN, KE, KR, KZ, LK, MA, MX, MY, NG, PE, PH, PK, SA, PL, RO, RU, TH, TR, UA, ZA	BR, CL, CO, IN, IL, KR, MX, MY, PL, RU (no 14q4-15q4 & 22q1-2), TH, TR (until 18q2), ZA
AE	AU, CA, CH, DK, GB, HK, IS, JP, NO NZ, SE, SG, US	AU, CA, CH (from 15q1), GB JP, NO, NZ, SE

C. Notes to Figures

Figure 1. Portfolio debt inflows are defined as liability flows in the balance of payments and total debt is the sum of portfolio debt and other investment (mainly bank) debt flows. Flows are defined as the absolute value of debt inflows since different inflow components can be positive and negative. *Source*: IMF Balance of Payments.

Figure 2. The portfolio shares are computed from security holdings of investors in EA by issuer type. For each quarter, we sum the holdings of all EA investors at market value and compute the share of securities issued by each issuer type. We compute the shares in the portfolio of all euro area investors separately for issuers from EMs and AEs. We do exactly the same for U.S. investors using TIC holdings data. *Source*: European Central Bank's Securities Holdings Statistics (SHS), and U.S. Department of the Treasury' Treasury International Capital (TIC).

Figure 3. The investor shares are computed from security holdings of sovereign bonds issued by emerging market and advanced economy governments. For each quarter, we sum the holdings of all euro area investors at market value and compute the share of sovereign debt held by each investor type. *Source*: European Central Bank's Securities Holdings Statistics (SHS), and U.S. Department of the Treasury' Treasury International Capital (TIC).

Figure 4. We use data from Arslanalp and Tsuda (2014) to obtain outstanding amounts at the end of each year of foreign held sovereign debt securities denominated in any currency and local currency. We divide the holding amounts recorded in SHS and TIC for euro area and US investors by the outstanding amounts to assess the coverage of our datasets in the outstanding amount of total (both domestically and externally held) sovereign debt for emerging market economy and advanced economy government debt securities (see Appendix B for the country samples). For Israel, we obtain debt securities in any currencies held abroad from the World Bank Quarterly External Debt Statistics and the total amount of debt securities in all currencies from the World Bank Public Debt Statistics to calculate the amount of sovereign debt securities in local currencies held abroad. For New Zealand, we subtract the amount outstanding of foreign currency sovereign debt securities from the BIS international debt securities statistics from total debt securities held abroad to obtain the amount of local currency sovereign debt securities

held abroad. *Source*: European Central Bank's Securities Holdings Statistics (SHS), and U.S. Department of the Treasury' Treasury International Capital (TIC), and Arslanalp and Tsuda (2014).

D. Robustness: CIP Results with Forwards-Based Measure

In this section we explore the robustness of our CIP results when we use a forwards-based measure of the CIP deviation. Let $(f_{t,t+\tau} - s_t)$ be the forwards-based forward premium for a forward contract of maturity τ and forward point $f_{t,t+\tau}$. We thus define the alternative measure of CIP wedge as

$$x^{CIP}_{b,t,t+\tau} = r_{b,t,t+\tau} - r^{h}_{b,t,t+\tau} - \frac{1}{\tau}\left(f_{t,t+\tau} - s_t\right), \quad h \in \{EA, US\} \qquad \text{(CIP forwards-based)}$$

Table A3

EA: CIP wedge (forwards-based measure)

Dependent variable: Portfolio share, $\log(w_{b,i,t})$	EM + Local & EUR	EM + Local	AE + Local & EUR	AE + Local
Panel A: Insurance				
$x^{CIP}_{b,t,t+\tau}$	0.421**	0.114**	-6.134	-2.703
	[0.209,0.470]	[-0.102,0.182]	[-49.325,-2.065]	[-Inf,+Inf]
Observations	3050	2428	3643	3541
Effective F-statistic	74.182	68.581	1.058	0.393
Panel B: Nonbanks				
$x^{CIP}_{b,t,t+\tau}$	1.393**	1.487**	-742.939	172.309
	[0.733,1.552]	[0.722,1.722]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	6209	5579	5756	5639
Effective F-statistic	58.304	36.860	0.001	0.012
Panel C: Banks				
$x^{CIP}_{b,t,t+\tau}$	3.227	-16.414	-66.410	-89.996
	[1.074,7.294]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	1987	1364	2414	2312
Effective F-statistic	2.456	0.007	1.853	1.224
Panel D: Other				
$x^{CIP}_{b,t,t+\tau}$	878.150	3.250	-7.393	-3.127
	[-Inf,+Inf]	[0.476,9.495]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	1678	1054	3856	3766
Effective F-statistic	0.001	0.665	0.076	0.056
Quarter FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Quarter x Issuer Country FE	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes
Maturity FE	Yes	Yes	Yes	Yes

Notes: Two stars next to the coefficient estimate denotes statistical significance at the 5 percent significance level. The 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 999 wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010). The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039.

