The Original Sin Revisited: Investor Composition and Sovereign Risk*

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Abstract

This paper proposes a new trade-off for emerging-market sovereign borrowing. Borrowing in local currency insulates sovereigns from default but increases the severity of bond fire sales in bad times, as local-currency bonds are endogenously held by intermediaries more vulnerable to fire-selling. We start by documenting three facts. First, investors with open-end funding structures who are subject to performance-based withdrawals hold most external local-currency debt. Investors with long-term and stable funding prefer to hold hard-currency bonds. Second, when open-ended intermediaries face funding withdrawals, local-currency bond prices fall differentially and issuers reallocate by issuing in hard currency. Third, issuers who have shifted towards issuing more local currency debt in recent years are more likely to experience bond market fragility. We rationalize these facts in a model where foreign households demand money-like claims denominated in their own currency from financiers who intermediate bond markets. Creditor sorting and bond fire sales arise endogenously from a complementarity between the open-end funding structure and the exchange rate risk embedded in local-currency debt. Our findings lean against conventional policy wisdom about the benefits of local-currency financing for financial stability.

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1 Introduction

For most of the 20th century, emerging-market sovereigns did not borrow from foreigners in their own currencies. Their dependence on debts denominated in the dollar, the pound sterling, and other hard currencies was so pervasive and long-lasting it was named the "Original Sin" by B. Eichengreen and Hausmann (1999), and bore part of the blame for the financial crises at the end of that century. Policy efforts led to a dramatic shift thereafter: Between 2005 and 2015, local-currency bonds grew from less than 5 to almost 40 percent of foreigners' emerging-market portfolios (Burger et al., 2012; Arslanalp & Tsuda, 2014; Du & Schreger, 2016). Has the shift to local-currency brought new challenges?

This paper documents that local-currency bonds held outside the domestic economy sort into the portfolios of open-ended intermediaries, subjecting them to fire sales. Intermediaries with with long-term and stable funding hold very little local-currency debt. Sorting of local-currency debt into open-end vehicles disproportionately exposes it to fire sales which depress prices below fundamental values. We argue theoretically that this sorting is not coincidental, but rather endogenous to frictions in intermediation of bonds with exchange-rate risk. Our findings lean against the conventional policy wisdom about the benefits of local-currency financing for financial stability.

The paper proceeds in three parts. The first part documents the prevalence of intermediary sorting across currency markets using administrative, security-level holdings data from the euro area. We begin with a new fact about the recent progress on the Original Sin problem: Between 2013 and 2018,[1] 94 percent of the increase in external local-currency debt in our sample was financed by open-end funds (Figure 1). These aggregate developments reflect systematic sorting of intermediaries across bond currencies, which we identify using variation in intermediary composition across bonds from the same issuer. Foreign intermediaries with long-term and stable funding structures – including insurers, pensions, and deposit-insured banks – display a preference for bonds denominated in euros and dollars over nearly identical local-currency bonds from the same issuer. An indicator for local-currency denomination alone can explain up to 32 percent of the cross-section of sovereign bond holdings for these insurers after controlling for bond issuer, maturity, and other characteristics.[2] In comparison, open-end funds display no differential willingness to hold hard-currency bonds over comparable local-currency bonds, and bond currency has little explanatory power over their sovereign bond holdings.

[1]This is the period in our sample during which local-currency expanded as a share of debt financing for the countries we study. Thereafter, local-currency as a share of aggregate financing remained relatively flat in our sample (Arslanalp & Tsuda, 2014). We discuss decompositions of holdings in levels and in other periods in the main text.

[2]For banks, this figure is 12 percent. Refer to Appendix Tables B.2-B.4 for more detail.

Why do intermediaries sort across bond markets? In the second part of the paper, we propose a theory in which sorting arises from complementarities between exchange-rate risk in local-currency bonds and open-ended funding. The premise of our theory is that exchange rates pose substantial fundamental risk to foreign portfolios over long horizons, even when sovereign credit risk is low. One unit of hard-currency invested in hard-currency bonds can support more long-term debt claims than the same unit invested in local-currency bonds—a premise we refer to as a hard-currency *collateral advantage*. In the presence of this advantage, local-currency bonds are expensive collateral for intermediaries with stable, long-term funding but relatively cheap for those with open-end funding.

We develop this argument in a model of financial intermediation and sovereign default. We model competitive foreign intermediaries who invest on behalf of households and hold portfolios of risky bonds. Given supplies of bonds in different currencies, these intermediaries choose how to set up shop: what kind of claims to offer households, and what bonds to hold in their portfolios. We microfound the hard-currency collateral advantage in foreign household demand for safe, money-like claims denominated in their own currencies. Household demand generates a money premium on claims issued by intermediaries. While money demand provides a tractable and convenient microfoundation, other frictions in intermediation can generate the same connection between exchange-rate risk and fire-sales as in our model.[3]

To manufacture these claims and reassure households of their safety, intermediaries adopt one of two strategies. One strategy is to issue debt backed by loss-absorbing capital and government guarantees. Intermediaries who take this route enjoy stable funding—households do not react when the market values of portfolios decline—but are constrained in their ability to hold assets with long-run, fundamental risk.[4] In our setting, exchange-rate risk is the distinguishing source of long-run fundamental risk in local-currency bonds. The second intermediation strategy is to issue redeemable claims on an open-end fund. Open-end funds capture part of the money

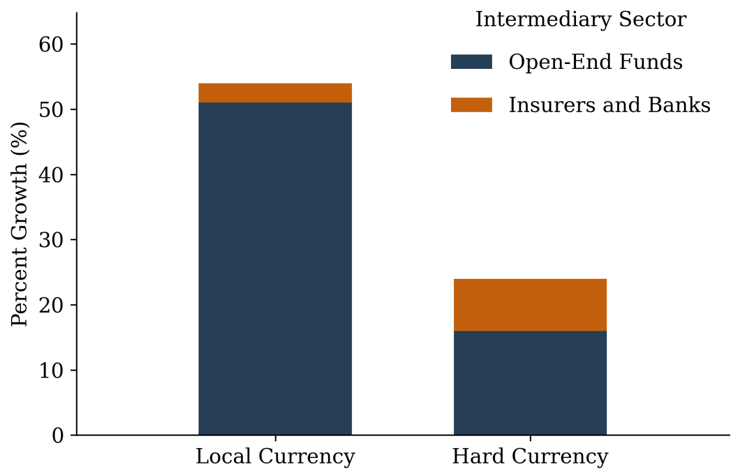
[3]Notably, one could start from a microfoundation based in contracting problems between intermediaries and households. The important idea behind our friction is that intermediaries capture some rents by contracting to buy and manage assets on behalf of households. In D. W. Diamond (1991), Chevalier and Ellison (1997), Myers and Rajan (1998), D. W. Diamond and Rajan (2001), and Stein (2005), similar ideas arise due to limited commitment, information asymmetries, and moral hazard. Short-term funding in these models allows lenders to hold manager behavior to account or to extract signals about borrower quality. A similar role of short-term funding appears in our intermediation model, which builds instead on the microfoundations in Stein (2012), Hanson et al. (2015), and W. Diamond (2020). We discuss alternative microfoundations in more detail in Appendix A.3.4.

[4]Specifically, these intermediaries are constrained in their ability to hold assets with significant value-at-risk over long horizons. We draw an analogy between this strategy and the following intermediary-types we observe in the data: Insurers, pensions, and deposit-insured commercial banks. While banks provide their clientele with redeemable, short-term claims, the key distinction we draw between intermediaries is *how* they make their claims safe. Our model nests the role of regulation in determining which assets certain intermediaries hold, and in particular, the constraints on banks and insurers in holding currency mismatch (Koijen & Yogo, 2014; Du et al., 2023). We discuss this distinction and the analogies we draw to intermediaries in the data more in Section 4.

premium by issuing short-term claims backed by the liquidation value of their assets. In bad states, households withdraw these claims.[5] Under this open-end fund strategy, intermediaries have more capacity to bear long-run fundamental risk but may be forced to liquidate the fund early.

The novel insight of the model is that intermediaries sort into financing local-currency bonds based on their liability structures. Because holding loss-absorbing capital against exchange-rate risk is costly, relatively fewer stable-funding types choose to hold local-currency bonds than do open-end types.[6] In equilibrium, unstable types disproportionately finance local-currency bonds.

Figure 1: Decomposition of Growth in External Debt, 2013 - 2018



Sources: Securities Holdings Statistics (ECB) and Arsalnap and Tsuda (2017). *Notes*: This table reports a decomposition of growth in external debt outstanding included in the sample of emerging market sovereign bonds described in section 2. The table is constructed under the assumption that the sectoral decomposition of holdings in the SHS is representative of the universe of external holdings, an assumption we discuss in Appendix B.3.1. All values are reported in percent.

Endogenous sorting affects sovereign bond prices, as intermediaries' liability structures also determine their propensities to sell bonds in bad times. While the open-end structure gives funds a comparative advantage in holding local-currency debt in normal times, it also forces them to liquidate more local-currency bonds in bad times. In the model, local-currency bonds are endogenously more exposed to fire sales and exhibit greater betas with capital outflows than hard-currency bonds. In addition, expected returns to foreign investors in local and hard-currency

[5]Formally, we model a fund which purchases bonds using a combination of secured, short-term claims and equity, much like a hedge fund which finances part of its portfolio with repo. We draw an analogy between this capital structure in the model and that of an open-ended bond mutual fund which faces performance-based withdrawals. We discuss this more in Section 4. In both cases, the key point is that some of the funding for this intermediary is vulnerable to withdrawals in bad states.

[6]One counterargument to our baseline model is that FX-hedging by stable intermediaries should eliminate sorting. We address this argument with one conceptual point and one empirical, which we discuss in Section 5.

bonds are not equated: the collateral advantage in hard-currency raises the price of hard-currency sovereign debt relative to local-currency debt, after adjusting for expected exchange-rate appreciations and default risk.[7]

In Section 5, we use security-level holdings data to test the model's predictions and validate its key assumptions. First, we test the main assumption that foreign investors face different risks across the two markets. To do so, we estimate value-at-risk (VaR) for local- and hard-currency bonds from the perspective of a euro-based investor. Local bonds exhibit substantially larger tail risks even within bonds of the same issuer, duration, size, and payment structure. For a euro-based investor, the gap between VaR in local-currency bonds is -0.8 percentage points over a one-year horizon, and -3.5 percentage points at a 5-year horizon.[8] Consistent with the model predictions, we find that these currency-related tail risks correlate strongly with intermediary composition in the cross-section of countries: The extent to which open-end funds sort into local-currency bonds relative to stable-funding intermediaries increases with the size of the left tail of currency depreciations against the euro.[9]

In the third part of the paper, we provide causal evidence for the model's main prediction: Outflows from open-end funds depress sovereign bond prices, but asymmetrically affect local-currency bonds. To identify the effects of withdrawals from open-end funds on bond prices, we exploit quasi-random variation across bonds in exposure to mutual-fund redemptions following the February 2022 invasion of Ukraine. This event prompted large withdrawals from European mutual funds. However, withdrawals were concentrated at portfolios exposed to issuers with geographic and geopolitical proximity to the war. We exploit the fact that some bonds were more exposed to these outflows solely through co-holdings with proximate issuers but not through changes in fundamentals. Our strategy compares observably similar bonds from the same issuer but held to different degrees at funds with these exposures.

We find evidence consistent with the fire-sale channel in our model. Prices of bonds held at highly-exposed funds fall significantly more than those of similar bonds held by residual investors and those held at funds experiencing fewer withdrawals.[10] We then test the more unique prediction of our model: That, in response to a fixed withdrawal from open-end funds, local-currency bonds experience larger price declines than hard-currency bonds. We test this by allowing for heterogeneous treatment effects across the two bond types in the differences-in-differences

[7]Throughout, we use uncovered return parity to refer to a zero spread between two risky bonds from the same country. We refrain from referring to this spread as a deviation from Uncovered Interest Parity, though the two are conceptually similar.

[8]This refers to the 25th percentile Value-at-Risk, stated in annualized returns.

[9]Our argument relates to studies on the role of rare disasters in the development of local-currency bond markets and financial institutions (Farhi et al., 2015; Rebelo et al., 2022).

[10]The dynamics of price impact are also consistent with fire sales: Prices of treated bonds revert to those of their untreated counterparts after 5 months.

study. Consistent with the prediction, nearly all of the negative price impact of mutual fund outflows is concentrated in local-currency bonds. This differential price impact is associated with larger quantities of sales in local-currency bonds relative to hard-currency: We estimate that sales of local-currency bonds associated with invasion-related fund outflows from euro-area funds were more than 2.5 times greater in magnitude than those of hard-currency sales.

Our estimates suggest mutual-fund outflows are an economically meaningful channel for fiscal costs. Our conservative estimate is that sales of local-currency bonds equal to one percent of the supply outstanding raise local-currency credit spreads by 40 basis points. In the 3 months following Russia's invasion of Ukraine in 2022, mutual funds sold 1.3 percent of the stock outstanding of local-currency debt securities in our sample, implying mutual fund price impact was about 50 basis points, or one-third of the aggregate increase in local-currency bond yields over the same period.[11] While the invasion offers a unique natural experiment, past outflow episodes have been larger. Averaging over four discrete episodes of capital retrenchment from emerging markets, mutual funds sold 3.6 percent of the local-currency debt stock.[12]

Finally, we consider the implications for governments issuing debt to foreigners. We extend the model to consider the problem of a sovereign who chooses what share of a fixed borrowing need to issue in local currency. In a standard, representative investor framework, the main rationale for choosing local-currency debt is to reduce the risk of costly default (Aguiar & Amador, 2014; Kalemli-Özcan et al., 2016).[13] Absent other frictions, a sovereign should only issue in local-currency. We incorporate this standard friction into our setting, allowing for costly default, but then show that frictions in foreign intermediation give rise to a trade-off.

In our model, the sovereign trades costly default off against two benefits of hard-currency debt which arise endogenously from frictions in intermediation. First, the intermediation side of the model generates deviations from uncovered return parity, and the sovereign can raise consumption by borrowing more in hard-currency bonds. Second, the local-currency share affects domestic investment in our model through a novel channel. When foreign funds offload bonds prematurely, domestic investors absorb some of this capital outflow. Fire sales by foreign funds constitute capital outflows which crowd out investment in private, domestic projects, effectively causing a credit crunch with negative spillovers on the domestic economy. To the extent that the debt manager internalizes these spillovers, they push the manager towards issuing more hard-currency debt. The novelty of our model is that these credit-crunch costs arise in concert with investor sorting, the key empirical fact that motivates our study.

[11] We discuss the computation of these magnitudes in Appendix B.6.

[12] See Section 3 for more detail on these episodes. For hard-currency securities, mutual funds were small net buyers, with average sales of –0.57 percent.

[13] Some models emphasize the hedging benefits of local-currency debt: Exchange rates that depreciate in bad times reduce the real local-currency debt burden. See Du et al. (2020).

We conclude by discussing how these results might shed light on recent developments in bond markets and capital-flow management policies (Bianchi & Lorenzoni, 2022; Das et al., 2022; Basu & Gopinath, 2024; Fontanier, 2025). Progress on the Original Sin stalled in the years after the global financial crisis, and net local currency issuance declined after two recent bond selloff episodes. We discuss through the lens of the model how foreign investor habitats might help explain this trend, in a similar vein to Clayton et al. (2025). Beyond the immediate policy implications for currency choice, our framework also highlights the important role of the domestic investor base in absorbing capital outflows, as well as the potential benefits of both (i) capital controls which discriminate not on investor domicile but on investor liabilities and (ii) foreign exchange management policies.

Roadmap. Section 3 studies documents investor sorting on currency; Section 4 provides the baseline theory of bond intermediation; Section 5 provides cross-country evidence in favor of the model; Section 6 provides causal evidence on the key model prediction; and Section 7 extends the model to consider issuer trade-offs.

Related literature. We revisit the literature on the role of the Original Sin in sudden stops. B. Eichengreen and Hausmann (1999) and Hausmann and Panizza (2003) first referred to the problem of borrowing abroad in hard currency as an "Original Sin." As the name insinuates, early empirical work attributed the phenomenon to forces outside the affected countries' control (B. Eichengreen et al., 2007). While the literature pointed out mechanisms which may push countries to issue in hard currencies—such as incomplete bond markets or cross-border transaction costs—it left their exploration for future research.[14] To our knowledge, our paper is the first to propose and test a specific channel through which financial frictions originating outside of emerging markets make currency mismatch costly for lenders, and generate a tradeoff for sovereigns who issue in multiple currencies.

A large literature hypothesizes that the currency mismatch resulting from Original Sin underpins financial fragility in emerging markets.[15] We instead emphasize that foreign investors

[14] Another literature viewed the Original Sin not as "original" but as arising from either hyperinflation or mismanagement of the domestic economy and exchange rates. For example, Reinhart and Rogoff (2009) and Reinhart and Rogoff (2011) document that many countries in Latin America attracted foreign investors into local-currency debt prior to the large inflationary episodes of the 1980s and 1990s. Our findings may help reconcile these two views. Burger and Warnock (2007) and Engel and Park (2022) argue that countries may overcome the Original Sin by pursuing macroeconomic stability or monetary credibility, respectively.

