Asset Elasticities and Currency Risk Transfer*

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Abstract

We use administrative security-level data from the U.S. and Euro Area (EA) portfolios to estimate asset demand and supply elasticities by exploiting exogenous variation in bond-specific currency wedges. Employing a Bartik-style shift-share identification approach, we document extensive heterogeneity in investor demand responsiveness to exogenous changes in the price of currency risk, conditional on the issuer characteristics. Demand for AE-bonds is always inelastic, whereas for EM-bonds, elasticity depends on investor type and currency: insurance/pension, nonbanks and banks have finite-elastic demand for EM-bonds that are issued in their own (investor) currency. For EM-issuer-currency bonds, only EA non-bank investors increase the share of these bonds in their portfolio when currency wedges widen, suggesting they accept higher currency risk for higher returns. In response, issuers adjust their supply endogenously: an exogenous increase of 8 basis point in currency wedges leads to a 0.26% decline in local currency bond issuance relative to GDP. We develop a theoretical framework where debt issuance decisions take into account heterogeneous demand of investors in terms of their response to changes in the price of currency risk.

Keywords: *FX-local currency bonds, banks and nonbanks, 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. The paper relies on confidential administrative datasets from the US Treasury International Capital (TIC) and the euro area Security Holdings Statistics (SHS-Plus), which have been accessed through coauthors. Other proprietary and administrative datasets, used and matched in the analysis, have been accessed through the ECB (centralized returns database) and Goethe University Frankfurt (Consensus Forecast). We thank Anusha Chari, Oleg Itskhoki, Hanno Lustig, Motohiro Yogo and Haonan Zhou for insightful comments and participants at seminars and conferences. E-mail addresses: *Corresponding author* Sebnem Kalemli-Özcan (sebnem_kalemli-ozcan@brown.edu). Carol Bertaut (carol.bertaut@frb.gov), Ester Faia (faia@wiwi.uni-frankfurt.de), Camilo Marchesini (cmarche5@asu.edu), Simon Paetzold (simon.paetzold@bundesbank.de), Martin Schmitz (Martin.Schmitz@ecb.europa.eu).

1. Introduction

The elasticity of asset demand from global investors is central to understanding issuers' market access, the cost of borrowing, and fiscal stability. A growing literature shows that regulatory constraints, institutional mandates, incentive problems, and market incompleteness can render investor demand inelastic, and—when combined with market segmentation and equilibrium price-setting—can explain persistent deviations from arbitrage conditions (see Koijen et al. (2017), Koijen and Yogo (2019), Gabaix and Koijen (2020), Koijen et al. (2021), Gabaix and Koijen (2023), Gabaix et al. (2025)). Inelastic demand also limits risk sharing, constraining the ability of issuers to place debt without moving prices. Existing empirical work typically estimates demand elasticities using granular instruments—such as shocks to large investors or investor sectors—under the assumption that their portfolio rebalancing triggers price adjustment.

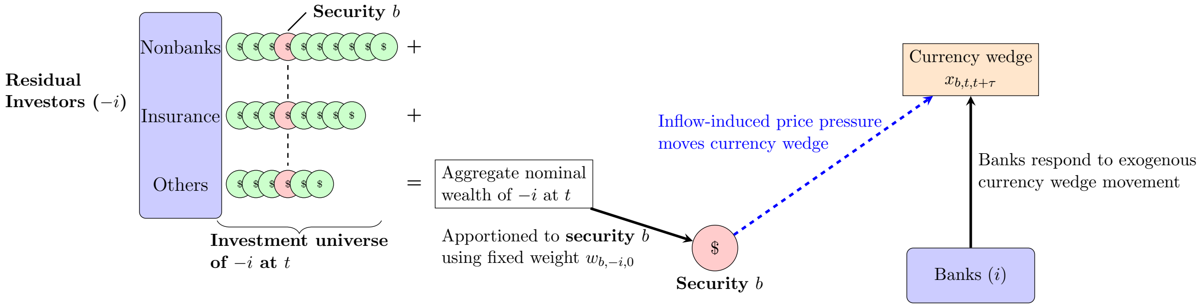
Our paper contributes on two fronts to this literature. First, we introduce a novel Bartik-style shift–share instrument that exploits heterogeneous portfolio rebalancing by investor type in response to synthetic systemic shocks—such as large regulatory changes, quantitative easing programs, or debt-financed fiscal expansions—to identify short-run demand elasticities. The key reason for this instrumentation strategy, instead of the commonly used granular strategy, is that we do not only rely on the mutual funds, but rather have a general approach. This way we can relate portfolio transactions and associated asset prices measured in micro data to macro capital flows. Our instrument has also the added benefit that it can be applied under many shocks and not only used for regulatory and/or Value-At-Risk constraint changes that force mutual funds to re-balance their portfolios, and hence can be used for different investor portfolios and asset classes under different shocks. Our second contribution is to allow for endogenous issuance, as a response to heterogeneous changes in investor demand, enabling the joint identification of short-run demand and long-run supply elasticities.

For both of these contributions, we need security-level data on holdings of U.S. and Euro Area (EA) investors for both advanced economy (AE) and emerging market (EM) bonds. Using such datasets, that cover the universe of investors and asset holdings, and exploiting exogenous variation in bond-specific currency wedges, we, first, estimate the price elasticity of demand. We find pronounced heterogeneity. Both the U.S. and EA investors have elastic demand when bonds are issued in their own currency (dollar or euros) with the exception of insurance companies who feature inelastic demand. Broadly, both set of investors also feature inelastic demand for AE bonds issued in other currencies. Interestingly, only EA nonbanks have elastic demand for EM-currency bonds: upon an increase in the currency wedge, they shift their portfolio towards higher currency risk bonds. Second, we estimate price elasticity of supply. Issuers adjust issuance in response to investor-specific demand, where issuers of EM-currency bonds reduce issuance when currency risk widens.

To conduct this empirical analysis we construct a Bartik (1991) instrument based on a simple theoretical background featuring a general form of inelastic demand, investor heterogeneity and market clearing conditions for each asset. We make the model identification strategy operational in the data as follows. To capture the excess demand for each investor i, we multiply the changes in total nominal wealth invested by all investors, other than the investor i of interest (leave out), in each security at time t, relative to time 0, by the investors' portfolio shares (of the corresponding security) at time zero. The changes in the security's total value, act as a "counterfactual" inflow of capital for investor i, and the time zero investor shares act as an "exposure" to the aggregate shifts in the market portfolios[1]. The latter is measured at time zero preserving the exogeneity with respect to excess returns. The instrument is also highly representative of the variation of excess demand across investors, in response to a shift in market values induced by factors external to the individual investor.[2] Figure 6 provides a graphical illustration for investor i type "Banks".

Figure 1

Identification Scheme



Our data is confidential, captures the universe of Euro Area (EA) and the U.S. investors international portfolio holdings and prices at the security-level, and comes 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 and hence capture representative and more comprehensive information relative to commonly used commercial sources such as Morningstar, FactSet, or PitchBook. To the best of our knowledge there is no other study estimating demand

1 The changes in wealth, relative to time zero or the counterfactual inflow may originate from macro-monetary shocks or from the rebalancing of other large investors.

2 Those arguments are valid only in the short run, that is when asset issuance does not react to changes in prices, as maintained in the literature exploiting granular IV (see Koijen and Yogo (2019) or Gabaix and Koijen (2024). We relax this assumption to estimate long run supply elasticities.

and supply elasticities based on official data covering international investment universe of EA and U.S. investors. By jointly identifying heterogeneous demand elasticities across investor types and the endogenous supply response of issuers, our framework can bridge micro-level portfolio behavior with macro-level patterns in capital flows, providing a unified lens to study the time-varying currency risk premia, portfolio flows and access to international bond markets, while quantifying the associated transfer and sharing of currency risk.

We mostly focus on short-term sovereign bonds with residual maturity of 1-5 years. The main reason for this focus is twofold: (a) As we document, most of the international portfolios of the U.S. and EA area investors is composed of sovereign bonds and not corporate bonds,[3] and (b) for longer maturities, international arbitrage holds (e.g. Lustig, Stathopoulos and Verdelhan (2019)). To estimate demand elasticities for the short-term sovereign bond holdings, our shift-share instrument is used to recover the exogenous variation in international arbitrage deviations, Uncovered and Covered Interest Parities (UIP and CIP), faced by each investor type for a given bond. We then apply a similar instrumentation, but using the amount outstanding from t to $t+1$, (a.k.a new issuance), as the endogenous variable to estimate long-run supply elasticities. Our instrument does not rely on the residual variation of *only large* investor demand in each security, but rather relies on the residual variation of all other investors, except the investor, whose elasticity is being estimated.