Table A4

US: CIP wedge (forwards-based measure)

Dependent variable: Portfolio share, $\log(w_{b,i,t})$	EM + Local & USD	EM + Local	AE + Local & USD	AE + Local
Panel A: Insurance				
$x^{CIP}_{b,t,t+\tau}$	-9.370	14.050	7.262	5.460
	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	1820	1077	1259	1202
Effective F-statistic	0.259	0.422	0.166	0.327
Panel B: Nonbanks				
$x^{CIP}_{b,t,t+\tau}$	-5.163	-4.450	-2.543	5.259
	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	3280	1894	1491	1407
Effective F-statistic	2.567	1.919	0.179	0.029
Panel C: Banks				
$x^{CIP}_{b,t,t+\tau}$	-2.462	7.163	-24.258	-8.610
	[-12.066,-0.794]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	759	309	765	703
Effective F-statistic	4.618	0.116	0.599	0.658
Panel D: Other				
$x^{CIP}_{b,t,t+\tau}$	-4.279	23.172	20.599	9.906
	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	2099	731	1043	968
Effective F-statistic	2.516	0.039	0.032	0.313
Year FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Year x Issuer Country FE	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes
Maturity FE	Yes	Yes	Yes	Yes

Notes: Two stars next to the coefficient estimate denotes statistical significance at the 5 percent significance level. The 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 512 wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010). The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039.

Table A5

EA: CIP wedge (forwards-based measure)

Dependent variable: Change in amount outstanding, $\Delta \log(Q_{b,t+1})$	EM + Local & EUR	EM + Local	AE + Local & EUR	AE + Local
$x^{CIP}_{b,t,t+\tau}$	-0.101**	-0.111**	14.431	9.374
	[-0.137,-0.046]	[-0.155,-0.047]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	5989	5385	5476	5361
Effective F-statistic	52.610	31.370	0.033	0.079
Quarter FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Quarter x Issuer Country FE	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes
Maturity FE	Yes	Yes	Yes	Yes

Notes: Two stars next to the coefficient estimate denotes statistical significance at the 5 percent significance level. The 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 999 wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010). The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039.

E. Model Appendix

In this section we provide additional details about the model solution and calibration. We also present one variant of the model which includes global investors that also optimally choose a currency coverage, leading to CIP.

Solution algorithm. The model is solved using value function iteration, within the broader class of collocation methods. The solution algorithm follows the following steps:

1. Generate a discrete grid of the shock state space and another discrete grid for the economy's foreign and local currency bonds. The grids for the income shocks are discretized using the Tauchen (1986) method and the global risk factor is discretized to match a square root process as described in section E. The intermediation cost shocks assumes two values. We choose a uniformly spaced grid for the bonds. Combine the two grids for foreign and local currency bonds to create a joint grid for each combination of foreign and local currency bonds.
2. Guess the value function V and prices for local and foreign currency bonds q, q^*.
3. For given prices q, q^*, solve for the optimal amounts of foreign and local currency bonds, the default decision of the government and compute the value function.
4. Compute the updated prices and check for convergence of the value function. If convergence is not met, go to step 3 using the updated prices.

Simulations are done for 10,000 periods to generate a sequence of values for each exogenous variable for each of the 100 issuers. The exogenous variables include the global risk factor, income, and the intermediation cost parameter. The sequences are determined by the transition probabilities between the states in the Markov chain of each exogenous variable. Based on the sequences of exogenous variables, the simulation generates the values for borrowing in foreign currency $b^{*\prime}$ and local currency b', the default decision and expected default probabilities δ as well as bond prices in foreign currency q^* and local currency q that arise endogenously in the model. We calibrate the exchange rate process used in the simulation leveraging on the literature using affine structures with one global factor (see Lustig, Roussanov and Verdelhan (2011), Bansal (1997); global factor follows Cox, Ingersoll and Ross (1985)).

F. Model with Investors' Hedging Choice

The appendix extends the investor problem to incorporate the choice of currency risk coverage, which gives rise to CIP deviations in the model (other models featuring international investor including CIP deviations are Du and Huber (2024); Kubitza, Sigaux and Vandeweyer (2024)) The investor incurs a cost from the hedging decision that is captured by the parameter a_2, giving rise to CIP deviations via the pricing of local currency bonds. There is a friction on the currency markets captured by the parameter a_1 that governs the average difference between UIP and CIP deviations in the model. The international investors choose $b^{i\prime}, b^{*,i\prime}$, and c to solve the following optimization problem:

$$\pi^i = \max_{b^{i\prime}, b^{\star,i\prime}, c} \Bigg[\frac{1-\delta}{1+r}\frac{b^{i\prime}}{e} + \frac{1-\delta}{1+r^*} b^{*,i\prime} - \frac{q}{e} b^{i\prime} - q^* b^{*,i\prime} - \Gamma(\gamma^i, b^{i\prime}) - \Gamma(\gamma^{*i}, b^{*,i\prime}) \\ + c b^{i\prime} \frac{1-\delta}{1+r^*} \left(\frac{1}{f a_1} - \frac{1}{E(e')}\right) - \frac{a_2 c}{2} \frac{b^{i\prime 2}}{E(e')} \frac{1-\delta}{1+r^*} \Bigg] \tag{F.1}$$