[15] See, for examples, Calvo (1998), Krugman (1999), Céspedes et al. (2004), Calvo (2005), and Lorenzoni (2014). Our work also relates broadly to work on emerging markets in the global financial cycle, and the spillovers from US monetary policy to the rest of world (Miranda-Agrippino & Rey, 2020; Ş. Kalemli-Özcan & Unsal, 2023; Kekre & Lenel, 2024; Fontanier, 2025). Relative to these papers, our work focuses on understanding capital structure considerations which link together ex-ante risk-taking by intermediaries and capital flight from local-currency assets

can drive financial fragility even in the absence of currency mismatch on the part of the issuer. In this way we contribute to the "Original Sin Redux" literature (Carstens & Shin, 2019; Bertaut et al., 2021; Lee, 2021) which observes that greater foreign participation in local currency markets has reallocated currency mismatch problems away from borrowers to lenders. We emphasize a channel through this reallocation of risk exposes borrowers to new frictions in foreign intermediation. Our current methodology uses the setting of sovereign debt as a laboratory to study these frictions, but the findings may be relevant for issuers of all kinds.

Our paper contributes to the literature on the synergies between financial intermediaries' assets and liabilities.[16] Our contributions are to study how these synergies manifest in the context of currency risk and the implications for sovereign borrowers. Other authors have observed the tendency of intermediaries with fixed or long-term liabilities to prefer hard-currency assets in other contexts (Bertaut et al., 2021; Faia et al., 2022; Du & Huber, 2023), and studied the cross-border portfolios of such intermediaries (Du et al., 2023). Our contributions are to provide a theory which explains both sorting and its effects on prices together, and to identify systemic sorting along currency lines in the context of sovereign debt.[17]

Second, we contribute to the literature studying capital flight and fickle foreigner investors.[18] We study how open-end funds contribute to capital outflows and financial fragility.[19] In the context of emerging markets, Chari (2023) shows that greater intermediation of capital flows by non-banks is associated with higher volatility and covariance with global financial conditions. Our findings highlight the importance of the liability structures of these intermediaries, as both a driver of their endogenous participation in risky assets and the outflows they experience in response to shocks. Zhou (2023) and Faia et al. (2024) show that foreign investor base effects help explain the cross-section of bond betas with the Global Financial Cycle and responses to euro-area monetary policy, respectively.

Finally, we contribute to the literature on the growth in local-currency issuance (Du & Schreger, 2016; Engel & Park, 2022; Bergant et al., 2023). Du and Schreger (2016) document the wedges between credit spreads in local and hard-currency bonds and argue that selective default, capital controls, and covariance between currency and credit risk explain much of the variance in these

in bad times.

[16]e.g., D. W. Diamond (1997), D. W. Diamond and Rajan (2001), Stein (2005), Koijen and Yogo (2014), Hanson et al. (2015), Chodorow-Reich et al. (2021), and Ma et al. (2022a).

[17]Our theory also relates to theories of safe-assets provision and international currencies (Farhi & Maggiori, 2018; He et al., 2019; Choi et al., 2022; Clayton et al., 2024; Coppola et al., 2025). Our theory posits that there are spillovers from the issuer of safe-assets other sovereign issuers, which could push emerging-market sovereigns to issue in the international currency as well.

[18]See Caballero and Krishnamurthy (2009), Mendoza and Smith (2014), B. J. Eichengreen et al. (2017), Caballero and Simsek (2020), Miranda-Agrippino and Rey (2020), and Kekre and Lenel (2024).

[19]See Jotikasthira et al. (2012), Falato et al. (2021), Darmouni et al. (2022), Ma et al. (2022b), Gormsen and Koijen (2023), and Coppola (2024).

wedges. Du et al. (2020) show that countries that cannot commit to containing inflation ex-ante face higher risk premia on local-currency debt. Eren et al. (2022) document a similar finding for corporates, who borrow in hard currency to signal their ability to commit to repaying in bad states to investors. We propose that endogenous changes in the investor base generate a novel tradeoff for issuers choosing to issue debt in one currency over another.

2 Bond Holdings Data

Investor holdings. The primary data source for our study is the Securities Holdings Statistics (SHS), maintained by the European Central Bank. The underlying data for the SHS are the reports of securities custodians who serve financial institutions and households domiciled in the euro area. From these data we observe individual bond-level holdings of Euro area investors at the holder-sector by holder-domicile level.

We construct a sample of bonds from 34 emerging issuers which meet the following two conditions: (i) sovereigns *without* fully-fixed exchange rate regimes (Ilzetzki et al., 2019) and (ii) sovereigns issuing debt in more than one currency at any point in the sample. We observe approximately 1,700 sovereign bonds in the holdings data each quarter after filtering on these criteria. Table B.5 reports the distribution of holdings and bond observations for our sample by issuer and currency, respectively. Euro area investors account for about one-third of total external holdings of emerging market debt securities and our data covers a large and important block of investors for these countries. Our SHS-based sample, therefore, captures a large and systemically important investor base with broad sectoral and currency coverage. We supplement the SHS data with fund share-class-level portfolio holdings data from Lipper, a commercial provider. Our sample includes all mutual funds domiciled in the euro area over the relevant period, but we restrict attention to those funds that hold any bond appearing in our SHS sample. This restriction defines our effective investment universe and comprises approximately 26 percent of euro-area mutual funds by assets under management. We use these fund-level holdings in Section 6.

Bond prices and returns. We merge the investor holdings data with bond-level pricing and characteristics from multiple sources to ensure comprehensive coverage. Dynamic bond information—including prices, yields, ratings, and coupons—is sourced from Bloomberg, and we limit our sample to bonds with pricing data based on executable quotes from multiple contributors. Bond-level fundamentals such as issuer identity, currency denomination, maturity and issuance dates, and seniority are obtained from the ECB's Centralised Securities Database. We supplement these fields with additional attributes, including legal jurisdiction, and callability, from LSEG/Refinitiv.

3 Three Facts

Three observations motivate us to study foreign intermediation of sovereign bonds. In section 6 we use the model to refine empirical tests and provide causal evidence for its main mechanism.

Fact 1: Intermediaries sort on currency

Open-end funds disproportionately financed the most recent period of growth in net local-currency issuance (Figure 1). These intermediaries' disproportionate participation in local-currency also appears in our sample in levels, in the decomposition of average holdings over time, in cross-country correlations between investor composition and currency composition, and almost universally across all of the countries in our sample. For example, Appendix Table B.1 reports that on average across our sample, intermediaries with open-end fund structures have accounted for just 45 percent of hard-currency holdings but 67 percent of local-currency holdings. Investors in pension, insurance, and banking sectors hold more hard- than local-currency debt, on average.[20] We find that in the cross-section of countries, aggregate local-currency issuance correlates strongly with the composition of the external intermediary base (Appendix Figure B.1).[21]

Is this a fact about bond currency, or a fact about other features of local-currency bonds? We rule out the latter using security-level variation in investor holdings. The security-level holdings data from the SHS allow us to control for possibly confounding drivers of investor sorting, including other features of local-currency bonds, their issuers, and the market conditions in which emerging-market sovereigns issue. For examples, we rule out the immediate concerns that high-credit-quality issuers select into supplying local-currency (Du et al., 2020), local-currency bonds tend to be of longer maturity (Bertaut et al., 2021), or local-currency bonds tend to be under local jurisdiction (Chamon et al., 2018). We pool individual bonds i and estimate the following regression separately for investor-types $j = \{\text{Funds, Insurers and Pensions, Banks}\}$

$$\mathbb{1}\{h_{it}^{j} > 0\} = \alpha_t + \Gamma' X_{it} + \beta_c \mathbb{1}\{\text{Bond Currency}_i = c\} + \epsilon_{it}^{j} \tag{1}$$

where h_{it}^{j} is the par value of holdings of bond i attributed to investor-type j in quarter t. Regression (1) therefore models the linear probability that an investor holds a given bond as a function of the bond's currency. X_{it} is a vector of interacted bond characteristics which include, in the most saturated specification, bond issuer, remaining maturity, an indicator for bond-structure

[20] The exception to this statement is the Dutch pension sector, which accounts for 6 percent of hard-currency holdings on average across our sample, but 13 percent of local-currency holdings. See Appendix B.1 for more detail.

[21] Authors before us have also observed or mentioned in other contexts the tendency of insurers and pensions to hold less local-currency exposures than funds. See Bertaut et al. (2021), Faia et al. (2022), Bergant et al. (2023), and Du and Huber (2023).

type, coupon structure, and legal jurisdiction. Our identification strategy compares the intermediary profiles of two observationally similar bonds denominated in two different currencies. α_t is a quarter fixed effect which absorbs confounding correlation over time between aggregate bond supply in currency c and investor demand.[22] In the baseline tests, we estimate two currency coefficients for currencies $c \in \{USD, \text{Local Currency}\}$.[23] We treat EUR-denominated bonds as the leave-out group. This allows us to interpret β_c as the additional probability of holding a bond denominated in currency c relative to a similar bond denominated in euros. We also estimate 1 for the intensive-margin of holdings using the outcome

$$\mu^j_{i,t} = \frac{h^j_{it}}{\text{Amount Out}_{it}} \tag{2}$$

conditional on the set of bonds for which $h^j_{it} > 0$ for each j. Specification 2 estimates an intensive-margin preference for bonds of currency c relative to similar euro-denominated bonds.

Table 1 reports the estimates for β_{USD} and $\beta_{\text{Local Currency}}$ from regression 1. The estimated coefficients imply that insurers and pensions are 45% less likely to hold a local currency bond than an otherwise similar euro-denominated bond. For banks, the point estimate is 55%. In contrast, investors in the mutual fund sector appear indifferent between euro-denominated and local currency bonds that are similar on other dimensions.

Additionally, within the hard currency category, these investors display a strong home-currency bias (Maggiori et al., 2020): they prefer dollar-denominated bonds to local currency bonds, but they prefer euro-denominated bonds most of all. Our theory will provide a prediction which can explain this differential treatment of local- and dollar-bonds, even though from the perspective of foreigners, both bonds carry exchange-rate risk.[24] On the intensive margin, conditional on owning any of a bond, these investors also tend to hold about 15% less of a bond when it is denominated in local currency relative to euros. For funds, this intensive margin preference is also apparent, but the point estimate is half as large (Appendix Table B.2). Not only do the differences in estimates between the two sectors suggest that investor types sort on currency, but

[22]For example, one may be concerned that, relative to open-end mutual funds, investors with long-term funding have more capital available to deploy in periods in which emerging-credit spreads are elevated. Such periods correlate with low risky-asset valuations, and perhaps reduced supply from issuers who rely on hard-currency financing. We run tests of 1 which replace α_t with time-varying controls for credit-market conditions and issuer-level conditions in Appendix B. Later, in Section 6 we also study a shock to mutual fund participation in local-currency bonds and find that this shock drives down local-currency bond issuance. Such a finding suggests that the omitted variable bias due to confounding variation in aggregate credit-market conditions may, all else equal, attenuate the estimates of β_c relative to their true mean.

[23]Our identification approach is similar to that in Maggiori et al. (2020).

[24]The theory will posit that the degree to which intermediaries with long-term and stable funding hold bonds in currencies which are not their own depends on the value-at-risk on those bonds; we show empirically later in Section 5 that this correlation holds in the data.

Table 1: Estimates of Investors' Extensive Margin Currency Preference, Relative to Euro

	Dependent Variable: $\mathbb{1}\{h_{it}^j > 0\}$								
	Euro-Based Intermediaries								
	Insurers			Banks			Open-End Funds		
$\mathbb{1}\{\text{Local Currency}\}$	-0.49	-0.48	-0.45	-0.56	-0.50	-0.55	0.02	0.02	0.03
	(0.01)	(0.07)	(0.09)	(0.01)	(0.12)	(0.10)	(0.00)	(0.02)	(0.01)
$\mathbb{1}\{\text{USD}\}$	-0.20	-0.19	-0.19	-0.27	-0.07	-0.26	0.03	0.02	0.03
	(0.01)	(0.05)	(0.08)	(0.01)	(0.04)	(0.06)	(0.00)	(0.01)	(0.02)
N	25024	24964	24981	25024	24964	24981	25024	24964	24981
Currency R^2		0.06	0.12		0.10	0.16		0.00	0.08
Issuer FE		✓	✓		✓	✓		✓	✓
× Maturity Bucket		✓	✓		✓	✓		✓	✓
× Debt Type		✓	✓		✓	✓		✓	✓
× Size		✓	✓		✓	✓		✓	✓
× Coupon Type		✓	✓		✓	✓		✓	✓
× Bond Rating		✓	✓		✓	✓		✓	✓
× Jurisdiction		✓	✓		✓	✓		✓	✓
Quarter FE			✓			✓			✓

Note: Table reports OLS estimates of the linear probability of holding a bond denominated in issuer's local currency and USD, relative to holding a similar EUR-denominated bond from the same issuer. Standard errors in parentheses are clustered at the bond and date level. Currency R^2 refers to the within-R^2. The first row of reports estimates for $\beta_{\text{Local Currency}}$ from regression (1), estimated separately for each intermediary-type. The second row reports estimates for β_{USD}. The first three columns report estimates for j = Insurers in regression (1); the second three-column group reports estimates for j = Banks; the last reports estimates for j = Open-End Funds

we also find that currency has more explanatory power over investor holdings in some sectors than in others (Table B.2). Indicators for currency alone can explain up to 30 and 10 percent of the cross-section of ownership shares insurers and banks, respectively, but only 4 percent of the cross-section for open-end funds.

Fact 2: Intermediaries contribute heterogeneously to capital outflows

The second observation which motivates our study is that intermediaries have heterogeneous propensities to sell assets in periods of capital outflows from emerging markets.[25] Specifically, intermediaries who have greater ex-ante propensities to participate in local-currency markets on average also tend to be the most likely to withdraw capital in response to global shocks.

In Figure 2, we examine four discrete episodes of capital retrenchment from emerging markets in the years of our sample. Two observations follow from the figure. In each episode, investors

[25] Similar facts about investor heterogeneity in capital outflows have been documented in various contexts. For examples, see Bertaut et al. (2021), Chari (2023), Zhou (2023), and Faia et al. (2024). Our contribution is to characterize how ex-ante investor habitats coexist with ex-post investor behavior because of competitive forces in intermediation.

in the open-end fund sector drove capital outflows from local-currency bonds. Funds are consistently the largest net sellers of local-currency bonds. In contrast, insurers, pension funds, and banks typically contribute small shares to or lean against the capital outflow. Second, outflows from local-currency securities consistently exceed those from hard-currency securities; in some cases, investors appear to substitute into hard-currency bonds.

Fact 3: Fund-driven capital outflows correlate with price declines

During these episodes of capital outflows, bonds held by open-end funds fall in value more than bonds held by other investors. We produce reduced-form evidence of this relationship here to motivate the study, and return to provide causal evidence of our price impact channel in Section 6. This fact suggests that the liability structures of foreign intermediaries matter for bond prices–in particular, that liquidations during periods of capital outflows may depress prices below fundamental value. Later in the paper, we revisit the implications of these bond liquidations as both determinants of the means through which foreign capital flows are financed in equilibrium (Section 4) and as potentially costly for sovereign issuers (Section 7).

We again consider the four discrete episodes of capital retrenchment in Figure 2. Pooling together these episodes, we test whether bonds held by open-end funds going into the episode experience larger price declines during the period of capital outflows. For each bond i in our sample and each capital outflow episode $\mathcal{T}$ referenced in Figure 2, we compute the drawdown on the bond as the maximum loss on the bond during the capital outflow period (Coppola, 2024). The drawdown is

$$\zeta_{i,\mathcal{T}} = \max_{t \in \mathcal{T}} \left\{ 1 - \frac{\Pi_{s=\mathcal{T}_0}^{\mathcal{T}_{max}} R_{i,s}}{\Pi_{s=t_{i0}}^{\mathcal{T}_0} R_{i,s}} \right\}$$

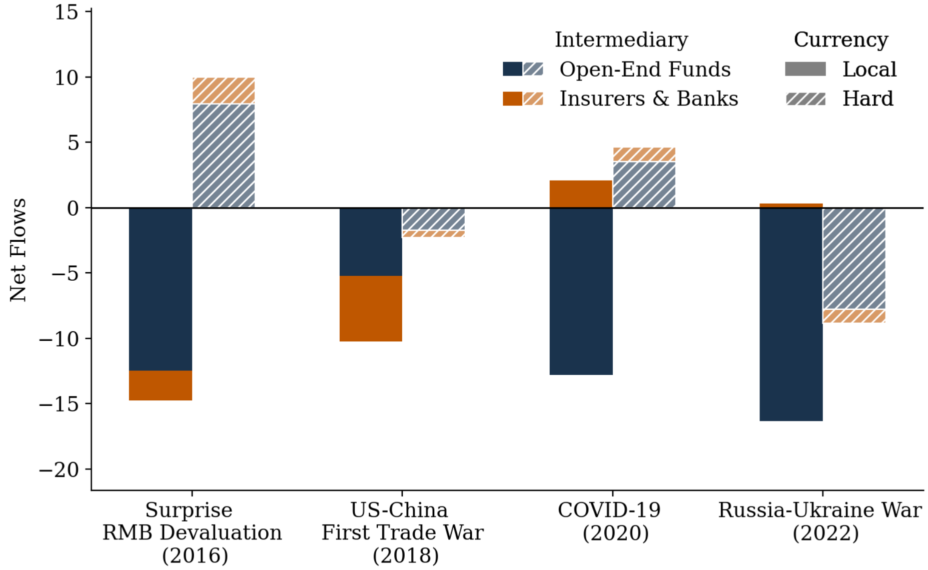
$\mathcal{T}$ indexes the capital outflow period, $\mathcal{T}_0$ indexes the first date of period $\mathcal{T}$, and t_{i0} indexes the first day of market information available to us for bond i. $R_{i,s}$ is gross returns in units of the bond currency.[26] We pool together individual bond $i \times$ episode $\mathcal{T}$ observations and estimate

$$\zeta_{i\mathcal{T}} = \alpha_{\text{currency}(i) \times \mathcal{T}} + \sum_{j \in \{\text{Insurers, Banks, Funds }\}} \gamma_j \mu^j_{i,\mathcal{T}-4} + \Gamma'(\text{Bond FE}_{i,\mathcal{T}}) + \epsilon_{i,\mathcal{T}} \tag{3}$$

[26]Note that these are gross, unhedged bond returns. Returns are computed using market pricing and coupon information from Bloomberg. The vast majority of bonds in our sample are fixed or zero-coupon bonds. We estimate the coupon portion of returns using information on the coupon rate and frequency. We exclude bonds with coupons denominated in currencies that differ from that of the bond principal, which make up a small share of the initial sample.