While there is quite a bit of heterogeneity by investor type for EM bond demand, demand for AE bonds is always inelastic.[4] Noteworthy is that we condition on issuer×time, bond-specific rating and maturity fixed effects, hence the results are not driven by general issuer risk (that is high average default and currency risk for EMs), but rather bond×time specific. On the supply side, we find that an increase in the currency wedges causes a decrease in the growth rate of the amount outstanding by the issuer. This supply elasticity is 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. These results suggest that the supply of EM bonds is very elastic to global investors pricing of EM currency risk, implying that issuing countries internalize investors' demand elasticities and adjust issuance (supply) accordingly. A decline in issuance implies that

3 Up to 70 (50) percent of EM bond portfolios are in sovereign bonds for the EA (U.S.) investors. And up to 30 (20) percent of AE bond portfolios are in sovereign bonds for the EA (U.S.) investors. The second largest group in AE bond portfolios is banks.

4 We observe insignificant and small responses. This may be due also to the nature of our instrument that is relevant for excess returns when the latter are proportional to the amount of outstanding debt. This condition may not materialize for AE securities due their safe asset status.

the issuer bears most of the currency risk. We dub this phenomenon as the "currency risk transfer".[5]

At last, we build a structural model of bond demand and supply that can motivate our econometric strategy and match the empirical results through simulated data. To capture heterogeneous asset demand elasticities the model features investors that, facing different frictions and operating in segmented markets (Greenwood et al. (2023)),[6] solve a portfolio optimization between domestic and foreign bonds. Asset demand elasticity is dictated by debt-elastic intermediation costs.[7]This in turn leads to arbitrage deviations, which are proportional to the relative size of the investors' frictions. Second, to capture the response of issuance to demand elasticities that we detect in the data, we model bond supply through an optimal issuance decision from a government that takes as given the country resource constraint and the investors' demands and faces productivity risk. Government internalize investors' demand to comply with the incentive compatibility constraint imposed by investors, who fear the possibility of strategic default (see Eaton and Gersovitz (1981)). In our model, less than fully elastic demand due to frictions provides an additional incentive mechanism (see Bulow and Rogoff (1989)). We show that the model equilibrium conditions lead to reduced form equations, which we can use to generate model-simulated data and compare to our empirical estimates, matching those results.

Relation to literature. Our study contributes with a novel empirical causal identification and with structural model foundations to the literature that aims at estimating asset price elasticities addressing the inherent endogeneity of market clearing conditions, where prices and quantities are contemporaneously determined. This literature, which recently goes under the name of the asset demand approach (see Koijen et al. (2017), Koijen and Yogo (2019), Gabaix and Koijen (2020), Koijen and Yogo (2020), Koijen et al. (2021), Gabaix and Koijen (2023), Gabaix et al. (2025)) starts from the premise that investors' demand have finite elasticities[8], heterogenous across investors and jointly with the market clearing conditions[9] determine asset prices. To overcome the endogeneity problem mentioned above they tend to instrument market excess demand with the changes in portfolio shares of large investors (hence the name Granular instrumental variable): the instrument captures exogenous variation from shocks to large investors. We start from the same premises and use the same underlying approach, but we construct a novel Bartik (1991)-style shift-share instrument, that exploits variation of all investor classes'

5 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.

6 We are agnostic on the nature of the frictions, as our strategy is not geared to identify that.

7 See also Bianchi and Lorenzoni (2021) or Bacchetta, Benhima and Berthold (2023).

8 The asset price systems based on stochastic discount factors and their decomposition usually assumes that demand are infinitely elastic.

9 Provided that asset supply is pre-determined in the short run.

demand, also in response to aggregate common shocks. We provide for our instrument both a toy model and a large structural model foundation. Like most of those papers we use administrative data: we scale it up by employing both the universe of US and European securities holdings, albeit focusing on bonds. Our instrument can conceptually accommodate also exogenous demand variation in response to large aggregate shocks, such as those related to quantitative easing policies or debt financed fiscal stimuli: as such it relates our study to works by Greenwood et al. (2023), Stein and Wallen (2023), Kashayp et al. (2025), or Chaudhary, Fu and Zhou (2024)). At last, there are a number of alternative approaches to demand elasticities identification, that are not based on market clearing conditions, but exploit either market segments or events of changes in accounting procedures or large market swings: some examples include Coval and Stafford (2007); more recently Jansen, Li and Schmid (2024), Pavlova and Sikorskaya (2023) or Zhou (2024).

Our study relates to a growing literature that employs securities holding from administrative data to various aspects of international asset pricing, and/or its macro consequences: Fang, Hardy and Lewis (2022), Faia, Salomao and Ventula-Veghazy (2025), Bertaut, Bruno and Shin (2021). Rey et al. (2024) use extensive proprietary data from Morningstar across countries on mutual funds holdings and document various novel and highly informative facts about international asset prices, employing decompositions that are also based on market clearing conditions.

We provide a structural interpretation of our empirical evidence by building on the pioneering sovereign issuance-default models a' la Eaton and Gersovitz (1981)-Arellano (2008). In those models governments internalize the changes in the premium required by investors.[10] We extend this class of models[11] to include investors' heterogeneity and inelastic demand, stemming from portfolio intermediation costs (see Bianchi and Lorenzoni (2021) or Bacchetta, Benhima and Berthold (2023) as examples) linked to regulations or other parts of the mandates. By allowing the government to internalize also the changes in demand (beyond the premium), we formalize the arguments advanced in Bulow and Rogoff (1989), by which further enforcement mechanisms are needed to explain equilibrium repayment. In similar vein, previous work by Broner, Martin and Ventura (2010) argued that secondary markets may provide additional enforcement and empirical evidence by Broner, Lorenzoni and Schmukler (2013) showed that the composition of issuance maturity changes when market spreads increase. The evidence of an adjustment in the supply in response to changes in demand that we uncover, and the related theoretical foundations, contributes to this literature.

10 The investors demand (quantities) in those models are infinitely elastic and homogenous across investors, in line with the general premises of the asset price tradition based on stochastic discount factors.

11 We use our model to replicate the empirical regressions, hence we need to include the equilibrium premium for default which we control for when we instrument the excess currency returns in the data.

Outline. The paper is structured as follows. Section 2.2 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

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

Our analysis exploits two large administrative datasets on securities holdings: the European Central Bank's Securities Holdings Statistics (henceforth, SHS) and the U.S. Department of the Treasury' Treasury International Capital (henceforth, TIC). To harmonize the analyses between the two datasets, our time sample goes from 2014 to 2022. Our datasets contain portfolio holdings respectively of the U.S. and euro area investors in the rest of the world.

Institutional Setting in the EA and in the U.S. The investors included in our dataset choose their portfolio based on different mandates, that is the set of regulations, institutional arrangements and clientele preferences. Therefore it is useful to understand the sources of variation arising from the institutional environment. Moreover, even within each currency area the mandates differ across investors. In most cases regulation also reflects the necessities and preferences of the underlying clientele.

In terms of regulation the main differences across investors' types can be summarized as follows. First, in the EA pension funds are subject to stricter regulations, summarized in the Solvency II Directive, than investment funds. We therefore expect on average lower exposure to risk and stickier portfolios. Second, the Basel Committee on Banking Supervision (BCBS) sets guidelines for the regulations of banks in the 28 countries that are members of the Committee. The guidelines have been revised in three waves, known as Basel I, II and III. The general principles of the Basel III banks' capital requirements are a common minimum component[12] and a set of surcharges that national regulators can impose, some common across the two currency areas and some being different.[13] Those in turn affect how much country and currency risk banks can be exposed to.

EA Data. European Central Bank's Securities Holdings Statistics (SHS) is a harmonized security-by-security collection of direct portfolio holdings of investors domiciled in the EA for all asset classes, including but not limited to government bonds, equities,

12 This consists 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.

13 Examples of those include the 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.

mutual fund shares, covered bonds. The consistent harmonized data collection process started in the last quarter of 2013 and continues to the present day.[14] The harmonized data are quarterly and are reported following the principle of residence of issuer and investor countries. The sample used in our analysis is 2014Q1 to 2022Q2. Importantly, the data collection process is the outcome of a 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.