The first order condition for the hedging share c is: $(1 + \frac{a_2 b^{i\prime}}{2}) a_1 f = \theta f = E(e')$. The first order condition for the local currency bond, $b^{i\prime}$, is: $q = \frac{1-\delta}{1+r} - \frac{1-\delta}{1+r^*} \frac{e}{E(e')} \frac{a_2 c}{2} b^{i\prime} - \frac{e}{E(e')} \gamma^i b^{i\prime}$. The first order conditions for the foreign currency bonds, $b^{*,i\prime}$, is: $q^* = \frac{1-\delta}{1+r^*} - \gamma^i b^{*,i\prime}$. Merging the optimal investors' demand with the market clearing conditions delivers the aggregate investors' demand:

$$b = \left(\frac{1}{\frac{1-\delta}{1+r^*}\frac{a_2 c}{2} + \gamma^1} + \frac{1}{\frac{1-\delta}{1+r^*}\frac{a_2 c}{2} + \gamma^2} \right) \frac{E(e')}{e} \left(\frac{1-\delta}{1+r} - q \right). \tag{F.2}$$

We re-write the aggregate demand in terms of price required to hold the assets, obtaining the expression that enters as a constraint the issuer optimization problem:

$$q = \frac{1-\delta}{1+r} - \frac{e}{E(e')} \hat{\gamma} b. \tag{F.3}$$

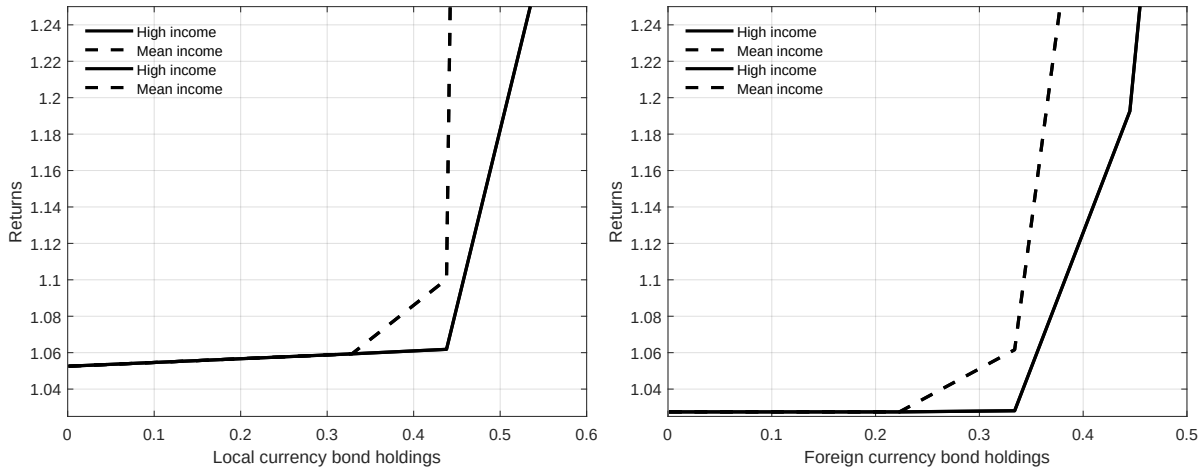
The issuer now chooses the optimal amount of debt taking into account also Equation (F.3). Note that in this context there exist a relation between the UIP and the CIP, which reads as follows:

$$E(UIP) = E\left(q^{*,rf} - q\frac{e'}{e}\right) = q^{*,rf} - q\frac{\theta f}{e} - Cov\left(q, \frac{e'}{e}\right) > CIP \tag{F.4}$$

where the second term is negative and leads to a larger UIP deviation than CIP deviation.

Figure F1 shows the solution to the bond pricing based on the adjusted investor problem using static parameter values for the hedging frictions. The upward-sloping local currency returns in the left panel demonstrate that investor pricing leads to increasing interest rate parity deviations, both driven by the investment cost γ as well as the frictional choice for currency coverage.

Figure F1



(a) Local currency bond returns

(b) For. currency bond returns

Notes: The figures show the equilibrium bond prices for foreign and local currency bonds. Following the data collection for U.S. mutual funds, the appendix uses the average negative hedging ratio of -0.14 from Chen and Zhou (2025) as the calibration target for the share of currency coverage c. The parameter a_1 is set 0.963 to match the average difference in the simulated UIP and CIP deviations based on 10,000 simulated observations to around 300 basis points from the data using 1-year sovereign bonds yields for the U.S. and the EM countries in our sample. The parameter a_2 is set to 0.1 to align with the relationship between forward rates and expected exchange rates, of around 0.97 for the EM countries in our sample, in line with the average local currency bond holdings of around 0.13 for 10,000 simulated observations in the model. The global risk shock determining the exchange rate is set to its mean. The foreign and local currency holdings are constant at close to zero in the figure on local and foreign currency holdings, respectively. High income refers to income shocks 2.5% above the mean. The investment cost γ is held constant. The remaining parameters are shown in Table 7.