Figure 2: Investor Contributions to Capital Outflows

Contributions to Net Purchases by Euro-Area Investors of Local- and Hard-Currency Bonds



Source: ECB SHS. *Notes*: Net purchases in each episode are computed as cumulative changes in par amount held relative to holdings at the start of the episode. We use par amounts reported in bond-currency units to neutralize the effects of currency valuations on reported holdings. We then compute aggregate net purchases summing across using pre-episode bond-sizes as weights. Contributions are computed in a similar manner, using pre-episode investor shares.

where, as in (2),

$$\mu^j_{i,\mathcal{T}_0-4} = \frac{h^j_{i,\mathcal{T}_0-4}}{\text{Amt Out}_{i,\mathcal{T}_0-4}}$$

is the par-value share of the bond held by Euro-area intermediaries in sector j four quarters prior to the start of period $\mathcal{T}$, which we denote date $\mathcal{T}_0$. This regression tests whether, relative to residual holders of bond i, ownership by investor j explains differentials in bond losses within similar groups of bonds. An estimate of γ_j is an estimate of the semi-elasticity of bond losses to ownership by intermediaries in sector j, relative to other intermediaries. The null we test is whether the coefficients $\gamma_{\text{Funds}}, \gamma_{\text{Insurers}}, \gamma_{\text{Banks}}$ are zero—that is, whether intermediaries matter for sovereign bond prices.

This paper emphasizes endogenous selection by certain investors into local-currency, so we estimate the drawdowns regression *within* currencies. However, there is still an identification concern in a within-currency regression of bond prices on investor base from other sources of *confounding* selection. Even within bonds of the same currency, open-end funds may select into bonds which perform worse during periods in which credit markets tighten–for example, because fund investors may prefer bonds which load more strongly on certain risk factors, like floating-rate notes, or high-duration bonds. To ameliorate concerns about confounding sources of selection, we use variation in investor composition across observationally similar bonds issued by the same country and in the same currency.[27] We include interacted fixed effects for the bond's issuer, remaining maturity, size, and coupon type. We also include currency×episode effects, meaning we estimate each γ_j within bonds experiencing the same currency valuation effects. Relative to bonds held by residual investors, similar bonds held by open-end funds significantly under-perform during these episodes of capital outflows. The estimates in Table 2 imply that, all else equal, a bond held in full by a fund loses 20 percent more of its value than a bond held in full by outside investors. In contrast, bonds held by investors with longer-term or more stable funding experience no significant differential performance during these periods.

We also find that investor base correlates with bond risk in the cross-section of countries. In Appendix B.4, we run a simple reduced form exercise that uses cross-country variation in the amount of external debt that is held by the investment fund sector. We estimate local-currency bond betas by running monthly time series regressions of the change in the local-currency credit spread on changes advanced-country credit market conditions. We then estimate the second-stage correlation of bond betas with the average share of debt held by foreign open-end funds over the sample period. The cross-country correlations between bond betas and open-end fund ownership reported in Figure B.3 show a tight link between local-currency bond covariance with the credit cycle and local-currency bond investor composition. Importantly, this cross-country pattern holds after controlling for total foreign participation in local-currency debt, suggesting a special link between open-end vehicles and this measure of bond risk.[28]

We leave further investigation of whether the evidence in Table 2 and the correlations in Appendix Figure B.3 reflect causal effects of open-end fund intermediation on bond prices to the analysis in section 6. To summarize, open-ended vehicles display both a strong propensity to participate in local-currency asset markets on average across time, and a strong propensity to withdraw from these markets in response to shocks. In the next section, we provide a theory that can explain why these two propensities coexist.

[27] The identifying assumption one would have to make to interpret these results as causal evidence is that there are no unobserved bond characteristics, beyond those captured in our interacted fixed effects, which drive both investor composition for the bond and its price.

[28] Related facts have been documented in Chari (2023), Converse et al. (2023), and Zhou (2023). Our contributions are to (a) provide causal evidence of this relationship using the laboratory of local-currency bonds and (b) to explain its coexistence with investor habitats.

Table 2: Intermediary Composition and Markdowns on Bonds During Capital Outflows

	Dependent Variable: Bond Drawdown $\zeta_{i\mathcal{T}}$ in Capital Outflow Period $\mathcal{T}$				
Insurers ($\mu^{\text{I}}_{\mathcal{T}_0-4}$)	0.0614	0.0370	0.0375	0.0375	0.0347
	(0.0474)	(0.0563)	(0.0565)	(0.0565)	(0.0572)
Banks ($\mu^{\text{B}}_{\mathcal{T}_0-4}$)	-0.0330	-0.0505	-0.0499	-0.0499	-0.0370
	(0.0564)	(0.0617)	(0.0618)	(0.0618)	(0.0625)
Mutual Funds ($\mu^{\text{F}}_{\mathcal{T}_0-4}$)	0.219	0.189	0.191	0.191	0.195
	(0.0948)	(0.112)	(0.113)	(0.113)	(0.115)
N	715	699	695	695	687
Identifying Bonds	468	457	454	454	450
Investor R^2	0.0263	0.0150	0.0151	0.0151	0.0153
F	2.709	1.637	1.629	1.629	1.540
Mean $\zeta_{i\mathcal{T}}$	0.1	0.1	0.1	0.1	0.1
SE $\zeta_{i\mathcal{T}}$	0.13	0.13	0.13	0.13	0.13
Currency × Event FE	✓	✓	✓	✓	✓
Issuer FE	✓	✓	✓	✓	✓
x Remaining Maturity	✓	✓	✓	✓	✓
x Debt Type	✓	✓	✓	✓	✓
x Size		✓	✓	✓	✓
x Coupon Type			✓	✓	✓
x Bond Rating				✓	✓
x Jurisdiction					✓
Other Holdings Controls	✓	✓	✓	✓	✓

Notes: Table reports results from pooled bond-level regressions of the form $\zeta_{i\mathcal{T}} = \alpha_{\text{currency}(i)\times\mathcal{T}} + \sum_{j\in\{\text{Insurers, Banks, Funds}\}} \gamma_j \mu^j_{i,T_0-4} + \Gamma'(\text{Bond FE}_{i,\mathcal{T}}) + \epsilon_{i,\mathcal{T}}$ for the full sample of sovereign bonds. Standard errors in parentheses are clustered at the bond and event level. The dependent variable is $\zeta_{i\mathcal{T}}$, the drawdown on the bond, calculated using $\zeta_{i\mathcal{T}}$ as defined in the main text. Sectoral ownership shares μ^j_{i,T_0-4} are computed using data from the Securities Holdings Statistics, described in Section 2. Coefficients should be interpreted as the maximum market-value loss on the bond (in percent / 100) associated with being held in full by investor j, relative to a residual, unobserved investor. The regression exploits cross-sectional variation in investor composition within a particular time period of capital outflows. There is one observation of μ^j_{i,T_0-4} and one observation of the drawdown $\zeta_{i\mathcal{T}}$ per bond i and episode $\mathcal{T}$. Each regression includes fixed effects for the currency of the bond × the episode; each column of the table reports the regressions after adding one successive interacted bond-characteristic fixed effect.

4 A theory of intermediary sorting and fire sales

Motivated by these facts, and to guide the empirical analyses we conduct in the next section, we develop a three-period model of foreign intermediation of sovereign bonds. We present first a version of the model in which investors take the supply of bonds in each currency as given, to clarify the mechanism behind endogenous sorting of investors. In section 7 we embed the investor demand block into a setting where rational, forward-looking issuers choose how to supply bonds in each currency.

4.1 Setup

We consider a three-period, two-country economy comprising: (i) an emerging-market sovereign who receives endowments in the form of primary budget surpluses and issues long-term bonds; (ii) foreign households who in units of hard-currency; and (iii) financiers who intermediate bond markets. Heterogeneous foreign financiers are the main characters of the model. In the initial period, these agents observe savings by foreign households and the supply of bonds from the sovereign and select capital structures through which to intermediate the two.

Timing. There are three periods, $t \in \{0, 1, 2\}$. We preview the timing of the model here but provide more detail below. In $t = 0$ the local sovereign issues bonds in local- (L) and hard-currencies (H) and consumes the revenue.[29] These bonds will have to be payed back in the final period $T = 2$, using uncertain primary fiscal surpluses Z.[30] Investors observe the supply of bonds in each currency, buy bonds, and issue claims to foreign households. Intermediaries cannot re-optimize their capital structures in subsequent periods. We view intermediation choices as long-term choices, which perhaps involve paying upfront costs we do not model explicitly here.

In $t = 1$, after purchasing bonds and setting up shop as intermediaries, investors learn more information about the future fiscal surplus Z_T. With probability $1 - b$, they learn that the surplus Z_T will follow a "responsible" fiscal rule and bond repayments will be made in the future with certainty. With probability b, the good fiscal regime ends and the future budget surpluses become uncertain. We interpret this event as a "bad-news" event, similar to an election or a global financial shock whose impacts on the domestic economy are initially uncertain but eventually become clear. The arrival of bad news causes foreign households to re-evaluate their claims on intermediaries. The news shock lasts for just one period: Thereafter, Z_T is realized and all uncertainty ends. We solve backwards from this date.[31]

Pricing conventions. We refer to the currency of the sovereign issuer as local currency, and the currency of foreign investors as the hard currency. The exchange rate is $\mathcal{E}_t$, stated in units of local

[29]In this section the supply of bonds in local-and hard currency debt are fixed and exogenous; we endogenize these in Section 7. The model abstracts from endogenous changes in the quantity of initial borrowing borrowing of the sovereign and focuses on the currency denomination of external debt. This assumption becomes more clear and relevant in Section 7. Of course, this assumption shuts down a potentially important margin of adjustment for sovereigns, but we the model provides enough richness to discuss how re-introducing this margin would affect the results. This is also our motivation for conditioning our empirical cross-country evidence on the overall level of external borrowing, which we take care to do in Sections 3 and 6

[30]That is, Z is an endowment which represents taxes collected minus total outlays.

[31]These timing assumptions are similar to those in the rollover crisis literature (Cole & Kehoe, 2000; Lorenzoni & Werning, 2019). However, here, fear of future default affects bond prices through competitive forces in bond intermediation, not through self-fulfilling rational expectations.

currency consumption per unit of foreign consumption. An increase in $\mathcal{E}_t$ reflects a depreciation of the local currency relative to the hard currency. We denote prices and quantities of local-currency securities with a superscript L and those of hard-currency securities with an H. The exchange rate $\mathcal{E}_t$ is exogenous. The focus of our empirical analyses and the theory we present here is the effect of long-term exchange rate risk on foreign participation in bond markets and the volatility of interim capital flows: Therefore, we abstract from exchange rate determination in intermediate periods, and hold exchange rates fixed at 1 until the final period. We normalize exchange rates prior to the realization of shocks to be equal to one, such that the value $\mathcal{E}_T$ can be interpreted as a gross exchange rate depreciation relative to previous periods.

Bond supply and default. In $t = 0$, the local sovereign issues one unit of long-term bonds to a competitive market of foreign investors, and sets a share θ to issue in the local-currency market.[32] In this section, θ is an exogenous parameter. The face value of debt obligations in the final period, stated in local currency, is

$$B_T = \theta + (1 - \theta)\mathcal{E}_T \tag{4}$$

Hard currency obligations are indexed to the exchange rate $\mathcal{E}_T$. If the bad-news state realizes, and Z_T becomes risky, the sovereign may default. Subsequently, the government realizes its terminal fiscal surplus Z_T, which is endowed in units of local currency, and the exchange rate $\mathcal{E}_T$. There is no strategic default: the sovereign repays all of its debts at face value if and only if the realized surplus is large enough to cover B_T. We can thus define the repayment function $\chi = \mathbb{1}\{Z_T \geq B_T\}$.

Together, B_T and χ demonstrate how the local-currency share θ affects the credit-risk profile of the sovereign debt. If the fiscal outlook becomes risky, then χ becomes a random variable whose distribution depends jointly on shocks to $Z, \mathcal{E}$, and the key parameter θ. At lower values of θ, the face value of the debt obligations is more exposed to exchange rate risk. The support of Z over which the sovereign is guaranteed to repay its debt shrinks as the value of θ declines. At the corner where $\theta = 1$, the risk of default is entirely decoupled from exchange rate risk: Exchange rates could depreciate, but as long as there are enough local-currency budget surplus, the debt will be repaid in full. However, through its direct effects on bond valuations from foreigners' perspective, exchange rates will still matter for bond prices and intermediation even at the corner where $\theta = 1$.

When there are not enough resources in the final period to repay the debts at face value, the sovereign defaults and allocates the resources to creditors in proportion to the face value of

[32] We model foreign investors as marginal buyers of sovereign debt in $t = 1$, and treat domestic investors as a residual. We provide more detail on bond supply, payoffs, and default in Appendix A.1.

their obligations. The shares of local-currency resources obligated to local- and hard-currency creditors under this scheme are given by

$$m^L = \frac{\theta}{B_T}, \quad m^H = \frac{(1-\theta)\mathcal{E}_T}{B_T}$$

The share of resources available to hard-currency creditors under our assumption of pari-passu adjusts mechanically with the exchange rate.[33] Payoffs on hard- and local-currency bonds can therefore be expressed as using the ratio of bond total repayments to obligations in the final period, stated in local-currency units:

$$X_T = \min\left\{1, \frac{Z_T}{B_T}\right\} \tag{5}$$

Together, these equations allow us to express ex-post payoffs on the two bonds under this creditor scheme quite simply. We express them, stated in units of hard-currency, as

$$X^L = \frac{X_T}{\mathcal{E}_T} \qquad X^H = X_T$$

The key point from the definition of payoffs is that, from the perspective of foreign creditors, hard-currency bonds are exposed to exchange rate risk only indirectly through its effects on credit risk. Local currency creditors are exposed to currency risk both directly through the hard-currency valuation of the bond, and indirectly through credit risk. In what follows, we express expected bond payoffs and returns from time $t = 0$ using the operator $\mathbb{E}$, and expected bond payoffs and returns conditional on realizing the bad-news state using the operator $\mathbb{E}_b$.

Foreign households. Foreign households cannot directly own these sovereign bonds themselves, but invest savings with financial intermediaries who buy bonds on their behalf. The key ingredient of our model is that households derive utility not only from consumption, but also from owning money-like claims. Foreign households have a utility function that is linear in the quantity of money-like claims:

$$U_0 = C_0 + \beta\mathbb{E}[C_T] + \gamma M \tag{6}$$

[33]In this sense, we assume a strict case of pari-passu bond repayments. This is a natural assumption to start from since the allocations of repayments across creditors are the same in both repayment and default states of the world. That is, m^L and m^H also describe the allocation of resources in the non-default state of the world. This has the implication that hard-currency debt becomes effectively senior to local-currency debt when exchange rates depreciate.

where M is the quantity of money-like claims purchased in time $t = 0$. Any claim which delivers a guaranteed payoff in time T is valued as a money-like claim by households from time $t = 0$. Households are indifferent between owning a claim on one unit of expected consumption denominated in hard-currency in T and β units of in consumption today, but they value a guaranteed claim on a unit of consumption in T at a discretely higher value $\beta + \gamma$. $\gamma > 0$ therefore parameterizes the utility value of the monetary services and hence the fixed convenience yield on safe claims.[34] The assumption that utility is linear in M implies that the economy will feature a fixed spreads between the interest rate on risky assets and the interest rate on safe assets. The assumption is not necessary to deliver the main intuition of the model, but it helps to focus the model on the question of *how* intermediaries will produce safe assets M and not what the aggregate quantity of safe assets will be.[35] Linearity makes the deviation from the assumptions in Modigliani and Miller (1958) very sharp: Here, households will never be satiated in their demand for money-like claims. The preferences in (6) imply that intermediaries can always lower their weighted average cost of capital for the purchase of a given asset if they can guarantee some part of the claim to households. How financiers choose to raise funds from households will therefore affect what assets they hold and sovereign bond prices in equilibrium.