The data records the holder of each security by country of domicile and by investment sector. Table A1 provides a precise outline of the sector coverage of the SHS and of our classification of each sector into one of the four main sectors that form the basis of our analysis. Those are 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.

U.S. Data. For the U.S. investors we rely on the security holdings dataset assembled and maintained by the U.S. Department of the Treasury, known as the Treasury International Capital (TIC) survey. The TIC collects annual detailed position data on holdings of long-term and short-term securities by the U.S. resident custodians, broker-dealers, and institutional end-investors, who hold foreign securities on behalf of the clientele, or for the U.S.-resident clients. Reporting and filing of the positions data is mandatory and compliance is enforced by the U.S. government. The data from the annual survey are available on an annual basis since 2003. To harmonize the samples with the EA one we focus on the time sample 2014Q1 to 2022Q2. The dataset contains information on the security issuer, on currency denomination, maturity and duration.

2.1. Variable Construction and the Sample of Analysis

In order to compute arbitrage deviations, we match the securities' returns with data from Bloomberg on forward, swap, and spot exchange rates as well as with data on exchange rates expectations at quarterly frequency throughout the reference period obtained from Consensus Forecast. For this reason we include in our sample a set of countries for which we can find consistent data on all those variables. For consistency we include in our sample countries for which foreign exchange markets are unified at the end of each quarter, for which the official exchange rates are fully floating or subject to managed floats following the classification in Ilzetzki, Reinhart and Rogoff (2019) and such that a positive fraction

14 National central banks have been collecting the data since 2003 and at monthly frequencies. The harmonized dataset needed for our analysis starts in 2013.

of total sovereign bond issuance is denominated in euro, in the U.S. dollar, and in local currency throughout the reference period. Furthermore, we include in our sample only securities held by investors that, in both datasets, hold at least the equivalent of one billion in investor currency for the 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, alleviating concerns that estimates may be affected by capital controls. More details are given in Appendix B.

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.

Besides the portfolio holdings data, in our datasets we observe several security characteristics, such as currency of denomination, maturity, and ratings. We use most of them as controls in our regressions of currency wedges on the instrument and portfolio shares on instrumented currency wedges. We discuss the empirical strategy and instrument construction below, where, here, we provide the definitions of the currency wedges.

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 for a contract with maturity τ.

2.2. Facts in International Portfolios from Administrative Data

In this section we document facts about portfolio holdings obtained from the SHS and the TIC datasets. Figure 2 uses the data from IMF's Balance of Payments Statistics to show that portfolio debt flows capture close to half of total debt flows into EM and AE economies and around 80% of the entire international borrowing of governments. Figure 3 shows, using the administrative micro data from SHS and TIC, the share of debt securities, broken down by issuer type[15], in the portfolios of each investor type. The issuers are governments, insurance companies, banks, nonfinancial corporations, and others. Most

15 Note that the classification of the issuing sector is the same as the classification of the investor sector.

of the holdings of EA investors in EM securities are in sovereign bonds or else issued by governments (Panel (a)), while most of the holdings in AE securities are in banks' bonds (Panel (b)). Most of the holdings of the U.S. investors in EM securities are also in sovereign bonds or else issued by governments (Panel (c)), while most of their holdings from AE issuers are in bank bonds (Panel (d)).

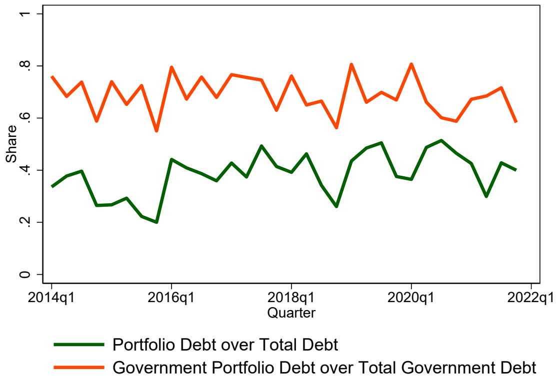
Given the prominence of sovereign bonds in investor portfolios, we focus on those in our empirical analysis.

Next, we examine the degree of investor heterogeneity for sovereign holdings from EM and AE issuers. To this purpose, Figure 4 depicts the relative shares of sovereign bonds for the four investor types, banks, nonbanks, insurance and other. Regardless of the issuer country, EA (upper panels) and the U.S. (lower panels) nonbanks, which are mainly mutual funds and hedge funds, hold the lion's share of total sovereign debt issuance. The next investors in the sovereign markets are banks.

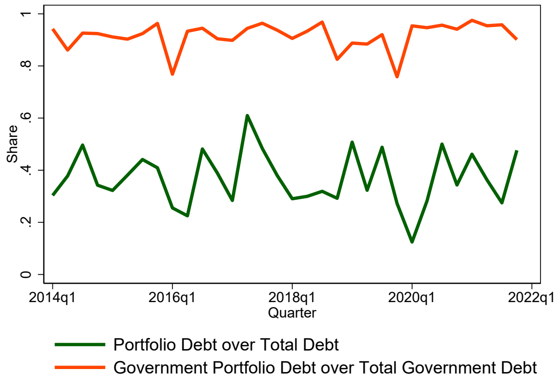
At last, Figure 5 breaks down the holdings of sovereign bonds, over the total amount outstanding, across investors' types. The upper panels plot the data for EA investors, gathered from the SHS, and the bottom panels plot data for the U.S. investors, gathered in the TIC dataset. The U.S. investors hold around 2 percent of AE sovereign outstanding debt and 6-9 percent of EM debt. The corresponding values for EA investors are roughly 10-12 percent for AE sovereign bonds and 20-25 percent for EM sovereign debt. For debt denominated in local (issuer) currency, the U.S. investors hold around 2 percent of AE outstanding debt securities and 4-12 percent of EM's ones. For EA investors these values are about 10-12 and 18-20 percent. Foreign holdings are obviously not a majority, due to the home bias in sovereign debt holdings, however the shares of EA and the U.S. investors combined, or in isolation, are large and shifts in their demand may pose significant challenges to financial and fiscal stability.

Figure 2
Debt in portfolio flows as a share of outstanding nonresident debt flows.

See Appendix C for detailed notes to this figure.



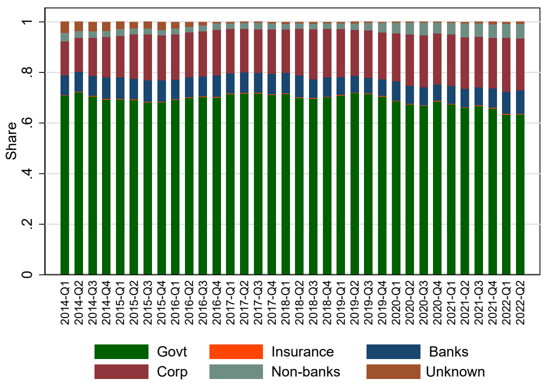
(a)
EM Debt in Portfolio Holdings



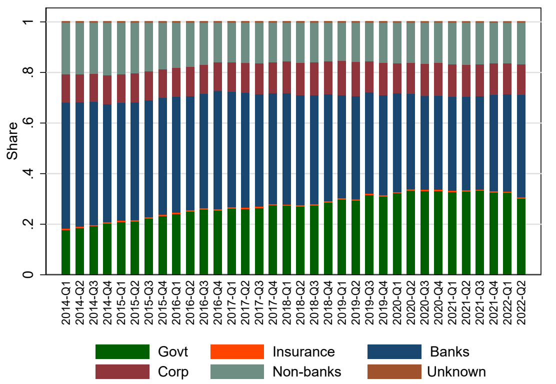
(b)
AE Debt in Portfolio Holdings

Figure 3
Issuer share in the total portfolio holdings of investors, by country sample

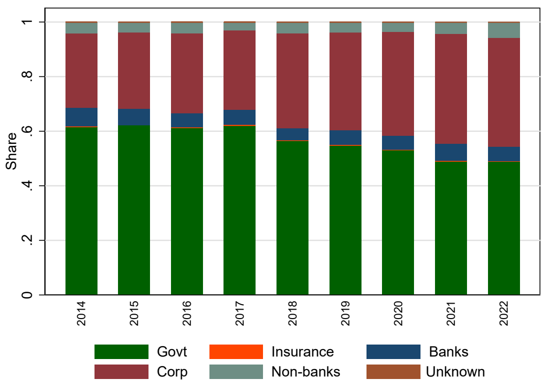
See Appendix C for detailed notes to this figure.