Our use of money in the utility function to generate a role for financial intermediation follows Stein (2012) and Hanson et al. (2015). We contribute to these models by microfounding credit and exchange rate risks in intermediaries' portfolios of sovereign bonds, studying how intermediation interacts with exchange rate risk, and endogenizing bond supply across currencies to the money premium (in Section 7).

Bond intermediaries. A unit continuum of heterogeneous bond intermediaries buy bonds and compete to raise financing from households.[36] Intermediaries take initial bond prices P_0^c, and expected bond payoffs X^c as given, and select a quantity of money-like claims backed by bond c to supply to households, denoted M_j^c for an intermediary type j.

Intermediaries construct money-like claims out of risky bonds using one of two strategies. First, intermediaries can issue money-like claims against the worst-case payoff on their asset port-

[34]As is made clear below, some intermediaries in our model provide claims which are certainly safe in their long-term payoff, and in equilibrium do not redeem these before uncertainty is resolved. Other intermediaries provide claims which are perhaps better described as liquid. In reality, households may value these two kinds of monetary services quite differently. In the context of the model, all agents have rational expectations and know how claims will be valued conditional on observing shocks, and the two services are equivalent in this setting. It is a simplification which can easily be relaxed in the model but for which we cannot offer any empirical discipline.

[35]This assumption will become especially useful for tractability when we consider the question of endogenous bond supply in each currency. In Section 7, we abstract from the overall size of the sovereign issuer's borrowing needs and focus on the question of how she should go about borrowing. Linear preferences make this abstraction straightforward.

[36]Recall, the focus of the model is on the currency mix of debt, and household preferences are linear. The total wealth supplied to intermediaries by households is inelastic.

folio, which requires holding bonds until all uncertainty has been resolved (to maturity). Second, intermediaries can issue money-like claims against the liquidation value of assets in their portfolio, which may be realized if the fiscal outlook deteriorates. We label these two strategies the "stable-funding" ($j = S$) strategy and the "unstable-funding" ($j = U$) strategy, respectively.

Stable-funding strategy. Financiers with stable funding earn the money premium by guaranteeing a minimum payout on their asset portfolio in the terminal period T. A stable-funding-type will thus expect the following profits from a unit of hard-currency invested in c-denominated bonds:

$$\max_{M_S^c} \quad \Pi_S^c = (\gamma + \beta) M_S^c + \beta \mathbb{E}\left[(X^c - M_S^c) \cdot \mathbb{1}\left(X^c \geq M_S^c \right) \right] - P_0^c \tag{7}$$

subject to a Value-at-Risk constraint $M_S^c \leq \underline{X}^c$. This constraint is the key feature of stable-funding intermediaries: The maximum quantity of claims these financiers can supply backed by a bond denominated in currency $c \in \{L, H\}$ is given by this worst-case payoff on their bond holdings, denoted $\underline{X}^c$, which we describe in more detail below. Because households value these completely safe claims at a higher value than risky claims on the bonds, U-type intermediaries earn the premium γ on $\underline{X}^c$. Stable intermediaries set $M_S^c = \underline{X}^c$ and we can simplify (7) to write

$$\Pi_S^c = \gamma \underline{X}^c + \beta \mathbb{E}[X^c] - P_0^c$$

The gross payoff from intermediating bond c for stable-funding-types exceeds the expected discounted returns on the underlying asset by the total money premium $\gamma \underline{X}^c$. In what follows, we assume $\underline{X}^c$ is a constant. In drawing analogies to the real-world institutions we study and the bonds they hold, we interpret this primitive parameter not as the literal worst-case payoff on the bond, but as the maximum amount of the bond purchase which can be funded by safe debt claims under a particular risk-based capital regime. The intuition of the model holds under both interpretations. Under the capital-regime interpretation, stable-funding-types guarantee claims from their portfolio by participating in a risk-based capital regime which sets a floor on the value of their portfolio in the final period. This floor may be equal to or greater than the worst-case payoff on the bond, depending on how generous the capital regime is. We pause here to describe such a regime in broad terms, but provide more details and a derivation of the general case in Appendix A.3.2.[37]

Under this regime, the financier can purchase fairly-priced insurance for the claims it offers

[37]Our results are robust to the general case under relatively weak assumptions about the distributions of the fiscal and exchange rate shocks Z and $\mathcal{E}$

households (e.g., deposit insurance), but must fund some portion of its bond portfolio with loss-absorbing equity.[38] We require, like many real-world examples of such schemes, that financiers meet capital requirements in order to participate in such a scheme. Specifically, in Appendix A.3.2, we assume that the guarantee scheme has been set up by a tax authority which only accepts bearing losses with some fixed probability π, and in turn, requires the financier to hold capital against losses which occur with probability π or greater.[39] Financiers are required to fund any bond purchases which experience losses with probability π or greater using equity. These equity-financed bond purchases are more costly than those financed by safe claims, which raise $\gamma + \beta$ per claim.

Unstable-funding strategy. An alternative approach is to create money-like claims backed by the liquidation value of the bond portfolio. In other words, financiers can also reassure households of the safety of their claims by allowing households to redeem claims early. This value is P_b^c, the market price of the bond in the bad-news state of the world. With full information about the market structure and the fiscal and exchange rate risks, bond funds have no uncertainty about this market price. Formally, this strategy finances the purchase of bond with a combination of collateralized short-term claims and common equity shares.[40] A unit of H invested in bond-c under this unstable-funding strategy yields

$$\max_{M_U^c} \quad \Pi_U^c = \gamma M_U^c + \beta \mathbb{E}\left[(1-b)X_{1-b}^c + bP_b^c\right] - P_0^c \tag{8}$$

subject to $M_U^c \leq P_b^c$. We abuse notation slightly here and use X_{1-b}^c to denote the payoff on bond c conditional on realizing the good-news state–that is $X_{1-b}^L = \mathcal{E}_T^{-1}$; $X_{1-b}^H = 1$. Formally, this strategy finances the purchase of bond c with a combination of a short-term claims M_U^c and common equity shares, which are valued at $\beta\mathbb{E}[(1-b)(X_{1-b}^c - P_b^c)]$. The key idea is that the short-term claim M is subject to redemption, which can force the liquidation of the underlying asset at price P_b^c.

There are two differences between unstable-types' profit function in (8) and stable-types' in

[38] Fairly priced insurance only covers a portion of expected losses. Therefore, it is costly to finance bond purchases with equity relative to with money, which earns a lower rate $\gamma + \beta$, even in the presence of this insurance.

[39] This is a crude assumption: We say that behind the scenes of the households we detail in equation (6), there is some additional risk-bearing capacity in the tax system. This risk-bearing capacity is fixed and unrelated to the risk preferences of households we detail in the main body of the paper. As crude as this assumption is, it is a simple way to capture the complex schemes through which taxpayers bear financial risk in the real-world setting we study. In the euro area and the United States, both insurers and banks participate in explicit guarantee schemes, like traditional deposit insurance, but the liabilities of insurers and pensions are also in many cases implicitly guaranteed by government programs in exchange for submitting to capital regulation and supervision. In the euro area, both explicit and implicit guarantees exist at both the supra- and national levels.

[40] We discuss this in more detail in Section 4.2

(7). First, while stable-types' profits from buying bond c are pinned down by the constant $\underline{X}^c$ and, ultimately, their access to the deposit guarantee scheme. Unstable-types' profits instead depend on endogenous liquidation values. The key distinction is how these financiers choose to produce M claims. The second difference is that unstable-types liquidate their investments in the event of learning bad news, and thereby give up the equity value of holding the risky bond conditional on realizing the bad news state. This means that the return on equity in unstable intermediary is capped at the realization of the bonds in the good state. Households value their claims on the unstable fund like a tranched product. In particular, we can re-write (8) as

$$\Pi_U^c = (\gamma + b\beta)P_b^c + \beta\mathbb{E}_{1-b}[(1-b)X^c] - P_0^c$$

In what follows, we denote the endogenous share of bond $c \in \{L, F\}$ intermediated through the unstable funding strategy $\mu^c(P_b^c)$. This expression highlights the key idea of the model: That intermediation of bond c and its price in bad states of the world P_b^c are endogenous objects, determined in part by the profit functions of intermediaries.

The intermediaries modeled above are specialists in these bond markets: Their choice of intermediation strategy is long-term and they cannot re-optimize their capital structures when new information is revealed.

Bond-market clearing and outside investors. We pause here to preview bond market clearing, before defining competitive equilibrium formally. We have assumed that initial bond supply in each currency is exogenous, given by $B_0^L = \theta, B_0^H = 1 - \theta$ (recall the $t = 0$ exchange rate is normalized to 1). In the event of bad news, unstable investors sell bonds, and bond supply on the secondary market becomes endogenous to the amount of each bond held under the unstable strategy. How will markets clear in these states of the world?

In the initial period, intermediaries are perfectly competitive and allocate their funding elastically across markets L and H and strategies U and S such that there are no profits to be made by deviating to another allocation. Intermediaries supply funding to each bond perfectly elastically and bond prices adjust to clear markets. However, market-clearing prices will depart from expected cash-flows because of household demand for money. Initial bond prices adjusts endogenously to clear initial bond supply.

In the bad-news state, households force unstable intermediaries sell their bond holdings. The supply of bond denominated in c in the bad-news state is endogenous to the share held by unstable intermediaries:

$$S_b^L = \theta\mu^L(P_b^L), \quad S_b^H = (1-\theta)\mu^H(P_b^H)$$

Forced bond sales constitute capital outflows by foreigners which must be absorbed by domestic investors.[41] To step in and absorb this supply of bonds, domestic investors require a discount on fundamental values of bonds. Domestic investors have demand for externally-held sovereign bonds denominated in currency c of

$$Q^c(P_b^L) = \eta \left(1 - \frac{P_b^c}{\mathbb{E}_b[X^c]}\right) \tag{9}$$

where $\eta > 0$. We use ζ^c to denote the discount on fundamental values of bond c:

$$\zeta^c \equiv \frac{P_b^c}{\mathbb{E}_b[X^c]}$$

We microfound these demand curves in Section 7.[42] The demand curve (9) simply states that the fire-sale price will be decreasing in the amount of bond c that is liquidated in equilibrium. Intermediaries, anticipating this downward-sloping demand curve and the possibility of forced sales, elastically set-up shop as unstable intermediaries up until the point where the marginal intermediary is indifferent towards switching a stable-funding strategy.

4.2 Equilibrium bond prices and investor composition

We now specify the conditions for equilibrium in bond markets. The model features two bond markets and two intermediary-types which participate in both markets. The endogenous objects are intermediation strategies μ^L, μ^H, which encode bond supply in the bad-news state, and pairs of state-by-state bond prices (P_s^L, P_s^H). The states of the world are the initial period (issuance prices) and the bad-news state (fire-sale prices). Outside of these states, bond prices are given by their frictionless, fundamental values.

The solution proceeds in two steps. First, intermediaries take initial bond prices as given and a zero-profit condition within bond markets pins down the unstable intermediation shares μ^H, μ^L. Second, a no-long run arbitrage condition across bond markets equates the expected intermediation profits across L and H bonds.

Definition (Competitive equilibrium in bond markets)**.** *Equilibrium is a pair of intermediation strategies (μ^L, μ^H) and pairs of state-by-state bond prices (P_s^L, P_s^H) such that:*

[41] It is without loss of generality to refer to these outside investors as domestic investors. We discuss this interpretation and its relation to our estimates of price impact in local- and hard-currency markets in Section 6

[42] We implicitly assume here that secondary-market investors in market L are segmented from those in market H, but for simplicity we assume the two markets are symmetric. This is an assumption we can relax, and do in Section 7.

1. ***Free entry.*** *Intermediaries are indifferent between setting up shop in bond market c with stable or unstable funding.*

2. ***No long-run arbitrage.*** *Intermediaries are indifferent between setting up shop in bond market L and market H.*

3. ***Market clearing.*** *Both primary and secondary markets for bonds must clear. In time $t = 0$, primary market clearing for bonds is implied by (2) and our assumption of linear preferences in (6). In time $t = 1$, there is secondary market trading only with probability b. In this event we require secondary bond-market clearing: $S_b^c = Q^c$. Bond-market clearing in the bad-news state implies a linear mapping between intermediation strategies (μ^L, μ^H) and the bad-news state prices (P_b^L, P_b^H).*

A few remarks are in order. First, we model intermediation choices as long-term choices. There is free entry to start, but once financiers choose their strategy, they are immobile until uncertainty is resolved. Second, free entry means that the marginal value of creating safe claims from the two bonds needs to be equal under both strategies. If stable-intermediaries have an advantage in hard-currency bonds–if $\Pi_S^H > \Pi_U^H$, then the relative advantage for unstable intermediaries needs to rise. This happens when more financiers pursue the hold-to-maturity strategy, hard-currency bond supply falls in the bad-news state, the fire-sale discount rises, and funds produce more money-like claims. Finally, the requirement of no long-run arbitrage implies that bond intermediaries in our model will internalize two kinds of bond risks: (i) the fundamental credit risk associated with issuing debts with exchange rate risk, and (ii) the risk of fire-sales. To the extent that hard-currency bonds support more safe-asset than local-currency bonds, market participants anticipate that there will be differential capital gains on the two bonds in the event of bad news and price this risk in today. This differential in capital gains in the fire-sale state is proportional to the difference in money-creation value.

To flesh out the mechanics of the model, we make the following two assumptions:

A1: If bad-news arrives, exchange rates and fiscal surpluses in the final period are exogenous. The exchange rate is drawn according to $\mathcal{E} = \exp(e)$, where e is drawn from a continuous distribution $F_e(e)$. $F_e(e)$ has support $\mathcal{S}_e = [\underline{e}, \bar{e}]$, where $\bar{\mathcal{E}} > 0$. That is to say, there is strictly positive probability that the exchange rate will depreciate. We define the worst-case exchange rate as $\bar{\mathcal{E}} = \exp(\bar{e})$. Similarly, we have $Z = \exp(z)$, where innovations$z$ are drawn from $F_z(z)$. $F_z(z)$ has support $\mathcal{S}_z = [\underline{z}, \bar{z}]$, and we define $\underline{Z} = \exp(\underline{z})$. Thus we can define

$$\underline{X} = \min\left\{1, \frac{\underline{Z}}{\theta + (1-\theta)\bar{\mathcal{E}}}\right\}$$

A2: Innovations to exchanges rates and primary surpluses are weakly negatively correlated: $\text{Cov}(z, e) \leq 0$. Bad times for domestic endowments correlate with depreciated exchange rates.

We solve for equilibrium as follows. We have two bond prices, (P_0^L, P_0^H), and two intermediation strategies (μ^L, μ^H) to pin down. Market clearing implies a linear mapping between intermediation strategies (μ^L, μ^H) and the bad-news state prices (P_b^L, P_b^H). We have four indifference conditions to pin these down, but one of these is redundant and the system is overdetermined by one equation. We thus normalize the net returns to investing in hard-currencies under the insurance strategy to zero, which allows us to pin down the issuance-cost spread $P_0^L - P_0^H$.

Free entry requires that intermediaries in each bond market are indifferent between setting up shop under the U strategy and the S strategy:

$$\Pi_U^c = \Pi_S^c \quad \text{for} \quad c \in \{L, H\}$$

Given the secondary market-clearing condition 2(a), these two indifference conditions pin down two values of ζ^c, the fire-sale discounts on the bonds in the bad-news state of the world. In turn, the ζ^c's pin down the intermediation shares μ^c. By market clearing in the bad-news state of the world, the intermediation share μ^c is a linear function of ζ^c. Supply in this state is given by the quantity of bonds which the unstable funds sell–which, under our current assumptions, is equal to the share of bonds they own (since we have assumed they liquidate everything here):

$$S_b^c = \theta \mu^c$$

Market clearing with potentially inelastic residual investors implies that bonds held by unstable funds will trade at a discount in the event that bad news arrives: $S_b^c = Q_b(P_b^c)$

Finally, the no-arbitrage condition pins down initial bond prices.[43] Intermediaries are indifferent between holding bond H and holding bond L: Together with condition (1) and our normalization of profits under one strategy, this condition implies there are zero net profits to be made from intermediation in equilibrium ($\Pi_U^H = \Pi_U^L = \Pi_S^L = \Pi_S^H$).

The key insight of the model is given in Proposition 1: Because of the downside risk associated with local currency bonds, the share of intermediation in those bonds done through the unstable funding strategy will always weakly exceed the share done through the stable strategy. Moreover, the model delivers two intuitive comparative statics, which we test in the data in Sec-

[43]First-period prices P_0^c will not be useful in pinning down the equilibrium mix of intermediation, since they represent symmetric costs across the two intermediation strategies.

tion 5. The share done through the the unstable funding strategy increases in the value-at-risk in exchange rates, because greater tail risk makes holding the local-currency bond costlier for stable intermediaries. In addition, when residual local-currency investors are more price-elastic, the liquidation value of these bonds increases, and fewer intermediaries need to sell during a fire-sale to remain competitive with stable-funding types.

Proposition 1 (Equilibrium investor sorting)**.** *If there is exchange rate risk, $\mu^L > \mu^H$ for any $\theta \in [0,1)$. Intermediaries with unstable funding intermediate a larger share of local-currency bonds. The degree of sorting $\mu^L - \mu^H$ is (i) increasing in the downside risk in exchange rates $\bar{\mathcal{E}}$, (ii) decreasing in the elasticity of residual investors η.*

Proof. See appendix A.1.2.