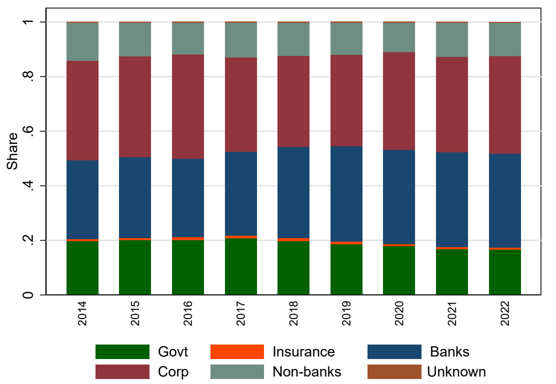
(a)
SHS: EA Holdings in EM Bonds, by Issuer Type



(b)
SHS: EA Holdings in AE Bonds, by Issuer Type



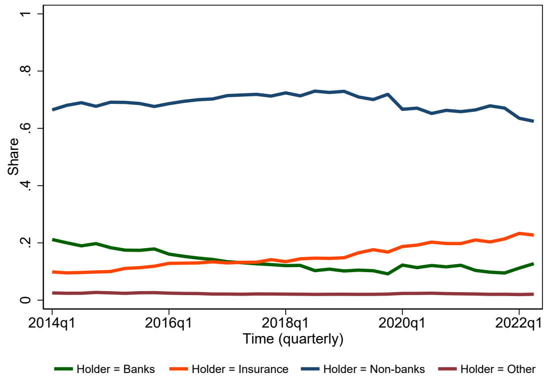
(c)
TIC: U.S. Holdings in EM Bonds, by Issuer Type



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

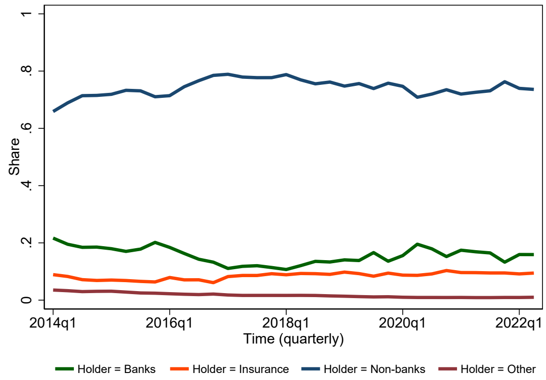
Figure 4
Investor shares in sovereign bonds, by country sample

See Appendix C for detailed notes to this figure.



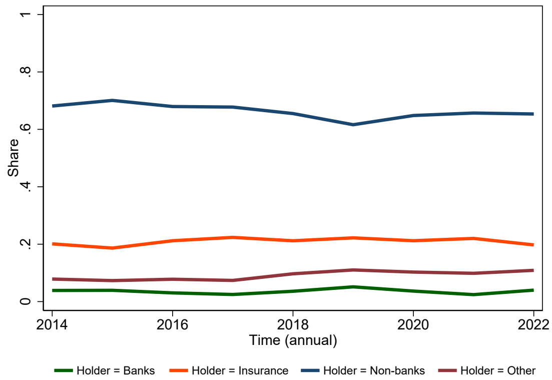
(a)

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



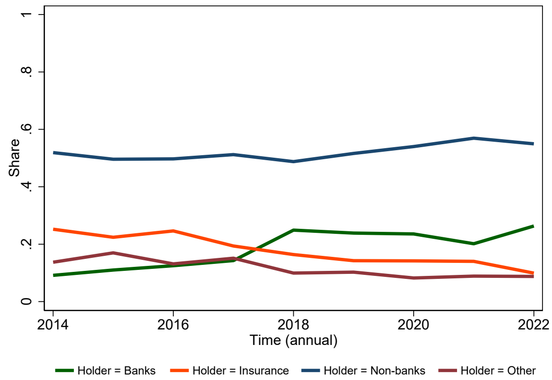
(b)

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



(c)

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

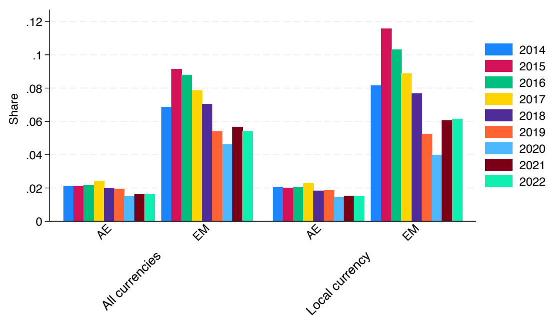


(d)

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

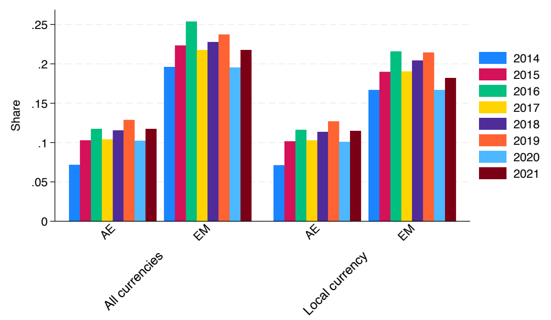
Figure 5
Coverage of TIC and SHS datasets over total sovereign debt, by issuer country group and by currency of debt denomination.

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 overall empirical design consists of three steps. The first two are designed to estimate demand elasticities, the third one to estimate long run supply elasticities.

Our identification of the demand elasticities follows the spirit of the recent methodologies that construct instruments from plausibly exogenous demand pressure, generated by residual market participants. The strategy has been applied to mutual fund (see Coval and Stafford (2007), Edmans, Goldstein and Jiang (2012), Lou (2012), Van der Beck (2022), Zhou (2024)), but also using portfolio data of pension funds (Jansen (2025)) or insurance and pension funds holdings data (see Koijen and Yogo (2019)). The main tenet behind this methodology is that institutional investors' have inelastic demand. This arises in presence of portfolio adjustment frictions, regulatory or value at risk constraints, which are part of institutional investors' mandates. Those in turn differ across investors, hence their demand too responds differently to the same shocks. The latter include, but are not limited to, changes in liquidity due to quantitative easing policies, fiscal adjustments or to the portfolio rebalance of other large investors that face liquidity shocks or tightening regulation. Most of the literature has focused on this last example using as instrument precisely the portfolio rebalance of granular investors, which is large enough to induce a large shift in market excess demand. We take a different and somewhat complementary perspective. Our shift-share instrument relies on the differential exposure of all investors, other than the one involved in the estimation of the demand elasticity, to any change in the market value of the security. The latter may arise from a macro shock or from the rebalance of large investors. We describe the instrument in detail in 3.2 and how it is employed in our three-stage econometric strategy in 3.2.

In a the third stage, we estimate the relation between the supply and arbitrage deviations.

3.1. Conceptual Framework

Consider a finite number of assets i and a finite numbers of investor types or sectors, m, such as insurance and pensions funds, banks or mutual funds. In each investor class, or type, there is a continuum of individual investors, $j \in [0, 1]$. Each sector has some assets under management, w_t^m, at time t, which are pre-determined with respect to the portfolio decisions. The demand for asset i by an institutional investor type m at time t can be obtained from a Min-Var portfolio optimization and reads as follows:

$$x^{i,m}\left(r_t^i, \sigma_t^i, x_t^{-i,-j}\right) = \frac{1}{\gamma^m} \frac{E_t\left[r_t^i(x_t^{-i,-m}) - r_t^f\right]}{\sigma_t^i} \tag{1}$$

where γ^m can be either the intermediaries' clientele risk-aversion, or the Lagrange multiplier associated on a regulatory constraint, $r_t^i\left(x_t^{-i,-m}\right)$ is asset i return, and r_t^f is the risk-free rate, so that their difference is the excess return. In our set-up this refers to the excess return of the currency. Finally, σ_t^i is the variance or risk of asset i valuation/returns.[16] Furthermore, note that the return of asset i depends on the demand of other assets, and by other investors, through the market clearing conditions. Define the total supply of each asset i, available at time t, as s_t^i. A large class of structural model would lead to an upward sloping asset supply, which depends on the asset returns so that $s_t^i\left(r_t^i\right)$. In this context we assume that supply adjust at longer horizons, hence the relation is taken as given and pre-determined from the point of view of the short run demand. In the structural model that we lay down in 4, the asset supply curve is obtained from a the optimization of a benevolent government that maximizes residents' utility subject to resource and limited commitment constraints.