Endogenous investor sorting also results in an equilibrium yield spread between the two currencies. The corollary below describes this result. To the extent that hard-currency bonds have a higher money-creation value relative to local-currency bonds, market participants anticipate that there will be differential capital gains on the two bonds in the event of bad news, and price it in today. This differential in capital gains in the fire-sale state is proportional to the difference in money-creation value. To see this, note that

$$\gamma\left(\underline{X}^H - \underline{X}^L\right) = (\gamma+\beta)\cdot(P_b^L - P_b^H) - b\beta\,\mathbb{E}_b[X^L - X^H].$$

The safety premium spread internalizes future fire-sale discounts relative to fundamental values. In Section 7, we revisit the implications of the safety premium for issuer's decisions. To preview the results, intermediation frictions distort the curve which describes how much revenue the issuer can raise at each value of θ, the local-currency share. All else equal, the presence of the safety premium means the slope of the revenue function in θ is lower than in the economy where there are no frictions in financial intermediation.

Corollary 1 (Equilibrium bond spreads)**.** *Local-currency bonds issue at lower price than hard currency bonds because of fire-sale risk. The spread is*

$$P_0^L - P_0^H = \gamma(\underline{X}^L - \underline{X}^H) + \beta\mathbb{E}[X^L - X^H] < 0 \tag{10}$$

Demand for money denominated in hard-currencies by foreign households generates a positive yield spread on local-currency bonds. In the event that bad-news arrives, the capital losses on local-currency bonds exceed those on hard-currency bonds:

$$R_b^L < R_b^H \tag{11}$$

where $R_b^c = P_b^c / P_0^c$.

Proof. See appendix A.1.2

The intuition behind Corollary 2 is as follows. Under competitive intermediation, no investment strategy can yield expected excess profits. Hard-currency bonds are inherently more efficient at capturing the safety premium γ, so investors bid up their prices until profits to being an insurer are equalized across currencies and intermediation strategies.

The corollary also states that local-currency bonds suffer larger capital losses in a fire sale, despite the safety value being priced in ex-ante. In a bad-news scenario, investors symmetrically reassess expected bond cash flows. However, because hard-currency bonds command a safety premium ex-ante, their good-news returns are lower than those of local-currency bonds. When investors revise expectations in the bad state, they deduct these good-state returns, which are smaller for hard-currency bonds. The model thus generates endogenous differences in bond covariances with bad news. We test this prediction directly in the next section.

Analogies to intermediaries in the data. Financiers who take the stable-funding strategy issue claims backed by assets guaranteed to pay out in the long run. We draw an analogy between this strategy and the capital structures of intermediaries classified in our data as insurers, pensions, and deposit-insured commercial banks.[44] The business models of these intermediaries is to maintain stable funding even when the market values of their portfolios decline. Sustaining this capital structure requires that the portfolio backing the claims be observably low risk in the long run.

In this way, our model nests the role of regulation in determining which assets certain intermediaries hold, and in particular, the constraints on banks and insurers in holding currency mismatch.[45] That is, the model endogenizes the bias of regulation against currency mismatch (Faia et al., 2022; Du & Huber, 2023; Gutierrez et al., 2023).

Intermediaries who take the unstable funding strategy purchase riskier bonds but subject themselves to the possibility of losing funding in the future. We draw an analogy between this

[44]One may observe that commercial banks are very much in the business of providing short-term, liquid claims to their customers, and should not be classified in this group. The key distinction between the two intermediary types we describe here is *how* they make their claims safe, and the answer to this question implies a differences in what households do with their claims in response to bad news. We think this distinction holds water in the real world and is consistent with other evidence on how banks and mutual funds differ in their behavior in response to external shocks.

[45]In both the euro area and the United States, insurers and banks participate in explicit guarantee schemes, like traditional deposit insurance, but the liabilities of insurers and pensions are also in many cases implicitly guaranteed by government programs in exchange for submitting to capital regulation and supervision. In the euro area, both explicit and implicit guarantees exist at both the supra- and national levels.

strategy and the capital structures of intermediaries classified in our data as open-end investment funds. The analogy deserves some discussion. In the literal terms of the model, unstable intermediaries fund a portion of their bond purchases with short-term, money-like claims collateralized by the underlying bond (M_U^c). Taken literally, the unstable intermediary resembles a repo-financed hedge fund, issuing both money and equity claims to households. The investment fund classification we link this intermediary to in the data pools together hedge funds and mutual funds, but the latter dominate in the euro area. This mapping is not exact: mutual funds issue redeemable equity claims, and typically do not finance much of their portfolios with repo or other forms of short-term borrowing. Our modeling choice reflects the empirical observation that, in contrast to insurers, pensions, and deposit-insured banks, these mutual funds experience large, correlated and performance-related share redemptions in bad times (Falato et al., 2021; Darmouni et al., 2022; Chari, 2023). The money premium γ in our model serves to generate something akin to these flows in a simple way, without taking a strong stance on the underlying manager incentives or behavioral biases which generate these flows. Like performance-driven flows, claims on the unstable intermediary in our model are endogenously high-beta: Relative to claims produced by stable intermediaries, they have higher rates of return conditional on realizing good news, and lower returns conditional on realizing bad-news.

A related idea is that mutual fund clients value their shares in the fund as providing liquidity services, since these shares can be redeemed at the same-day net-asset-value (Ma et al., 2022a). In appendix A.3.3, we explore this idea further, and derive the conditions under which we could interpret γ as these liquidity services in our setup. The key question in that appendix is the conditions under which households incentive-compatibly redeem their equity claims on the fund and convert them into money. The assumption required to interpret outflows from unstable funds in our model this way is that demand for money is sufficiently large relative to quantity of safe assets which can be produced by the sovereign bonds backing the fund portfolio.

5 Why do investors sort on currency? Testing the model

In this section, we validate the key assumption underlying Proposition 1 and test its comparative statics. We then turn to the question of causal price impacts and a test of Corollary 1 in Section 6.

First, assumption 1 in Section 4 says that local-currency bonds are not efficient collateral for money-like claims denominated in hard currency. We show evidence in favor of this assumption: Local-currency bonds carry significantly larger left tail risks from the perspective of a foreign investors. Formally, we estimate a quantile fixed-effects regressions of the left tail of holding period returns on an indicator for whether the bond is denominated in local currency. We estimate

$$Q_\tau[HPR_{it} \mid \text{Bond Currency}_i, X_i, t] = \alpha_t(\tau) + \beta_c(\tau)\mathbb{1}\{\text{Bond Currency}_i = c\} + \Gamma'(\tau)X_i \qquad (12)$$

separately for the quantiles $\tau = 25$ and $\tau = 10$ and separately for holding period returns over the 1-, 3-, or 5-year horizon. Holding-period returns in euros over horizon h are computed as

$$HPR_{it}(h) = \frac{P_{i,t} + \sum_{s=t-h}^{t} C_{is}}{P_{i,t-h}} \frac{\mathcal{E}_{t-h,c(i)}}{\mathcal{E}_{t,c(i)}}$$

where $\mathcal{E}_{t-h,c(i)}$ is the bilateral exchange rate between the currency $c(i)$ of bond i and the euro i month t, stated in units of the local currency.[46] All holding-period returns are annualized. The regressions in (12) provide tests of whether two similar bonds from the same issuer but in local- and hard-currencies have different value-at-risk profiles for euro-based intermediaries.

Table 3 reports the estimated percentage point difference in the left tail of annualized returns between local and hard currency bonds. Focusing first on the 1-year horizon, we find that the value at risk in local-currency bonds from the perspective of euro-based investors is significantly larger than that in comparable hard-currency bonds. Moving to the right across this table, we find that the gap in value-at-risk does not diminish over investment horizons, and in fact even widens at longer investment horizons, suggesting the value at risk for the local currency bonds is larger over longer holding periods. Importantly, differences in tail outcomes from the perspective of a euro-based investor persist within issuer.

Differences in outcomes over longer holding periods provides a motive to model the interaction bond intermediation in the way we have in section 4. Stable-funding intermediaries create long-term liabilities and are happy to hold assets whose market values fluctuates in the intermediate periods, as long as the asset converges in expectation to a fundamental value that can back its liabilities. Currency risk in local-currency bonds introduces a significant degree of uncertainty about ultimate convergence to fundamental values.

Next, we directly test the model predictions of Proposition 1. These model predictions are, to some degree, inherently issuer-level predictions and we therefore provide cross-country, reduced form evidence in their favor. The first testable hypothesis from Proposition 1 is that the degree to which mutual funds dominate local-currency financing relative to other types of foreign intermediaries will be increasing in the currency risk associated with local-currency bonds. The key intuition of the model is that the right tail of exchange rate outcomes puts an upper bound on the money-creation capacity of local-currency debt relative to its hard-currency counterpart. The

[46]Of course, for euro-denominated bonds we have $\mathcal{E}_{t,c(i)} = 1$.

Table 3: Estimated Relative Value-at-Risk in Local-Currency Bonds

	Dependent Variable: $Q_\tau(HPR_{it})$					
	1-year		3-year		5-year	
$\mathbf{1}\{\text{Local Currency}\}, \quad \tau = 10$	-16.09	-8.718	-10.46	-1.766	-11.17	-2.996
	(15.47)	(5.950)	(2.591)	(1.733)	(2.941)	(1.495)
$\mathbf{1}\{\text{Local Currency}\}, \quad \tau = 25$	-3.352	-2.792	-7.256	-1.469	-8.324	-2.613
	(2.542)	(2.712)	(1.330)	(1.529)	(1.879)	(1.309)
N	266,346		159,426		85,408	
Time FE	✓	✓	✓	✓	✓	✓
Remaining Maturity FE	✓	✓	✓	✓	✓	✓
× Size	✓	✓	✓	✓	✓	✓
× Coupon Type	✓	✓	✓	✓	✓	✓
× Issuer		✓	✓	✓		✓
	Unconditional quantile estimates					
$\bar{Q}_{\tau=10}$|Hard Currency	-6.7		-4.4		-1.8	
$\bar{Q}_{\tau=25}$|Hard Currency	-.57		0.98		3.65	
$\bar{Q}_{\tau=10}$|Local Currency	-10.3		-5.4		-5.3	
$\bar{Q}_{\tau=25}$|Local Currency	-1.4		-.39		-.12	

Notes: Estimates from quantile regressions of the form $Q_\tau[HPR_{it} \mid \text{Bond Currency}_i, X_i, t] = \alpha_t(\tau) + \beta_c(\tau)\mathbb{1}\{\text{Bond Currency}_i = c\} + \Gamma'(\tau)X_i$. Holding period returns are calculated inclusive of coupon payments and exchange rate valuation effects vis-a-vis the Euro, and annualized. Quantile regressions of holding period returns test whether local-currency bonds have different left tails of returns at medium and long-term horizons relative to similar bonds denominated in hard-currencies. Bootstrapped standard errors are reported in parentheses, with the bootstrap clustered at the bond level. Fixed-effects regression implemented using the multi-step location-scale procedure of Machado and Santos Silva (2019) for quantile regression.

testable implication is that mutual funds should sort into holding local currency more so than other investors when issuers' currencies have greater right-tail risk.[47]

The second testable hypothesis from the Proposition is that the degree to which mutual funds dominate local-currency financing relative to other types of foreign intermediaries rises with the elasticity of outside investors in local-currency bonds. The intuition behind this result is that deep-pocketed outside investors dampen the effects of fire sales, and raise the money-creation advantage of short-term funding intermediaries relative to those with long-term funding, holding fixed the risk properties of the bond.

We test these two predictions by collecting issuer-level information on exchange rates and domestic investors, which we borrow from Arslanalp and Tsuda (2014). We compute the two key moments of interest from the exchange rate data at the issuer level: quantiles from the right-tail of exchange rate outcomes vis-a-vis the euro, and the volatility of the bilateral exchange rate vis-a-vis the euro. From Arslanalp and Tsuda (2014), we borrow information on the share of sovereign

[47]Recall $\mathcal{E}$ is stated in units of local currency throughout the paper. The right tail of outcomes is the region over which the local currency depreciates against the euro.

debt held by domestic investors, and use this as a proxy for the size of outside investors in local-currency debt. Our tests of the hypotheses described above are quite simple: In cross-country regressions, do the comparative statics of Proposition 1 hold?

In estimating each of the individual binscatters in Figure 3 on annual panel data, we control for the three measures described above and absorb issuer-level effects. The degree of investor sorting we use comes directly from the proposition. For each sovereign issuer c and year t, we compute

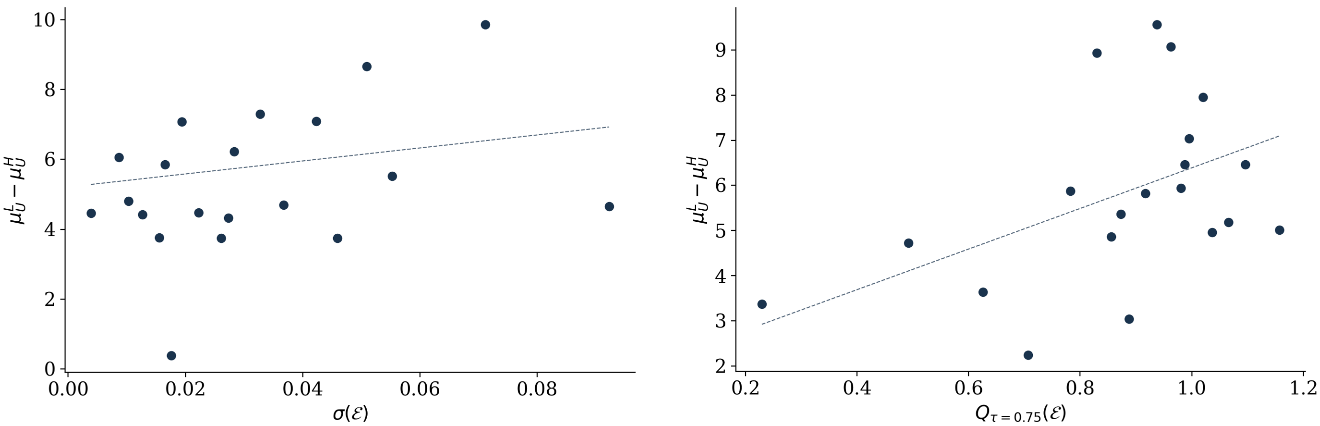
$$\mu_{c,t}^{L,\text{Funds}} - \mu_{c,t}^{H,\text{Funds}} = \frac{\sum_{i\in\mathcal{I}_c} h_{it}^{\text{Funds}} \mathbb{1}\{\text{Bond Currency}_i = \text{Local Currency}_c\}}{\sum_{i\in\mathcal{I}_c} \text{Amt Out}_{it} \mathbb{1}\{\text{Bond Currency}_i = \text{Local Currency}_c\}} - \frac{\sum_{i\in\mathcal{I}_c} h_{it}^{\text{Funds}} \mathbb{1}\{\text{Bond Currency}_i = \text{Hard Currency}\}}{\sum_{i\in\mathcal{I}_c} \text{Amt Out}_{it} \mathbb{1}\{\text{Bond Currency}_i = \text{Hard Currency}\}}$$

Consistent with the model predictions, we find positive correlations between $\mu_{c,t}^{L,\text{Funds}} - \mu_{c,t}^{H,\text{Funds}}$ and exchange-rate volatility, the right-tail of exchange-rate outcomes, and (weakly) the size of the domestic investor sector. One counterargument to our view on the drivers of investor sorting is that FX hedging by stable intermediaries would eliminate sorting. We address this argument with one conceptual point and one empirical. First, providing an FX hedge for the supply of bonds requires some residual agent to buy local currency forward in a net sense. Hedging exchange rate risk can eliminate sorting on an individual bond-contract sense, but not in equilibrium. In a competitive equilibrium, intermediary types are already indifferent towards carry-trade risk, so a transfer of new carry trade risk from stable intermediaries to mutual funds (if the mutual funds provide the hedge) will not hold.[48] That leaves the sovereign, or some un-modeled actor, to provide a hedge in our setting. If the sovereign agrees to buy local currency forward, they must borrow in dollars today and increase their currency mismatch. We discuss later in the paper how the sovereign's preferences determine their willingness to supply such a hedge. But if the sovereign is inelastic on this front, the cost of the FX hedge will rise, and the stable-funding intermediaries will remain at a disadvantage relative to mutual funds in holding local currency.

Empirically, this seems a relevant case: CIP deviations for a subsample of the currencies we study are prohibitively expensive; in particular, conducting hedges at long horizons is typically technically infeasible (banks just don't offer this kind of contract) – and rolling over short-term FX hedges in these currencies is prohibitively expensive. Another way to state this claim is that funding the carry trade with redeemable equity securities might be socially undesirable but because of the liquidity premium on mutual fund shares, it is just cheaper than funding it with

[48]Recent evidence does suggest that mutual funds provide some hedging capacity in net to other investors through their speculative FX positions. See Chen and Zhou (2025). This is consistent with our model prediction that investors with open-end funding structures have more capacity to hold carry-trade risk.