Given the above, and assuming two investor types for simplicity, we can write the market clearing condition for each asset i as follows:

$$\int_0^1 w_t^1 x^{i,1}\left(r_t^i, \sigma_t^i, x_t^{-i,-j}\right) di + \int_0^1 w_t^2 x^{i,2}\left(r_t^i, \sigma_t^i, x_t^{-i,-j}\right) di = s_t^i\left(r_t^i\right) \tag{2}$$

Let us now substitute the optimal demand, 1, into the market clearing condition, 2:

$$\int_0^1 w_t^1 \frac{1}{\gamma^1} \frac{E_t\left[r_t^i\left(x_t^{-i,-m}\right) - r_t^f\right]}{\sigma_t^i} di + \int_0^1 w_t^2 \frac{1}{\gamma^2} \frac{E_t\left[r_t^i\left(x_t^{-i,-m}\right) - r_t^f\right]}{\sigma_t^i} di = s_t^i\left(r_t^i\right) \tag{3}$$

Since individual investors in each of the sectors are atomistic, we can integrate their demand and derive an expression for the excess return, from 3, as follows:

$$E_t[r_t^i\left(x_t^{-i,-m}\right) - r_t^f] = \left[\frac{w_t^1}{\gamma^1} + \frac{w_t^2}{\gamma^2}\right]^{-1} \sigma_t^i s_t^i\left(r_t^i\right) \tag{4}$$

Equation 4 relates the excess returns, $E_t\left[r_t^i\left(x_t^{-i,-m}\right) - r_t^f\right]$, to asset risk, σ_t^i, weighted by the portfolio shares of each investor, the residual demand of other investors and the asset issuance or supply, s_t^i.

Identification Problem. Estimating and identifying the individual security elasticity is subject to an identification problem since its demand depends on the return through the market clearing condition. To see this lets us derive the elasticity of investor m demand of asset i to risk or to a shock by using 2, where we have aggregated across individual investors:

$$x^{i,1}\left(r_t^i, \sigma_t^i, x_t^{-i,-j}\right) = \frac{1}{w_t^1}\left[-w_t^2 x^{i,2}\left(r_t^i, \sigma_t^i, x_t^{-i,-j}\right) + s_t^i(r_t^i)\right] \tag{5}$$

Both the left and the right side of 5 depend on the asset return, which in turn depend on the demand of all other investors. Even if supply is pre-determined at time t the slope of

16 In the empirical specification asset risk, other than currency risk, is proxied through fixed effects for ratings and maturities.

the demand curve with respect to an exogenous shift would depend on the rebalancing of all other investors, which in turn depends on the excess returns that clear the market. This captures the nature of the identification problem. The instruments used in past literature relied on the shift of large investors. The one we consider, and which we describe further below, is a Bartik (1991) instrument through which we proxy the excess returns from the predicted residual aggregate excess demand for each security of all investors, others than the one of interest. This relies on variation in excess demand of all investors.

In this simple model we have assumed that the degree of risk taking as reflecting regulatory constraints or clientele preferences, γ, is constant. It is possible for it to change according to the amount of asset flows that need to be absorbed by the market. Such endogenous changes too would affect the demand elasticity. In the larger structural model we examine further below, the degree of risk taking is endogenous to the amount of investment and we show that model can match well our empirical evidence.

3.2. The Instrument

For each investor we instrument excess demand as its exposure, given by its portfolio share at time zero, to changes in the aggregate nominal value of the asset held by all other investors at time t relatively to time 0. We now explain the rationale, the construction of this instrument and provide arguments for its validity.

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:

$$w_{b,i,t} = \frac{D_{b,i,t}}{\sum_{b=1}^{B_{i,t}} D_{b,i,t}}, \tag{6}$$

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 $-i$:

$$w_{b,-i,0} = \frac{\sum_{j\neq i}^{I} D_{b,j,0}}{\sum_{b=1}^{B_{-i,0}} \sum_{j\neq i}^{I} D_{b,j,0}} - \frac{1}{|B_{-i}|}, \tag{7}$$

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 $x_{b,t,t+\tau}$. As shown before, we define the following wedges:

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

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

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. In Appendix E we compute an alternative measure for CIP wedge using forward rates.

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

$$z_{b,-i,t} = w_{b,-i,0} \frac{\sum_{b=1}^{B_{-i,t}} \sum_{j\neq i}^{I} D_{b,j,t}}{\sum_{b=1}^{B_{-i,0}} \sum_{j\neq i}^{I} D_{b,j,0}}, \tag{8}$$

Note that the excess portfolio share $w_{b,-i,0}$ defined in (7) is time-invariant at the security level. It encapsulates indeed all constant security-level attributes (e.g., liquidity, pledgeability, etc.), and nets out diversification inflows into security b.

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 $\sum_{b=1}^{B_{-i,0}} \sum_{j\neq i}^{I} D_{b,j,0}$, is an instrument, $z_{b,-i,t}$, for the shifts in the security's price in response to changes in market excess demand. It captures the predicted inflow into security b, when residual aggregate demand shifts are *apportioned* to the unit of observation, b. Our instrument uses the variation in exposure to the aggregate time series shock via the predetermined shares. It is a shift-share instrument that is consistent with Borusyak, Hull and Jaravel (2025), specifically their apportioning formula.

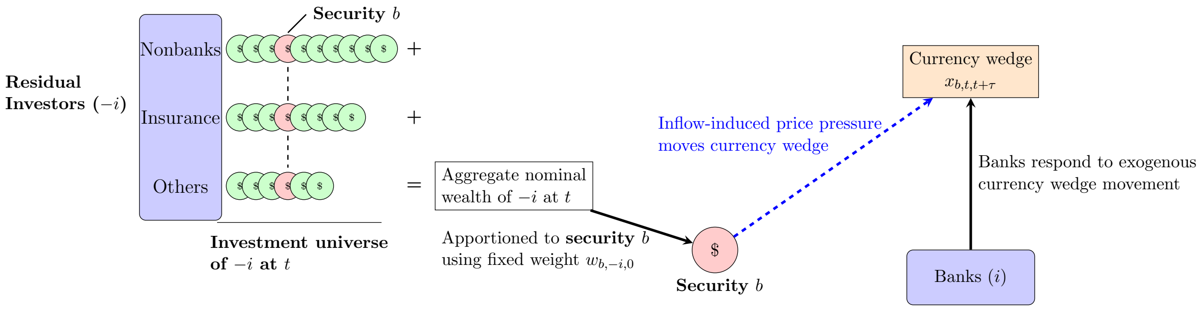
Instrument Validity. The exogeneity of the instrument is supported by arguments on relevance and exclusion. The instrument is weighted by the initial excess portfolio shares $w_{b,-i,0}$, which are predetermined, constant by construction and do not depend on aggregate shocks. Thus, these predetermined shares do not relate to variables that contemporaneously affect the nominal wealth of the residual market participants. Following Koijen and Yogo (2019), the investment universe of investors in $-i$, as well as the nominal wealth distribution among investors in $-i$ at t, is plausibly pre-determined. In addition, our strategy allows for a long run response of the asset issuance (b) to the currency wedges, conditional on assuming supply of b would not instantaneously adjust in the short run.

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 the price impact, that is *exclusively* through the effect on the currency wedges. One concern may be that sector i learns fundamental information about security b, or its issuer, by observing the shift induced by a rebalancing of investors $-i$. This is possible, but if so this would only affect the portfolio decisions of investor i from time t onward, neither of which enters the instrument, which is instead weighted by shares at time zero. The estimated residual from the currency excess return can only convey information that is publicly available to the market.

Figure 6 provides a graphical illustration of the identification strategy, as also noted in the introduction. We are interested in estimating the elasticity of a specific investor asset demand, or portfolio share, to a shock that induces a excess demand from the remaining investors.