Figure 3: Euro-Area Intermediary Sorting and Exchange Rate Risk



(a) Exchange Rate Volatility vis-a-vis EUR

(b) Right Tail of Exchange Rate Realizations vis-a-vis EUR

Note: Figure displays a binscatter of the degree of intermediary sorting into local-currency at the issuer level against the estimated moments of bilateral exchange rates vis-a-vis the euro. The degree of intermediary sorting at the issuer level is computed from the SHS data as the share of local-currency bonds held by euro-area mutual funds less the share of hard-currency bonds held by euro-area mutual funds, consistent with the model-implied measure in Proposition 1. The estimated moments of the exchange rate are computed from quarterly data. Binscatters are computed using annual panel of issuer×year observations, and controls for (i) Exchange Rate Volatility vis-a-vis the Euro, (ii) the right tail of exchange rate realizations, (iii) the share of local-currency debt held externally from Arslanalp and Tsuda (2014), and a time fixed-effect. In panel (a), we compute the standard deviation of the exchange rate (demeaned) against the euro; in panel (b) we compute the 75th percentile outcome of the exchange rate stated in local currency units. Panel (b) thus uses a measure of the right tail of exchange rate *depreciations* against the euro, a proxy for our model parameter $\bar{\mathcal{E}}$ in Section 4.

long-term claims and hedging it.

6 Price impact of mutual-fund capital flows

Does investor composition matter for bond prices, as we have assumed in (9)? And if so, what are the implications for issuers? The rest of the paper addresses these questions.

This section first tests the underlying assumptions that mutual funds face imperfectly elastic buyers when liquidating assets to meet capital withdrawals. We then test the more unique prediction of our framework from Corollary 1: that outflows from mutual funds have differential price impact on local- and hard-currency bonds. Using the same identifying variation as in the first step, we document that in episodes of credit market tightening a given shock is associated with larger price declines in local currency markets, consistent with , and a shift in bond supply away from local-currency towards hard-currency.

6.1 Isolating the price impact mechanism

We test the main price impact mechanism we introduced in equation (9): Redemptions of claims on mutual funds by households drive down sovereign bond prices. The intuition of our framework rests on the claim that such outflows drive wedges between fundamental bond values and market prices. We encounter the familiar simultaneity problem that arises when seeking evidence of fire sales in asset markets: Disentangling changes in bond prices due to new information about the fundamental value of bonds from non-fundamental shifts in demand. We test this mechanism by isolating quasi-exogenous variation across bonds in exposure to mutual fund outflows.

The invasion of Ukraine in February of 2022 drove large and heterogeneous outflows from European mutual funds. As we verify below, some of the variation in outflows across funds appears to be due to funds' pre-invasion exposure to issuers directly affected by the effects of the invasion. The idea behind our empirical design is that some bonds were more exposed than others to mutual fund outflows–but not the fundamentals of the invasion itself–purely through co-holdings with these bonds. We test whether prices of such bonds fell significantly more than similar bonds held at funds without co-holdings in the months after the shock.

Using the same variation, we test the unique prediction of the model in Corollary 1: That bond price declines from mutual fund outflows will be concentrated in local-currency bonds. We extend the baseline differences-in-differences design to a triple difference which estimates heterogeneous treatment effects across currencies.

Event study design. We identify the effect of mutual fund outflows on local- and hard-currency bond prices by comparing yields among bonds who are held at funds with outflows to matched bonds held at funds with fewer outflows, in a standard event-study design:

$$y_{it} = \alpha_i + \alpha_t + \sum_{h=-12, h\neq 0}^{12} \gamma_h(\hat{\delta}_i \times \mathbb{1}\{t = h\}) + \Gamma' X_{i,t} + \varepsilon_{it} \tag{13}$$

We construct two bond-level, continuous treatment variables z_{ic} which measure the exposure of bond i to event-driven mutual fund outflows, described below. We report both pooled and monthly, dynamic versions of the regression (13). $X_{i,t}$ is a vector of bond and bond×date fixed effects. Importantly, we estimate versions of (13) both with currency×date fixed effects and with controls for spot exchange rates. In the former case, fixed effects absorb changes in bond price due to changes in currency risk premia, allowing us to identify price impact on the idiosyncratic credit-spread portion of the bond yield.[49]

The parallel trends assumption we make is that conditional on these observable bond characteristics, and in the absence of high co-holdings in funds which experience worse outflows, bonds matched on X_{it} would experience the same evolution in prices over the sample period. Importantly, this parallel trends assumption need only hold for the yields of bonds we study, and not necessarily for the funds which experience disproportionate outflows after the event. We run multiple tests to support our use of these assumptions in Appendix B.5. We also assume that treatment effects are constant across bonds conditional on observables in X_{it}.

Constructing the treatments z_i. The procedure to construct continuous bond-level treatment variables proceeds in four steps. (1) First, we observe the set of bonds in the investment universe of the mutual funds in our sample[50] and define the set of bonds directly exposed to the fundamentals of the event in February 2022. In this step we include any bond issued by an issuer domiciled in (a) ex-Soviet states, (b) states bordering Russia or Ukraine, or (c) Russia or Ukraine.[51] (2) Second, for each mutual-fund portfolio j, we calculate the portfolio weight in these securities in December 2021, 3 months before the shock, and denote it ω_j^R. Letting ω_{ijt} denote the portfolio weight for security i in portfolio j in month t, and $\mathcal{I}^R$ the set of securities which

[49]This design is consistent with our abstraction from price impact in spot exchange rates in the main model.

[50]The construction of the mutual fund sample is provided in Section 2

[51]Formally, we tag any fixed-income security from issuers in these domiciles. These include fixed-income securities from non-sovereign entitites. The sample of mutual funds we consider is dominated by portfolios with a fixed-income focus and have relatively little equity exposure. This change to the analysis makes little difference to the results. We also run versions of the test in which we include exposure to equity securities from these issuers, and versions where we include former members of the Warsaw Pact in the directly-exposed set of issuers. This also makes a small difference.

we tag as fundamentally exposed according to the above criteria, we compute

$$\omega_j^R = \sum_{i \in \mathcal{I}^R} \omega_{ijt} \times \mathbb{1}\{t = 2021\text{m}12\} \tag{14}$$

(3) Third, we sort mutual-fund portfolios. ω_j^R quantifies the exposure of funds to potential outflows after the shock of the invasion; our treatments quantify the coholdings of bonds in our sample which expose them indirectly to outflows. We split our sample of mutual fund portfolios along the median of ω_j^R, and define high-ω^R portfolios as those with holdings above the median in December 2021, and the rest as low-ω^R portfolio holdings.[52] (4) Fourth, we construct two different treatments for the bond-level shock. The first computes bonds' pre-invasion exposure to high-ω^R funds. For fund-portfolios $j \in \mathcal{J}^R$ we compute

$$\delta_i^R = \sum_{j \in \mathcal{J}^R} \frac{h_{ij,2021\text{m}2}}{\text{Amt Out}_{i,2021\text{m}2}}$$

And the exposure of bond i to high-ω^R portfolios relative to all portfolios as $\hat{\delta}_i^R = \frac{\delta_i^R}{\delta_i}$. The second measure computes the relative importance of bond i to high-ω^R funds. The *portfolio weight* of bond i in high-ω^R funds is

$$\omega_i^R = \frac{\sum_{j \in \mathcal{J}^R} h_{ij,2021\text{m}2}}{\sum_{j \in \mathcal{J}^R} \text{TNA}_{j,2021\text{m}2}}$$

where TNA refers to the total net assets of fund j. Both δ_{ic} and ω_{ic} have potential justifications in the theory, as each represents a different scaling of the key quantity: bond supply to outside investors. The bond-centric measure δ_{ic} is a natural scaling when bond liquidations by mutual funds facing withdrawals are closer to i.i.d. across bonds in the portfolio. Then the exposure of the bond to high-exposure funds is a good predictor of the bond supply conditional on withdrawals. On the other hand, if bond funds systematically liquidate bonds in proportion to their portfolio weights, the scaling of ω_{ic} may be a more natural predictor of bond supply. We report results for both. In appendix B.5, we also consider a shift-share treatment based on directly on the exposures of bonds to high-and low-outflow funds; the results are consistent with the results we report below for these two measures.

To summarize the procedure, we compute the exposures of non-$\mathcal{I}^R$ sovereign bonds in portfolios which rank relatively highly on the ω_j^R measure. The procedure inevitably involves degrees of freedom which could, in principle, introduce bias or confounding variation into the treatments;

[52]The results are robust to splitting funds along terciles or quintiles of this measure, which we report in B.5.

our approach to this concern is to ensure no single choice in the procedure drives the results. Robustness tests can be found in Appendix B.5.

In estimating (13), we make three adjustments to the sample of bonds to limit concerns about confounding variation driven by bond fundamentals. First and most obviously, we exclude bonds which are used in the construction of ω^R, the sort of funds on proximity to the fundamentals of the war. The price dynamics of these bonds are confounded by definition. Second, we exclude euro-denominated bonds in an effort to exclude confounding variation due to the aggregate effect of the war on any additional issuers who rely heavily on euros but are not captured in $\mathcal{J}^R$. Our results are robust to the inclusion of euro-denominated bonds. Finally, we exclude bonds from issuers which defaulted on any bond in the periods covered by the event study (Egypt and Sri Lanka).

Validating the fund portfolios sort. High-ω^R funds' flows fall by about 2 percent more than those of bond funds with low ω^R in the six months after the invasion of Ukraine (Appendix Figure B.4). the invasion relative to low-exposure funds. We demonstrate this by estimating a simple differences-in-differences regression of fund flows on the sorting measure. Letting portfolio j have outflows[53] f_{jt} in month t, we estimate

$$f_{jt} = \alpha_j + \alpha_t + \sum_{h=-12}^{12} \beta_h \left(\mathbb{1}\{j \in \mathcal{J}^R\} \times \mathbb{1}\{t - h = 2022m2\} \right) + \varepsilon_{jt} \tag{15}$$

β_h is an average difference in flows between low- and high-ω^R portfolios conditional on portfolio and time fixed effects; we do not interpret it causally.

Appendix figure B.4 summarizes the cumulative effects of the invasion on fund flows estimated in (15). Our procedure identifies a subset of funds $\mathcal{J}^R$ which were differentially affected by the events of the War in February 2022: Flows into these portfolios declined by 2 percent in the three months after the invasion, and remained persistently lower up to 8 months later. We find pre-invasion trends in flows that differ the two groups of funds. However, identification in our setting relies not on the assumption of parallel trends in fund flows across differentially affected portfolios, but on parallel trends in bond spreads between similar bonds held differentially by different funds.

Results. Tables B.9 and B.10 report estimates of regression (13) with $z_{ic} = \delta_{ic}$ and ω_{ic}, respectively. The first four columns report results for the entire pool of sovereign bonds. The dependent

[53]We aggregate fund flows up to the portfolio using the simple mean of fund flows. We also conduct robustness here on fund size-weighted means and median fund flows.

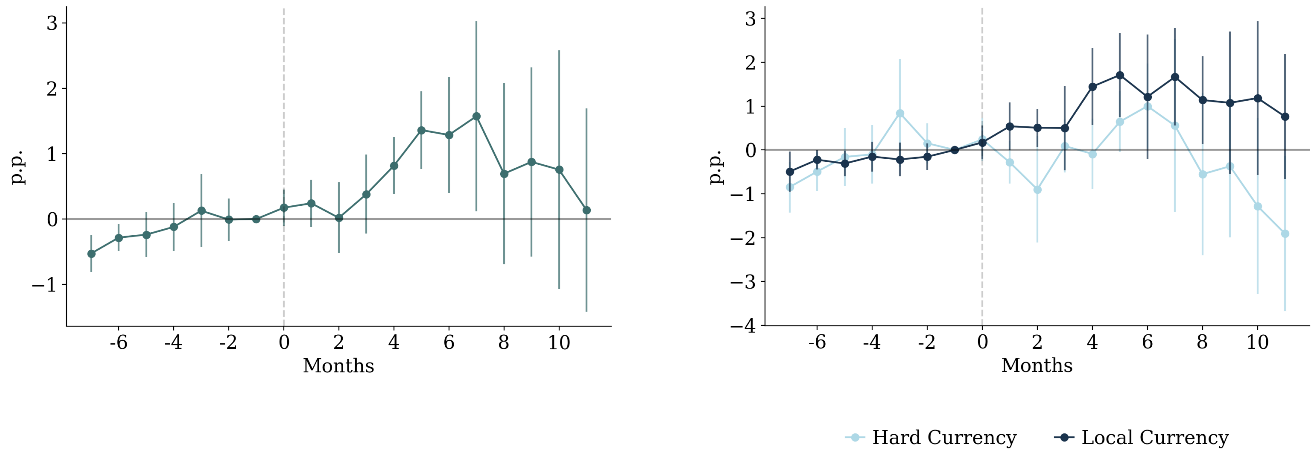
variable is raw bond yield-to-maturity. Treatments are scaled in regressions by their in-sample standard deviation, so that regression estimates can be interpreted as the differential pre-to-post yield increase associated with a standard deviation increase in the treatment, stated in percent. The first column for each treatment is the canonical two-way fixed effects estimator; it does not hold fixed observable bond characteristics on which we condition the parallel trends assumption. The second column includes interacted fixed effects for bond characteristics and, the third a control for the contemporaneous exchange rate depreciation against the dollar. The last column supplants FX controls with currency$\times$ month fixed effects, in which case regression estimates may be interpreted as price impact on the idiosyncratic credit-spread portion of bond yields. We also conduct tests in which we include currency$\times$ remaining maturity$\times$month fixed effects, to absorb any confounding variation due to changes in forward premia across bonds of different durations. Standard errors, in parentheses, are clustered at the issuer and date level using the wild bootstrap procedure.

Results from pooled regressions provide weak evidence of yield impact from our mutual-fund-outflow treatments. However, these weak average effects obfuscate large dynamic effects of the mutual fund shock on bond prices. In Figure 4a we report the estimated coefficients from the dynamic version of (13). Consistent with the price dynamics one would expect in a fire sale, we find evidence of large but temporary price dislocations among bonds exposed to fund-driven capital withdrawals, and that the cumulative price effects are near zero.

When we add a third difference to the regression, and allow for heterogeneous effects across currencies, the picture changes. We report results from this triple-difference design in columns 5-8 of Appendix Tables B.9 and B.10, as well as the dynamic effects split by currency in Figure 4b. The triple-difference results reveal that pooled estimates are averages of negligible yield impacts on hard currency bonds, and significant positive yield impact from mutual-fund outflows on local currency bonds. Importantly, these results hold when estimated on variation within sovereign issuers and other bond characteristics. Our estimates imply that a one-standard deviation increase in exposure to mutual-fund outflows is associated with an 20 basis-point credit spread in local-currency bonds in excess of the effect on an untreated bond from the same issuer. In Appendix B.5, we conduct a number of robustness tests to support our construction of the treatments z_i and the empirical design. We find evidence to support our approach in placebo tests for both the continuous bond-level treatments z_i as well as the event dates. We also find our results to be robust to changes in the procedure for the construction of the treatments, weighting schemes for bond-level variation, and pertinent changes to the sovereign sample.

Magnitudes and interpretations. How should we interpret these estimates, and what are their implications for typical bond outflow scenarios? To provide intuition, we conduct a simple ex-

Figure 4: Dynamic Price Impact of Capital Outflows from Mutual Funds



(a) Pooled effects

(b) Heterogeneous effects by currency

Notes: Figure reports estimated coefficients from the regression $y_{it} = \alpha_i + \alpha_t + \sum_{h=-12,h\neq 0}^{12} \gamma_h(\hat{\delta}_i \times \mathbb{1}\{t = h\}) + \Gamma' X_{i,t} + \varepsilon_{it}$. The continuous treatment variable $\hat{\delta}_{ic}$ is the share of bond i held at high-Russia-exposure funds relative to the share of bond i held at all funds. The dependent variable is the raw annualized bond yield-to-maturity y_{it}. The error bars indicate 90 percent confidence intervals, using standard errors clustered at the issuer and month level. The leave-out date for the dynamic diff-in-diff is January 2022. The x-axis units (for bond yield) are in percentage points, and can be interpreted as the excess yield-spread post-invasion associated with a bond held in full at high-exposure funds ($\hat{\delta}_i = 1$) relative to a similar bond with no exposure to high-exposure funds. Panel (a) presents pooled effects across all bonds, while Panel (b) shows heterogeneity by currency.

trapolation exercise to illustrate the magnitude of the channel we identify from this episode. This exercise is intended as a benchmark, as our cross-sectional variation does not allow us to identify aggregate effects of capital outflows on average yields. The exercise proceeds in two steps.

First, we compute the price elasticities implied by our canonical difference-in-differences estimates in (13), using a two-stage design and data on bond-level sales (Appendix B.6 provides further details). The implied semi-elasticity of local-currency bond yields with respect to a one-percent change in mutual-fund sales (relative to outstanding supply) ranges between 37 and 80 basis points. We make two observations regarding this estimate.

First, do differences in price impact reflect differences in quantities sold in a fire-sale episode, or differences across markets in the presence of outside investors? Our framework attributes differential price impact across bonds to endogenous differences in quantities sold.[54] Consistent with this interpretation, we find that mutual-fund sales of hard-currency bonds were significantly smaller than sales of local-currency bonds at all levels of treatment. Specifically, we estimate that local-currency bond sales associated with invasion-related fund outflows were more

[54]The model is neutral with respect to cross-market differences in the demand elasticities of outside investors. We assume symmetric outside investors as a baseline, and the theory does not deliver unique predictions regarding their relative elasticities.