Figure 6

Identification Scheme



Empirical model. Formally the econometric specification reads as follows:

$$x_{b,t,t+\tau} = \pi_i z_{b,-i,t} + \nu_t + \xi_c + \phi_{c,t} + \vartheta_t^m + \theta_t^r + \varepsilon_{b,t}, \tag{9}$$

$$\log\left(w_{b,i,t}\right) = \beta_i x_{b,t,t+\tau} + \nu_t + \xi_c + \phi_{c,t} + \vartheta_t^m + \theta_t^r + \eta_{b,i,t}, \tag{10}$$

$\forall i$, where ν_t, ξ_c, and $\phi_{c,t}$ are time, issuer country, issuer country-by-time fixed effects, respectively, while ϑ_t^m and θ_t^r are time-varying residual maturity and rating controls, 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 alleviate concerns that the small number of clusters with a time-based exogenous shift may lead to inaccurate confidence intervals, we employ the wild restricted efficient (WRE) bootstrap to construct the Anderson-Rubin (AR) 95 percent confidence intervals around our coefficient estimates (see Davidson and MacKinnon (2010) and Finlay and Magnusson (2014)). Such confidence intervals are always robust to weak identification (Andrews, Stock and Sun (2019)) and efficient in our just-identified IV design. In the case of large clusters like ours, it has been shown (Canay, Santos and Shaikh (2021)) that wild bootstrap-based tests are asymptotically valid.[17]

3.3. Results on Investors' Demand Elasticities

Our baseline results are presented in Tables 1 through A3. We present separately results for the SHS dataset and for the TIC dataset. We interchangeably refer to the former as 'EA results' and to the latter as 'US results'. We estimate our empirical strategy separately for EM and AE securities. The coefficient of interest is β_i in the specification 10.

The first two columns from the left present the results for the EM sovereign bonds and the last two columns from the left present results for AE sovereign bonds. 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. Note that our focus is on differential investors' exposure to foreign currency risk and the rebalancing that follows.

We estimate demand elasticities in the short and medium run, that is when the identifying assumption of a pre-determined asset supply holds. For this reason our sample includes securities with 1 through 5 years of residual maturity. In the tables, the 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 999 (512 in the TIC dataset) wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010), and clustering at the time level. The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039. A value of the F-statistic above this threshold denotes a strong instrument. Two stars next to the coefficient estimate denote that the estimate is significant at the 5 percent significance level.

Overall, we uncover significant heterogeneity across EA and US investors and across

17 This is true for at least five clusters. In our case there are 9 clusters in the US sample and 34 in the EA sample).

investors' types in their demand elasticity across different currency denomination and between emerging market and advanced economy issued securities.

EA investors. Table 1 shows the estimated elasticities for EA investors in response to an exogenous fluctuation in the UIP wedge.

First, only the portfolio shares of EM securities significantly respond to UIP deviations, while the response of AE securities is largely insignificant. This suggests that only for EM economies investors perceive significant currency risk and rebalance their portfolio in response to changes in the currency pricing, as measured by unhedged return differentials. Instruments are also non-weak only for EM securities.

Second, for EM securities we find that a 1bps increase in the UIP wedge, hence an increase in borrowing costs for the issuer, leads on average to a 0.58 percent increase in the portfolio share of insurance companies, a 2.1 percent increase in the portfolio share of mutual funds, and a 1.4 percent reduction in the portfolio share of banks. The magnitudes are economically meaningful. Their ranking also suggests that the portfolio of insurance and pension funds tends to be stickier than that of other investors. This is understandable in light of their mandates: those investors have long term goals and a risk averse clientele that does not value frequent rebalancing. On the contrary, investment funds tend to be more active, hence their portfolio shares are the most elastic.

The direction of the elasticities to a UIP deviations also varies across investors. Insurance companies and nonbanks buy up assets, whose unhedged return increases (estimates shown in the first column). 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 when the 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 when UIP deviations increase, whereas EA banks, like US investors, decrease the share of EM bonds when the UIP wedge increases. Overall, and complementing the results by Gabaix et al. (2025) we find transfer risk across investors, albeit in some cases limited by the stickiness of the portfolios.

The results on EA insurance companies and non-bank investment funds are especially interesting when those investors are confronted with higher CIP deviations. In this case currency risk is hedged, hence a CIP deviation may indicate an increase in higher hedging costs or more expensive synthetic euros than cash euros or a higher covariance between the returns of the foreign security and the exchange rate (see Bacchetta, Benhima and Berthold (2023)). 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.[18] Compared

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

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)), who documented less active rebalancing for those investors.[19]

US investors. Table 2 shows results for US institutional investors, which exhibit a more homogeneous behavior. As the first column shows, a widening of the UIP wedge generally induces portfolio rebalancing away from emerging market dollar-denominated sovereign bonds for all investor types. Such broad-based rebalancing is more pronounced for nonbanks than for other investors, and least pronounced for insurance companies. Once again, and in parallel with what observed with EA investors, insurance and pension funds have the stickier portfolios, while investment and mutual are the most active. Once again, insurance companies are the most reluctant to shed EM sovereign securities off their portfolios.

Noteworthy is the similarity of the rebalancing behavior 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 in compliance with the Basel requirements, as documented in the regulatory framework of the banking sector explained in Section 2.2.

The estimates for the elasticities of the portfolio shares of US investors to CIP deviations, which we report in Table A3 in Appendix D, are largely insignificant. The instrument is also weak in this case and that may partly explain the insignificant results. There maybe several reasons for this. First, as explained earlier CIP deviations capture costs unrelated to currency risk. Those other costs may not pose significant incentives to rebalance for US investors.

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

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 controls	Yes	Yes	Yes	Yes
Maturity controls	Yes	Yes	Yes	Yes

Notes: 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), clustering at the time level. The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039. A value of the F-statistic above this threshold denotes a strong instrument. Two stars next to the coefficient estimate denote that the estimate is significant at the 5 percent significance level.

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 controls	Yes	Yes	Yes	Yes
Maturity controls	Yes	Yes	Yes	Yes

Notes: 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), clustering at the time level. The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039. A value of the F-statistic above this threshold denotes a strong instrument. Two stars next to the coefficient estimate denote that the estimate is significant at the 5 percent significance level.

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 controls	Yes	Yes	Yes	Yes
Maturity controls	Yes	Yes	Yes	Yes

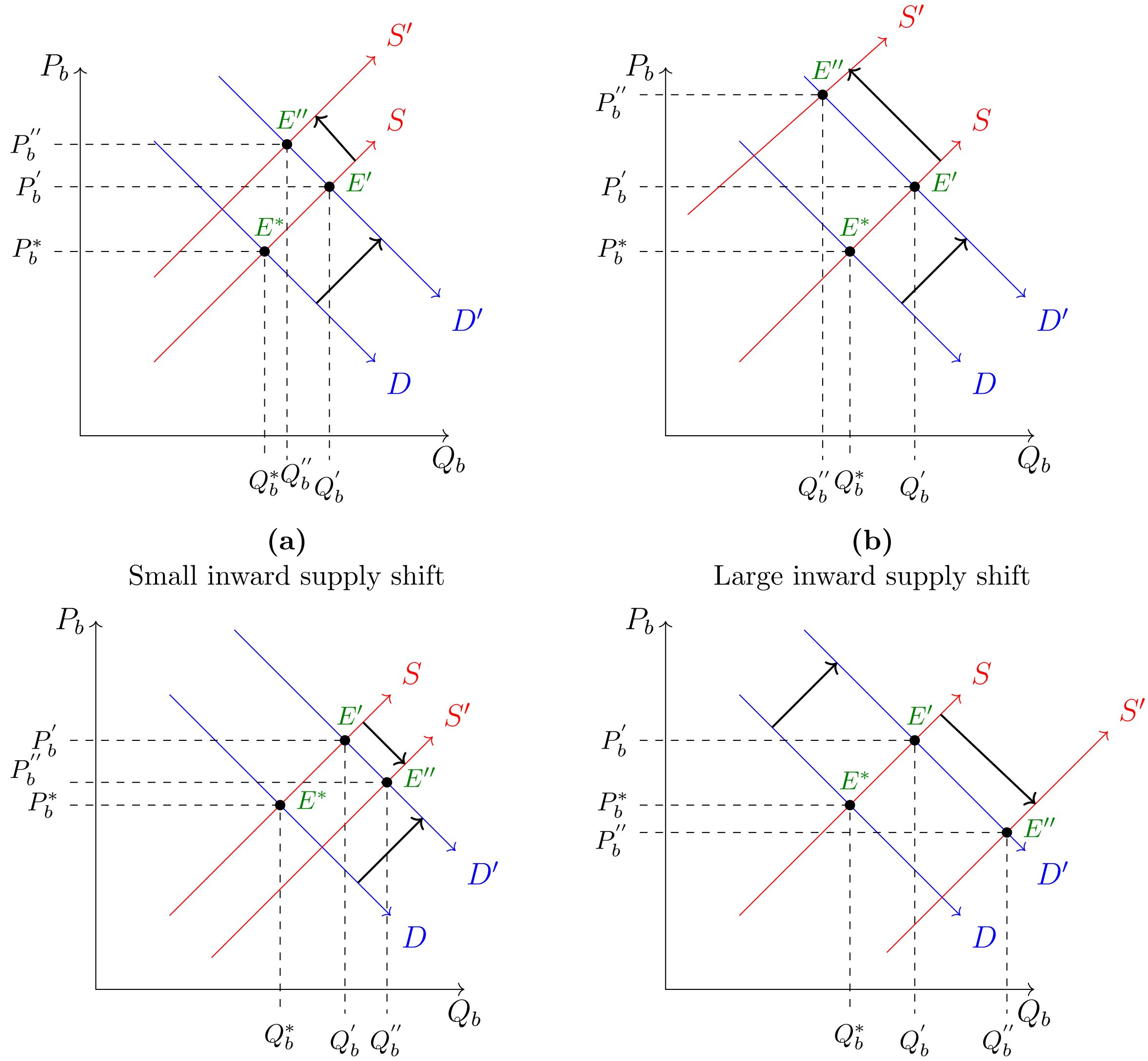
Notes: The 95-percent Anderson-Rubin confidence intervals (Anderson and Rubin, 1949) are reported in square brackets and they are computed using 999 wild restricted efficient bootstrap (WRE) replications following Davidson and MacKinnon (2010), clustering at the time level. The Olea and Pflueger (2013)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