Table 4: Baseline Differences-in-Differences Estimates of Price Impact
Local Currency Sovereign Bond Yields on Mutual Fund shock

	Dependent Variable: Bond Yield y_{it}					
	Treatment: δ_i			Treatment: ω_i		
Post × Treat	0.449	0.845***	0.203*	0.420***	0.389***	0.157**
	(0.286)	(0.136)	(0.110)	(0.125)	(0.112)	(0.0670)
N	14869	12224	13210	14616	12089	13001
Identifying Bonds	423	374	414	415	368	406
F stat	2.462	19.44	3.379	11.34	7.817	5.484
Mean Y	6.39	5.48	5.78	6.41	5.50	5.79
SE Y	5.63	3.74	3.86	5.66	3.75	3.88
Mean Treat	0.62	0.65	0.65	0.20	0.20	0.20
SE Treat	0.38	0.36	0.37	0.30	0.32	0.31
Month FE	✓	✓	✓	✓	✓	✓
ISIN FE	✓	✓	✓	✓	✓	✓
Issuer FE		✓	✓		✓	✓
x Remaining Maturity		✓	✓		✓	✓
x Size		✓	✓		✓	✓
x Coupon Type		✓	✓		✓	✓
x Currency		✓	✓		✓	✓
Currency × Month FE			✓			✓
Δ FX Control		✓			✓	

Table reports results from pooled differences-in-differences regressions of the form $y_{it} = \alpha_i + \alpha_t + \gamma\,(\text{Treat}_i \times \mathbb{1}\{t \geq 2022\text{m}2\}) + \Gamma' X_{i,t} + \epsilon_{it}$ at the bond$-i$ level for the subsample of local-currency bonds. The dependent variable is raw bond yield-to-maturity. Standard errors, in parentheses, are clustered at the bond and date level. Columns (1) through (3) report regressions using δ_i, the pre-invasion exposure of bond i to high-outflow funds, as a treatment. Columns (4) through (6) report regressions using ω_i, the pre-invasion weight of bond i to high-outflow funds, as a treatment. Both Treatments are scaled in regressions by their in-sample standard deviation, so that regression estimates can be interpreted as the differential pre-to-post yield increase associated with a standard deviation increase in the treatment, stated in percent. The first column for each treatment is the canonical two-way fixed effects estimator; the second column includes interacted fixed effects for bond characteristics and exchange rate controls. The last column supplants FX controls with currency× month fixed effects. *Sources:* Lipper, Bloomberg.

than 2.5 times larger in magnitude than hard-currency bond sales. In the two-stage specification, this manifests in a weak first-stage relationship for hard-currency bonds: our mutual-fund exposure instruments have limited explanatory power for hard-currency sales. As a consequence, our estimated elasticity of yields with respect to hard-currency bond sales is large but imprecisely estimated.

Formally, our procedure delivers local average treatment effect within each market. Effects are local to an episode in which hard-currency bonds were not subject to comparable fire-sale pressures, so we cannot reject the interpretation that the observed price differences are driven by differential outside investor demand.[55] Our results therefore allow us to abstract from the possibility that all observed price elasticities are driven by differences in outside investor demand, and instead highlight the role of variation in quantities sold.

Second, how should we think about the magnitudes of these estimates? The holdings data allow us to extrapolate our elasticity estimates to other capital outflow episodes, which we do in Appendix Table B.16. For the same episodes we used as motivating evidence in Section 5, we compute the mean issuer and currency-level securities sales (relative to total par outstanding). Consistent with the motivating evidence and with the predictions of the model, sales of local-currency securities typically significantly exceed those of their hard-currency counterparts in these episodes. Extrapolating our price impact estimates suggest the mutual fund withdrawal channel has meaningful implications for sovereign financing costs: A median outflow is associated with about a 40 basis point yield spread in excess of the average credit spread observed during these episodes.

6.2 Supply response: Substitution away from local-currency

Do these differential price dynamics drive issuers to substitute away from local currency markets? In the model we present in the next section, fire-sale related wedges between local-and hard-currency bonds present an arbitrage opportunity for issuers: an issuer can raise its overall stream of expected consumption by reallocating bond issuance to the high-price market (Ma, 2019; Liao, 2020; Caramichael et al., 2021). To the extent that issuers can costlessly subsitute between markets, they may dampen the price wedges we posit exist in Section 4.

Consistent with this intuition we find that in response to the differential price impact associated with capital outflows, issuers reallocate bond supply to hard-currency markets. To show this, we use the same quasi-random variation across bonds in exposure to mutual-fund capital outflows used in the previous section. This variation is appropriate for the study of the supply response under similar assumptions of parallel trends and constant treatment effects which we make in the preceding section.

The approach we take to study the supply response of issuers is to match two similar bonds from the same issuer, but denominated in two different currencies and test whether capital outflows in local-currency net local-currency issuance *within* the matched bond pair to decline. Consider a pairing, or "portfolio," k of two bonds from the same issuer, with similar remaining maturity, debt structure, and of size. The portfolio comprises a bond denominated in the local currency of the issuer, and a bond denominated in euros. The identifying variation in this setup comes

[55] Indeed, it may be natural to think that some local-currency markets have more residual buyers. This is not in conflict with our framework. If hard-currency bonds are intrinsically less liquid in distress periods (fewer outside buyers), the extent to which unstable investors sort into local-currency bonds would rise and strengthen our channel.

from the cross-section of matched bond-pairs on characteristics *other* than currency. Therefore, we make one amendment to the parallel trends assumption we make in the preceding section: We strengthen the assumption to say that conditional on observables excluding currency, two bond pairings would experience the same trends in net local-currency issuance in absence of the mutual-fund exposures captured in our z_i's. We compute for this bond pairing and each month t the net issuance in local currency, which we denote $\tilde{\theta}_{k,t}$:

$$\begin{aligned}\tilde{\theta}_{kt} &= \Delta \log(\text{Par Amount Outstanding in Local Currency}_{kt}) \\ &\quad - \Delta \log(\text{Par Amount Outstanding in Hard Currency}_{kt})\end{aligned}$$

This measure flexibly captures all of the margins through which an issuer might adjust the relative supply in local currency, including new issuance, redemptions at maturity, tender offers, and reopenings. In computing $\tilde{\theta}_{kt}$, we first translate all par amounts outstanding in each bond from the denomination of the bond currency into December 2021 euros. We seasonally adjust θ_{kt} at the issuer level.[56] Armed with $\tilde{\theta}_{k,t}$, we estimate a regression in spirit similar to the differences-in-differeces specification in (13), but with bond pairings as the observational unit. We then pool bond pairings and months and estimate

$$\tilde{\theta}_{kt} = \alpha_k + \alpha_t + \gamma_L \left(z_k^L \times \mathbb{1}\{t \geq 2022\text{m}2\} \right) + \gamma_H \left(z_k^H \times \mathbb{1}\{t \geq 2022\text{m}2\} \right) \Gamma' X_{k,t} + \epsilon_{kt} \tag{16}$$

The regression contains two treatments: z_k^L is a continuous variable which measures the exposure of the local-currency bond in pairing k to event-driven mutual fund outflows; z_k^H measures that of the dollar bond in pairing k. The regression tests whether *conditional* on a given capital-outflow exposure in hard-currency bonds, exposure to capital outflows in local-currency bonds induces the issuer to substitute into hard-currency. We make one amendment to the test as it has been described so far. Issuance at the individual bond level is highly idiosyncratic and the variation in θ_k at any individual matched bond-pair level is therefore quite sparse. In order to estimate (16), we aggregate the bond-pairings up to portfolios of bonds which match on issuer, remaining maturity, size, and debt type. k therefore indexes a size-weighted portfolio of similar bonds, containing potentially many bonds denominated in both local- and hard currencies. In constructing these pairings, we naturally exclude any bonds which do not have a counterpart matched on these observables in the alternate currency.

Table 5 reports the estimates for equation (16). The first row of coefficients report the estimate for γ^L, which is the response to mutual fund capital outflows from local-currency bonds in pair-

[56]Seasonal adjustment is most important for hard-currency bonds, where issuers tend to go to market for new issuances only a few times a year. For example, Goldman reports that Latin American issuers tend to go to market for USD bonds disproportionately in January (Research, n.d.).

ing k. As in Tables B.9 and B.10, the treatments z^c_{kt} are standardized such that coefficients may be interpreted as the change in outcome above the post-event trend associated with a one-standard deviation increase in exposure to mutual-fund capital outflows. The first and fourth columns of the table report the baseline twoway fixed-effects estimator using $z^c_{kt} = \hat{\delta}_{kt}$ and $z^c_{kt} = \omega_{kt}$, respectively. The remaining columns condition the estimates on the same set of interacted bond fixed effects used in the most saturated columns of Tables B.9 and B.10. The third and sixth columns add the controls for z^L_{kt}, the treatment on hard-currency bonds in pairing k. Standard errors, in parentheses, are clustered at the issuer and date level using a wild bootstrap. The estimates re-

Table 5: Net Local-Currency Issuance Response to Mutual Fund shock

	Dependent Variable: Net Local Currency Issuance $\tilde{\theta}_{k,t}$					
	Treatment: δ_k			Treatment: ω_k		
Post × Treat on Local-Currency Bonds z^L_k	-0.0560	-0.0946	-0.0743	-0.0242	-0.0474	-0.0369
	(0.0306)	(0.0335)	(0.0318)	(0.0199)	(0.0156)	(0.0133)
Post × Treat on Hard-Currency Bonds z^H_k			0.00226			-0.0285
			(0.0315)			(0.0340)
N	5658	5658	5658	5658	5658	5658
Identifying Bond Pairs	275	275	275	275	275	275
F stat	7.589	5.584	23.91	9.155	2.504	24.06
Mean $\tilde{\theta}_{kt}$	0.01	0.01	0.01	0.01	0.01	0.01
SE $\tilde{\theta}_{kt}$	0.45	0.45	0.45	0.45	0.45	0.45
Month FE	✓	✓	✓	✓	✓	✓
Bond-pair k FE	✓	✓	✓	✓	✓	✓
Issuer FE		✓	✓		✓	✓
x Remaining Maturity		✓	✓		✓	✓
x Size		✓	✓		✓	✓
x Coupon Type		✓	✓		✓	✓
x Currency		✓	✓		✓	✓
Currency × Date FE		✓	✓		✓	✓

Notes: Table reports results from pooled differences-in-differences regressions of the form $\tilde{\theta}_{kt} = \alpha_k + \alpha_t + \gamma\left(\delta_k \times \mathbb{1}\{t \geq 2022\text{m}2\}\right) + \Gamma' X_{k,t} + \epsilon_{kt}$ at the bond-portfolio$-k$ level. Bond portfolios, or "pairings," are constructed as size-weighted portfolios of bonds matched on issuer, remaining maturity, size, and coupon type. Bond portfolios contain both local and hard-currency bonds matched on these characteristics. The dependent variable is Net Local-Currency Issuance within bond portfolios: $\tilde{\theta}_{kt} = \Delta \log(\text{Par out in local}) - \Delta \log(\text{Par out in hard currency})$. $\tilde{\theta}_{kt}$ is constructed from the CSDB and seasonally adjusted. Standard errors, in parentheses, are clustered at the issuer and date level using a wild bootstrap. *Sources:* Lipper, CSDB.

ported in 5 imply issuers reduce net local-currency supply by between 3.7 and 9.6 log-points in response to capital outflows from these bonds and the associated price impact. A very crude back-of-the-envelope calculation using the estimates from Tables B.9 and B.10 allows us to frame this in substitution elasticities: The same standard deviation in bond-level exposure to mutual fund capital outflows is associated with between a 16- and 20- basis point increase in yields.[57]

7 Implications for issuers

What are the implications of these bond fire-sales for sovereign issuers? How would a sovereign who internalizes the costs of intermediation frictions pick an optimal local-currency share of debt? We approach these questions by extending the model to consider the problem of a sovereign with a fixed borrowing need of 1 unit in local-currency, and the decision to select a share θ to issue in the local-currency market. When choosing θ, the sovereign considers its effects on domestic consumption and investment.

The local-currency share affects aggregate consumption in our model through two familiar channels. First, default is costly. A greater local-currency share reduces the sovereign's exposure to exchange-rate risk and the probability of default. Our model thus features the familiar motive to reduce exposure to exchange rates in order to relax the government budget constraint and avoid costly default. Second, when there are deviations from uncovered return parity between local- and hard-currency bond markets, the sovereign can raise consumption by reallocating supply to the high-price market. The intermediation side of the model outlined in Section 4 endogenously generates such deviations, because of the inherent money-creation advantage in hard-currency bonds.

Finally, the local-currency share can affect domestic investment in our model. When foreigners offload bonds prematurely, domestic investors absorb some of this capital outflow. To do so, they reallocate balance sheet space away from domestic private investment. Fire sales by foreign mutual funds constitute net capital outflows which crowd out investment in private, domestic projects. To be induced to forego these projects, domestic investors bid down the price of sovereign bonds in the fire sale until the expected returns to holding bonds and domestic projects are equalized. Reductions in domestic investment returns are made up for by arbitrage profits from the fire sale. However, if there are any spillovers from domestic private investment,[58] the ex-post reallocation of domestic savings to private versus public investment – and therefore the size of the fire sale – affects the debt-manager's decision.

The debt manager optimizes the expected stream of consumption, which is the sum of proceeds from government issuance, domestic investment, and dead-weight losses from default. The focus of the paper and the analysis that follows is the optimal choice of local-currency issuance

[57] We intend to compute the implied substitution elasticity.

[58] We model domestic private investment as having positive externalities on domestic output. One could microfound these externalities in a number of ways, including as arising from a net worth channel or collateral constraints. See Céspedes et al. (2004), Mendoza (2010), and di Giovanni et al. (2022) for examples. We abstract from a microfoundation for simplicity.

given a particular current account balance or borrowing need. As in previous sections, we abstract from the total leverage of the domestic economy.[59]

Our theory of optimal currency choice carries analogies to "trade-off theories" of how corporates should select their capital structure in the face of costly external finance (Leland, 1994; Bolton et al., 2011). As in this literature, sovereigns in our setting trade off pecuniary benefits of one kind of external finance (e.g., hard currency, or debt) against the benefits of avoiding distress in another form (e.g., local currency, or equity).

Bond-pricing assumptions. In Section 4, we priced bonds under the numeraire of a foreigner who consumes a good denominated in hard currency. As we turn in this section to the consumption of a sovereign who consumes a good in local-currency, we simplify the intuitions by introducing an assumption which links the two numeraires. We make the following assumptions:

A3: The numeraire for a local-currency sovereign is a synthetic local-currency bond which delivers one sure unit of local currency in $t = T$. We denote the risk-neutral local-currency measure using $\mathbb{L}$, and that of the hard-currency measure $\mathbb{H}$. We denote the risky discount factors for local- and hard-currency households β^L, β^H, respectively. We assume

$$\beta^H \mathbb{E}^{\mathbb{H}}[\mathcal{E}_T^{-1}] = \beta^L \tag{17}$$

A4: From time $t = 0$, there is no expected exchange rate depreciation under the hard-currency numeraire. $\mathbb{E}^{\mathbb{H}}[\mathcal{E}_T^{-1}] = 1$.

Assumption 3 provides us with a risk-free numeraire denominated in local currency. It allows us to price the revenue raised by issuing to foreigners and the repayments made to foreigners under a consistent numeraire. The implicit assumption in equation (17) is that the sovereign prices its expected consumption stream relative to a safe benchmark in which financial markets do not allow for risk-free arbitrage between local-currency assets and hard-currency assets.[60]

We discuss these assumptions and weaker assumptions in more detail Appendix A.2.

[59]Of course, another margin through which sovereigns may choose to reduce their exposure to the channels we study here is to pursue policies which reduce the need for borrowing abroad, including financial repression. The purpose of our analysis is to highlight the margins through which currency choice can affect the domestic economy, but the aggregate effect of these margins on outcomes of course depends on the degree to which the sovereign needs to borrow form foreigners to begin with.

[60]I.e., a forward which delivers 1 unit of L in exchange for 1 unit of H in T has price $F_{0,T} = \frac{\beta^L}{\beta^H} = \mathbb{E}^{\mathbb{H}}[\mathcal{E}_T^{-1}]$

7.0.1 Government consumption

The generalized government budget constraint is

$$G_t = Z_t + \sum_{c\in\{L,H\}} P_t^c \left(B_{t+1}^c - B_t^c\right) - \sum_{c\in\{L,H\}} \kappa_t^c B_t^c \tag{18}$$

Government consumption consists of exogenous primary surpluses Z_t plus the revenue raised from new bond issuance, $\sum_{c\in\{L,H\}} P_t^c \left(B_{t+1}^c - B_t^c\right)$, less the debt repayments made to investors, B_t. Under the assumptions we made in Section 4, the government raises revenue in $t = 0$ only and makes repayments in $t = 2$ only.[61] The key repayment parameters are $\kappa_T^L = 1, \kappa_T^H = \mathcal{E}_T$.

When raising revenue, the debt manager faces competitive bond markets and cannot strategically default. This means they cannot choose θ to raise consumption at the expense of bondholders, as market participants will price in credit, exchange rate, and fire-sale risks. However, issuers in our model can raise consumption by issuing in hard-currency because foreign household demand for money drives a fixed spread between hard-and local-currency bonds, generated by foreign household demand for money. Proposition 2 summarizes this result.