3.4. 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 7, 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 7
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 recover the average response of supply in the data 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 7 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:

$$\Delta \log \left(Q_{b,t+1}\right) = \kappa x_{b,t,t+\tau} + \nu_t + \xi_c + \phi_{t,c} + \vartheta_m + \theta_r + \eta_{b,t}. \tag{11}$$

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 4 and 5). When we focus on the local currency bonds (columns (2) of Tables 4 and 5), 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 7.

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 4 and 5. After averaging the resulting numbers over the period 2014Q1-2022Q2[20] we find that EM governments would on average reduce net issuance of local currency debt by approximately 0.26 percent of GDP.

20 We apply the exceptions detailed in Appendix, Table A2

Table 4

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
$x^{UIP}_{b,t,t+\tau}$	-0.154**	-0.103**	0.578	0.706
	[-0.248,-0.067]	[-0.150,-0.046]	[0.166,1.681]	[0.187,2.378]
Observations	6025	5419	5511	5396
Effective F-statistic	23.507	41.096	2.282	1.828
Quarter FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Quarter x Issuer Country FE	Yes	Yes	Yes	Yes
Rating controls	Yes	Yes	Yes	Yes
Maturity controls	Yes	Yes	Yes	Yes

Notes: 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), clustering at the time level. The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039. A value of the F-statistic above this threshold denotes a strong instrument. Two stars next to the coefficient estimate denote that the estimate is significant at the 5 percent significance level.

Table 5

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
$x^{CIP}_{b,t,t+\tau}$	-0.081**	-0.103**	2.397	2.150
	[-0.111,-0.036]	[-0.142,-0.040]	[0.577,4.632]	[0.549,3.755]
Observations	6025	5419	5511	5396
Effective F-statistic	127.565	47.641	2.860	3.810
Quarter FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Quarter x Issuer Country FE	Yes	Yes	Yes	Yes
Rating controls	Yes	Yes	Yes	Yes
Maturity controls	Yes	Yes	Yes	Yes

Notes: 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), clustering at the time level. The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039. A value of the F-statistic above this threshold denotes a strong instrument. Two stars next to the coefficient estimate denote that the estimate is significant at the 5 percent significance level.

4. A Model of International Asset Demand and Supply

Our empirical strategy was devised to estimate demand and supply elasticities. We now devise a structural model, whose reduced forms underlie our econometric strategy. The model also captures the main implications and facts gathered in the data, and its simulated data are used to verify whether it matches the empirical results.

Our empirical analysis had the following main implications. First, global investors exhibit different elasticities, a fact 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 to changes in asset demand from heterogeneous investors, a fact which implies that issuing countries internalize the investors' demand elasticities beyond the returns required to hold currency risk.

Given the above, investors in the model feature 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, together with arbitrage, lead to a UIP wedge that depends on the heterogeneous frictions. Those frictions make investors' demand inelastic.[21] Equilibrium in the asset markets is achieved through a set of market clearing conditions, one for each assets. Bond supply in the model is determined by the optimizing decision of an issuing country.

A Ramsey planner chooses the optimal amount of debt in local and foreign currency to maximize aggregate welfare, subject to the country resource constraint, a process for TFP and a set of conditions that arise from merging investors' asset demand and the market clearing. In the model we allow for the possibility of strategic default a' la Eaton and Gersovitz (1981). The main reason for this is to parallel the empirical strategy, which controls for default and issuer risk. In practice the no-default constraint, required in models with strategic defaults, implies that the government takes into account the default premium requested by investors. In the context of our model this premium depends also on investors intermediation costs (we adopt the formulation in Bacchetta, Benhima and Berthold (2023)) and on the conditions that clear the asset markets. This implies that our planner faces additional constraints that act as discipline devices (see Bulow and Rogoff (1989) on arguments for the need of additional discipline devices to explain enforcement). Indeed the investors' inelastic demand implies that the government cannot issue any desired amount at the requested premium, but may have to reduce supply if the market would not absorb it. This aspect is key in capturing the evidence of an elastic supply that we uncovered in our empirical analysis.

Issuance Optimization Problem. 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 resource constraint and the bond residual demand summarized by the investors' price schedules (which we also call also investors' demand) and the market clearing conditions. 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:

$$\max_{\{c_t, b_{t+1}, b^*_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t u(c_t), \tag{12}$$

subject to the budget constraint in equation (13)

$$c = y + q(b', b^{*\prime}, e', y, \gamma)b' - b + eq^*(b', b^{*\prime}, e', y, \gamma^*)b^{*\prime} - eb^*. \tag{13}$$

21 We can also extend this optimization problem by allowing for the choice of currency risk coverage to get a CIP wedge as shown in Appendix G.

The price schedule for the local currency bond in equation (14) and for the foreign currency bond in equation (15) are defined below:

$$q(b', b^{*\prime}, e', y, \gamma) = \frac{1 - \delta(s')}{1 + r} - \frac{e}{E(e')}\gamma b', \tag{14}$$

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

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, derived in the investors' optimization problem described further below. The investors face investment costs for the local and foreign currency bonds, which 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. The first is then disciplined by an incentive compatibility constraint. 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 can only 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:

$$V^R(y, b, b^*, e, \gamma) = \max_{b', b^{*\prime}} u(y + qb' - b + \tag{16}$$
$$eq^* b^{*\prime} - eb^{*\prime}) + \beta \int_{y', e', \gamma'} V^0(y, b', b^{*\prime}, e', \gamma') f(\gamma' \mid \gamma) f(y' \mid y) f(e' \mid e) de' dy' d\gamma',$$

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

$$V^D(y; y^d) = u(y^d) + \beta \int_{y',e',\gamma'} [\theta V^0(y', 0) + (1-\theta) V^D(y', 0)] f(\gamma' \mid \gamma) f(y' \mid y) f(e' \mid e) de' dy' d\gamma'. \tag{17}$$

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:

$$\delta(s') = \int_{D(s)} f(\gamma' \mid \gamma) f(y' \mid y) f(e' \mid e) de' dy' d\gamma'. \tag{18}$$

International Investors. The government borrows from international investors. They are heterogenous ex ante as they face different intermediation costs (see Bacchetta, Benhima and Berthold (2023) or Bianchi and Lorenzoni (2021)). The index i denotes investors' types. The investors choose the amount of domestic and foreign currency bonds[22] by maximizing profits, π^i and 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 and they differ across investors. The index i indicates the investor type, which we distinguish according to the adjustment costs they face. The international investors take the government default probability as given. To maximize their profits in foreign currency, they choose the amount to invest, $b^{i\prime}, b^{*,i\prime}$

$$\pi^i = \max_{b^{i\prime}, b^{*,i\prime}} \left[\frac{1-\delta}{1+r} \frac{b^{i\prime}}{e} + \frac{1-\delta}{1+r^*} b^{*,i\prime} - \frac{q}{e} b^{i\prime} - q^* b^{*,i\prime} - \Gamma(\gamma^i, b^{i\prime}) - \Gamma(\gamma^{*i}, b^{*,i\prime}) \right]. \tag{19}$$

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

$$q = \frac{1-\delta}{1+r} - \frac{e}{E(e')} \gamma^i b^{i\prime}; \quad q^* = \frac{1-\delta}{1+r^*} - \gamma^{*i} b^{*,i\prime}. \tag{20}$$

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

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

on the returns, or else bond prices, of the domestic and foreign currency denominated bonds, also leads to an expected UIP:

$$UIP = q^{*,rf} - q\frac{E(e')}{e} = \frac{1}{1+r^*} - \left(\frac{1-\delta}{1+r} - \frac{e}{E(e')}\gamma b'\right)\frac{E(e')}{e} \tag{21}$$
$$= \frac{1}{1+r^*} - \frac{1-\delta}{1+r}\frac{E(e')}{e} + \gamma b'.$$

Likewise in the econometric specification, the above relation includes proxies that capture the issuer risk of default.

Market Clearing. In the tradition of models for asset demand systems (see early work by Kouri and Porter (1974)) equilibrium is achieved through market clearing. To fix ideas we describe them with two investor types, whose masses are m_1 and m_2 in the model. The simulation will feature a larger but finite number of them. Within each investor type, there is a continuum of individual investors. The market clearing condition for local currency debt is:

$$\int_0^1 b^{1,i\prime}(q,e,\gamma^1)di + \int_0^1 b^{2,i\prime}(q,e,\gamma^2)di = m^1 b^{1\prime}(q,e,\gamma^1) + m^2 b^{2\prime}(q,e,\gamma^2) = b, \tag{22}$$

and for foreign currency debt:

$$\int_0^1 b^{*,1,i\prime}(q^*,e,\gamma^{*1})di + \int_0^1 b^{*,2,i\prime}(q^*,e,\gamma^{*2})di = m^1 b^{*,1\prime}(q^*,e,\gamma^{*1}) + m^2 b^{*,2\prime}(q^*,e,\gamma^{*2}) = b^*, \tag{23}$$

where b and b^* are the supply of each debt type, that are optimally chosen by the government as described above and that the individual investors take as given. Combining the individual pricing functions with the market clearing in equation (22) and (23) delivers the following equation which was included among the government optimization constraints:

$$b' = \frac{1-\delta}{1+r}\frac{E(e')}{e}\left(\frac{1}{\gamma^1} + \frac{1}{\gamma^2}\right) - \frac{E(e')}{e}\left(\frac{1}{\gamma^1} + \frac{1}{\gamma^2}\right)q \tag{24}$$

$$b^{*\prime} = \frac{1-\delta}{1+r^*}\left(\frac{1}{\gamma^{*1}} + \frac{1}{\gamma^{*2}}\right) - \left(\frac{1}{\gamma^{*1}} + \frac{1}{\gamma^{*2}}\right)q^* \tag{25}$$

The investors' demand elasticicities depend also on cross-elasticicities 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 maintain tractability we do not extend the model to include a monetary side or else a market for currencies and a central banks. Still, to close the model the exchange rate needs to be determined. This is achieved through a no arbitrage condition on risk-free rates determined by an affine structure. 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 structure (Lustig, Roussanov and Verdelhan (2011)). The risk-free discount rates are give by one common global risk factor ω, that follows an affine representation:[23] $-log(m') = \tilde{\delta} + \left(\psi + \frac{\lambda^2}{2}\right)\omega + \lambda\omega^{\frac{1}{2}}\epsilon'_{\omega}$, $-log(m'^{*}) = \left(1 + \frac{\lambda^{*2}}{2}\right)\omega + \lambda^{*}\omega^{\frac{1}{2}}\epsilon'_{\omega}$.

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 included in the empirical sample described in Table 6. The parameters are used to replicate the empirical results in Section 3.

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 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 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 UIP deviation of EM yields relative to US sovereign yields, over the sample period. Calibration parameters are summarized in 6.

We then simulate a series of shocks to the parameter capturing intermediation frictions, $\gamma = \left(\frac{1}{\gamma_1} + \frac{1}{\gamma_2}\right)$, which 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 above mentioned 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. The government endogenously chooses the amounts to borrow in each currency, $b^{*\prime}$ and b', 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

23 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.

risk factor shocks for 10,000 periods.[24] The 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 bond price, q the local currency bond price and e the exchange rate. This part of the model estimation procedure corresponds to the first stage of our empirical analysis.

Table 6

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,

24 The first 20 generated observations for local and foreign currency securities of each issuer are dropped.

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 $\phi_{c,t}$.

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

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

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:

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

Results for this estimation procedure are reported in Table 7. 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 7 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.

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.

Table 7

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: 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. A value of the F-statistic above this threshold denotes a strong instrument. Two stars next to the coefficient estimate denote that the estimate is significant at the 5 percent significance level.

5. Conclusion

We present and quantify a unified view of the implications of international arbitrage deviations for investors' demand and issuer's supply decisions. Our results show extensive heterogeneity for investors' response to arbitrage deviations that is internalized by the issuers.

Three are our main contributions. First, we estimate demand and supply elasticities with a Bartik-style instrument for securities held in the portfolios of Euro Area and 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 extend the asset demand system approach to international assets issued in different currencies, taking into account the endogenous response of supply by the issuer.

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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[25]. 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, 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,

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

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.

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).

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 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 2. 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 3. 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 4. 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 5. 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. Other Results

Table A3

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 controls	Yes	Yes	Yes	Yes
Maturity controls	Yes	Yes	Yes	Yes

Notes: 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), clustering at the time level. The Olea and Pflueger (2013) critical value for effective F-statistic at distortion parameter $\tau = 30\%$ equals 12.039. A value of the F-statistic above this threshold denotes a strong instrument. Two stars next to the coefficient estimate denote that the estimate is significant at the 5 percent significance level.

E. 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 A4

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 controls	Yes	Yes	Yes	Yes
Maturity controls	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 A5

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 controls	Yes	Yes	Yes	Yes
Maturity controls	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 A6

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
$x^{CIP}_{b,t,t+\tau}$	-0.102**	-0.113**	18.317	11.060
	[-0.141,-0.046]	[-0.162,-0.047]	[-Inf,+Inf]	[-Inf,+Inf]
Observations	6025	5419	5511	5396
Effective F-statistic	50.812	29.579	0.019	0.052
Quarter FE	Yes	Yes	Yes	Yes
Issuer Country FE	Yes	Yes	Yes	Yes
Quarter x Issuer Country FE	Yes	Yes	Yes	Yes
Rating controls	Yes	Yes	Yes	Yes
Maturity controls	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.

F. 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 F. 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)).

G. 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. 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:

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

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:

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

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:

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

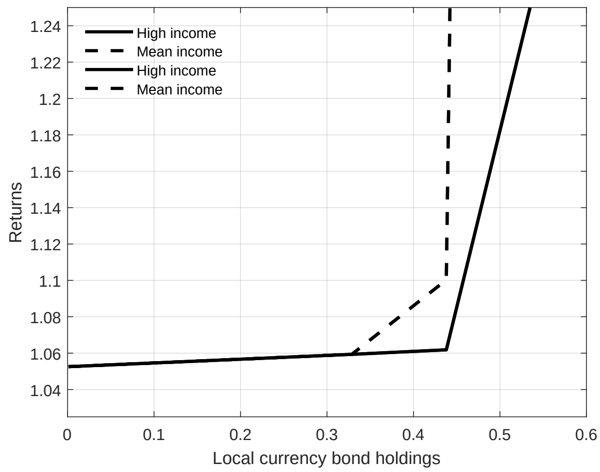
The issuer now chooses the optimal amount of debt taking into account also Equation (G.3). Note that in this context there exist a relation between the UIP and the CIP, which reads as follows:

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

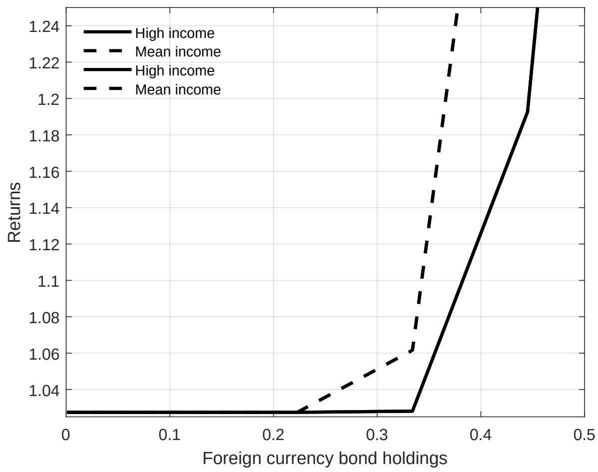
where the second term is negative and leads to a larger UIP deviation than CIP deviation.

Figure G1 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 G1



(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 6.