Proposition 2 (Net Revenue Curve)**.** *Under Assumptions 3 and 4, the sovereign cannot raise net revenue from issuance by changing θ except insofar as there is a fixed spread between the money-creation values of hard and local currency. Under the local-currency risk-neutral measure $\mathbb{L}$, net revenue is*

$$\textit{Net Revenue} = \sum_{c\in\{L,H\}} \theta^c \left(\gamma^H \underline{X}^c + \rho\, \mathbb{E}^{\mathbb{L}}[X^c]\right),$$

where $\rho = 1 - \frac{\beta^L}{\beta^H}$. Under Assumption 4, $\rho = 0$. Thus, the sovereign can raise consumption via θ only if a fixed spread exists between the money-creation values of the two currencies. The marginal effect of raising the local-currency share is

$$\frac{\partial}{\partial\theta}(\textit{Net Revenue}) = \gamma^H \left(\underline{X}^L - \underline{X}^H\right)$$

which is negative.

Proof. See Appendix A.2.1.

Currency denomination matters for government consumption because foreign households reward the issuers of hard-currency denominated money with γ^H. Proposition 2 highlights how our assumption of households' utility from hard-currency-denominated money in (6) breaks

[61] That is, $\boldsymbol{\kappa}_1 = \begin{bmatrix}0 & 0\end{bmatrix}'$ and $G_0 = Z_0 + \mathbf{p}_0^\top \mathbf{b}_1$, $G_1 = Z_1$, and $G_2 = Z_2 - \boldsymbol{\kappa}_2' \mathbf{b}_2$

from the assumptions of Modigliani and Miller (1958). The same friction which drives financiers to sort into intermediating local- and hard-currency bonds gets passed through to issuers here via the no-long-run-arbitrage condition (Corollary 1).

7.0.2 Costly default

In the final period, all new issuance stops and uncertainty is resolved. In the event of default the domestic economy suffers a dead-weight cost in the form of lost output (Aguiar & Amador, 2014). Domestic output follows

$$\mathcal{C}_t = \begin{cases} \mathcal{C}, & \chi = 1 \quad \text{or} \quad t < T \\ \mathcal{C} - \ell, & \chi = 0 \end{cases} \tag{19}$$

where $\mathcal{C} \geq 0$ is a constant endowment. The dead-weight loss in default is

$$\ell \equiv \phi \underbrace{(B_T - Z_T)}_{\text{intensity of default}} \cdot \underbrace{(1 - \chi_T)}_{\text{default indicator}}, \qquad 0 < \phi < 1$$

Consistent with our assumption of no selective default, costs of default on the borrower are equalized across defaults in local- currency and hard-currency markets. In what follows, we denote expected default losses under the local-currency numeraire using $\mathcal{L} = \mathbb{E}^{\mathbb{L}}[\ell]$. Without loss of generality, and to simplify the notation, we set $\mathcal{C} = 1$.

7.0.3 Domestic investment

A measure η^c of identical, risk-neutral domestic investors provide one unit of local-currency endowment each to domestic investment opportunities denominated in currency $c = \{H, L\}$.[62] Domestic investment opportunities yield a gross private return of $R(\iota^c)$ per unit of investment ι^c, where $R' > 0$ and $R'' < 0$. These private investment opportunities also yield an additional net return of $\alpha R(\iota^c)$ which private investors cannot internalize.[63]

Domestic investors in market c choose their investment period-by-period and state-by-state. Outside of the bad-news state, investors allocate all of their endowment to domestic projects and returns are trivially given by $\eta^c \times R(1)$. If the bad-news state occurs, another investment oppor-

[62]We can easily assume, and do below, that the positive investment spillovers of projects denominated in hard-currency do not accrue to the domestic economy. It may be more natural to imagine that domestic investors are only willing to absorb local-currency supply, and that other outsider foreigners will have to absorb the hard-currency bonds, but we present the general case first. We explore this assumption further below.

[63]A large literature studies the spillovers associated with capital outflows; see (Mendoza, 2010). We abstract from microfounding these spillovers for simplicity.

tunity arises: to buy sovereign bonds on the secondary market at a discount from foreigners. This investment yields an expected return of $\frac{\mathbb{E}_b^{\mathbb{L}}[X^c]}{P_b^c} = \frac{1}{\zeta^c}$. In this state, local-currency domestic investors choose an amount q^c of their endowment to buy sovereign bonds at a fire-sale discount. For local-currency investors, the profit problem is

$$\max_{q^L} \quad \pi_b^L = R(\iota^L) + q^L \mathbb{E}_b^{\mathbb{L}}[X^L] \quad \text{subject to} \quad \iota^L + P_b^L q^L = 1 \tag{20}$$

Hard-currency investors have a symmetric profit function, which we detail in appendix A.2. Note that implicitly, domestic investors in market H are segmented from those in market L. We can relax this assumption and retain the intuitions of what follows.[64]

In what follows, we assume $R(\iota) = \iota^{1-\rho}/(1-\rho)$ for concreteness. The solutions to the profit-maximization problem (20) imply demand curves for investment in real projects given by

$$\iota_b^c = (\zeta^c)^{\frac{1}{\rho}}$$

Asset market clearing and aggregate investment. In order to clear bond markets in the bad-news state, each domestic investor in c-currency projects must absorb a quantity $\frac{P_b^c \theta \mu^c}{\eta^c}$ of sovereign bonds in the bad news state. Aggregate domestic investment in c-currency projects in the bad-news state is therefore

$$I_b^c = \eta^c - \theta^c P_b^c \mu^c \quad \text{for} \quad c \in \{L, H\}$$

In partial equilibrium, endogenous intermediation by open-end funds in currency c crowds out domestic investment. However, μ^c is also endogenous to the zero-profit conditions for competitive intermediaries in Section 4. Intermediaries have a reservation liquidation-value of bond c given by ζ^c and pick their intermediation strategy μ^c perfectly elastically to hit this reservation price. Therefore, we have that aggregate demand for domestic investment in currency c in the bad-news state is given simply by $I^c = \eta^c(\zeta^c)^{1/\rho}$, and the market clearing condition (**??**) gives intermediation by open-end funds of local-currency bonds. Which is to say, formally, crowding out depends in general equilibrium on the supply of local currency θ only through its effects on the fire sale discounts ζ^c. By the budget constraint, aggregate demand for sovereign bonds in the

[64] We think of investors absorbing bonds in a currency c on the secondary market as specialists in that currency, whereas global intermediaries who buy bonds in $t = 0$ can participate freely in both markets. The qualitative intuitions of what follows are not affected by this assumption because returns from buying in fire sales are pinned down by competitive foreign intermediaries. By Corollary 1, returns from buying local-currency in the fire sale always exceed those on hard-currency.

bad-news state is

$$Q_b^c = \eta \left(1 - (\zeta^c)^{\frac{1}{\rho}}\right)$$

which provides the microfoundation for the demand curves in Section 4. Net domestic returns to investment, inclusive of both those internalized by private investors and those internalized by the local sovereign, are

$$\mathcal{I}_t = \underbrace{\sum_{c \in \{L,H\}} \eta^c \pi_t^c}_{\text{private returns}} + \underbrace{\alpha \sum_{c \in \{L,H\}} \eta^c R(\iota_t^c)}_{\text{social investment spillovers}} \tag{21}$$

In the fire sale, domestic investors make a profit at the expense of foreign bondholders, captured in the private returns term of (21). This is an ameliorating effect of bond fire sale on domestic consumption. These gross private returns are offset by gains or losses from a social perspective, which depend on the degree of spillovers from investment in real projects ι. Both private profits and spillovers depend on the policy choice of the local-currency share θ because domestic investors are always indifferent between making a unit of profits in the fire sale and a unit of profits on domestic investment.

Which of these two effects dominates–the private returns to financial arbitrage in the fire sale and the gross social gains from investment in real projects–depends on two terms: ρ, which governs the curvature of the domestic production function R, and α, which parameterizes the total spillovers. The intuition behind these parameters is the following. The marginal returns to arbitrage in the fire sale are pinned down by competitive foreign intermediaries. But at steeper parts of the production function R, domestic investors forego more returns from real investment for smaller quantities of profits from the fire sale in order to equalize marginal returns across the two opportunities. One might interpret greater values of ρ as reflecting a setting with higher marginal products of capital, or greater social welfare weights on higher-return sectors of production. In such settings, foregoing investment in real projects in order to arbitrage in the fire sale is costlier from a consumption perspective than in settings where the production function is closer to constant-returns. Similarly, at higher values of α, all fire sales are relatively more costly, and the region of ρ over which they are costly expands.

7.0.4 Debt manager's problem

The debt manager maximizes the expected stream of consumption, which is the sum of proceeds from government issuance, domestic investment, and deadweight losses from default.

$$\max_{\theta} \mathcal{W} = \sum_{t=0}^{2} \mathcal{C}_t + \mathcal{I}_t + G_t \tag{22}$$

where $\mathcal{C}_t, \mathcal{I}_t, G_t$ are given by (19), (21), and (18), respectively. In solving (22), the debt-manager trades off the effects of θ on revenue and default against its effects on the risk of capital outflows and their spillovers. Proposition 3 clarifies this tradeoff. Capital outflows in the bad-news state may generate a transfer of profits from foreign investors to domestic investors, but only to the extent that domestic investors are willing to forego profitable domestic private projects and the expected returns on those projects rise. In other words, the cost of absorbing capital outflows is only in its effects on the quantity of domestic investment. The debt manager does not internalize the capital losses on foreign investors' balance sheets associated with fire sales. We show in appendix A.2 that the government's indifference condition for the choice of local-currency share θ simplifies to

$$\underbrace{b\mathcal{L}_\theta}_{\substack{\text{marginal cost,}\\ \text{expected default}}} = \underbrace{-\gamma^H \left(\theta \underline{X}^L + (1-\theta)\underline{X}^L\right)}_{\substack{\text{marginal cost,}\\ \text{foregoing safety premium on H}}} - \underbrace{b\mathcal{I}_\theta}_{\substack{\text{marginal cost,}\\ \text{fire sale}}}$$

The indifference condition for the social planner equates the marginal cost of the Original Sin – which are given by greater vulnerabilities to exchange rate depreviations and higher default costs – to the marginal costs of overcoming the Original sin, which arise from channels: (i) raising θ requires foregoing the safety premium on hard-currency debt, and (ii) raising θ reinforces mutual-fund driven capital outflows, which crowd out domestic investment. The indifference condition implies a fixed-point problem in θ, which is a function of exogenous parameters and the endogenous intermediation shares μ^L, μ^H. The optimal local-currency share $\theta^\star$ is the solution to the fixed point problem. We characterize the optimal local-currency share in Proposition 3.

Proposition 3 (Optimal Local-Currency Share)**.** *Assuming the domestic production function R is sufficiently concave, the sovereign's problem in* (22) *admits interior solutions for θ, and the optimal local-currency share θ^* is:* (*i*) ***decreasing*** *in the financial friction γ^H,* (*ii*) ***decreasing*** *in the value-at-risk in exchange rates $\bar{\mathcal{E}}$,* (*iii*) ***increasing*** *in the size of the domestic local-currency investor base η^L,* (*iv*) ***increasing*** *in the costliness of default ϕ, and* (*v*) ***increasing*** *in the covariance of exchange rate risk with endowments, that is, increasing with minus $Cov(\mathcal{E}, Z)$.*

Proof. See appendix A.3.1

All else equal, the optimal local-currency share will be higher when there are greater costs of currency mismatch, lower when there is a larger safety premium on hard-currency debt, and lower when spillovers from fire sales in local-currency are larger. The comparative statics for this trade-off in Proposition 3 have intuitive interpretation. All else equal:

(i) When demand for hard-currency money is higher, parameterized by a greater γ^H, there are two forces which push the sovereign to issue more hard-currency. First, the spread between the money-creation value of local- and hard-currency bonds widens, and issuers raise consumption by reallocating bond supply to hard-currency. Second, all else equal, the costs of fire sales in local currency rise with γ^H: Higher demand for money incentivizes more money-creation out of local-currency bonds by open-end funds, relative to that in hard-currency bonds, and reduces fire sale prices and therefore the quantity of domestic investment in private projects.

(ii) When the currency has greater value-at-risk, parameterized by a greater value of $\bar{\mathcal{E}}$ the premium on hard-currency external debt is greater, and fire sales in local-currency debt are worse.

(iii) A greater domestic local-currency investor base, parameterized by η^L, raises the liquidation value of local-currency bonds and ameliorates fire-sales in local-currency.

(iv) Costlier defaults make currency mismatch costlier.

(v) A more negative $\mathrm{Cov}(\mathcal{E}, Z)$ means exchange rates provide a worse hedge for sovereigns against endowment losses and raises expected default losses. In addition, as exchange rates provide a worse hedge to issuers, the expected fundamental cashflows on local-currency bonds decline relative to their value-at-risk, and they are intermediated more by stable intermediaries.

8 Conclusion

The experience of Chile is illustrative. In the early 2000s, Chile had strong institutions by both regional and global standards. It ranked near the top of Latin America in measures of rule of law and had adopted a range of sound policies to manage the risks of foreign borrowing—including capital account regulation, prudential oversight, and transparency requirements. It also maintained a flexible exchange rate regime to discourage excessive currency mismatches. Yet despite this institutional strength and policy credibility, Chile continued to borrow from foreigners using dollar-denominated debt.

Writing in 2005, Hausmann, Eichengreen, and Panizza pointed to this paradox, observing that "the standard institution-strengthening measures appear to have relatively little ability over policy-relevant horizons" to induce borrowers to eliminate Original Sin. The term itself implies that the source of the problem may lie beyond the borrowing country's immediate control.

This paper proposes a novel explanation for Original Sin grounded in such external constraints. We highlight a financial friction rooted in the structure of financial intermediation in advanced economies. These frictions—shaping the behavior and portfolio choices of foreign investors—create a persistent preference for hard currency bonds, making it costly for even well-managed emerging markets to borrow abroad in their own currencies.

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A Model appendix

A.1 Derivations for Section 4

A.1.1 Further details on debt supply and repayments in Section 4

Bond repayments. While all of the model intuitions would go through with a generic characterization bond risks, we specify sources of risk as arising from both pure credit risk and currency mismatch so as to properly characterize the tradeoffs faced by issuers later in Section 7. Local- and hard-currency bonds pay out fixed rates in the final period of $\boldsymbol{\kappa} = [\kappa^L, \kappa^H]^\top$, stated in their local-currency. For simplicity, we assume $\kappa^L = 1, \kappa^H = \mathcal{E}_T$ and retain the vector $\boldsymbol{\kappa}$ as a useful notation. The face value of debt obligations in the final period, stated in local currency, is therefore

$$\boldsymbol{\kappa}^\top \mathbf{b}_T = \theta + (1-\theta)\mathcal{E}_T \tag{23}$$

Obligations in hard currency are indexed to the exchange rate $\mathcal{E}_T$. In the final period, the government realizes its terminal fiscal surplus Z_T, which is endowed in units of local currency. Without strategic default, the sovereign repays the debt at face value if

$$Z_T \geq \boldsymbol{\kappa}^\top \mathbf{b}_T \tag{24}$$

If the bad-news state realizes, both the resources available to repay the debt Z_T and the exchange rate $\mathcal{E}_T$ are drawn exogenously from distributions we describe below. We can thus define the repayment function

$$\chi = \mathbb{1}\{Z_T \geq \boldsymbol{\kappa}^\top \mathbf{b}_T\} \tag{25}$$

In the main text, we use the scalar $B_T = \boldsymbol{\kappa}^\top \mathbf{b}_T$. Together, 23 and 24 demonstrate how the local-currency share θ affects the risk profile of the sovereign debt. At lower values of θ, the face value of the debt obligations is more exposed to exchange rate risk. The support of Z_T over which the sovereign is guaranteed to repay its debt shrinks as the value of θ declines. At the corner where $\theta = 1$, the risk of default is entirely decoupled from exchange rate risk: Exchange rates could depreciate, but as long as there are enough local-currency assets, the debt will be repaid in full. As will become clear below, however, exchange rate risk will still matter for the investment decisions of foreign investors even if the sovereign does not have currency mismatch.

If the Poisson news event does not occur and the fiscal regime is unchanged, then $\chi = 1$ with probability 1 and all repayments are made at face value. If the fiscal outlook becomes risky, then χ becomes a random variable whose distribution depends jointly on shocks to $Z, \mathcal{E}$, and the key parameter θ. When there are not enough resources in the final period to repay the debts at face value, the sovereign defaults and allocates the resources to creditors in proportion to the face value of their obligations.[65] The shares of local-currency resources obligated to local- and hard-currency creditors under this scheme are given by

$$m^L = \frac{\theta}{\boldsymbol{\kappa}'\mathbf{b}_T}, \quad m^H = \frac{(1-\theta)\mathcal{E}_T}{\boldsymbol{\kappa}'\mathbf{b}_T} \tag{26}$$

The share of resources available to hard-currency creditors under our assumption of pari-passu rises mechanically with exchange rate devaluations. We now define the ratio of bond re-payments to obligations in the final period, stated in local-currency units:

$$X_T = \min\left\{1, \frac{Z_T}{\boldsymbol{\kappa}'\mathbf{b}_T}\right\} \tag{27}$$

We can express ex-post gross returns on the two bonds in units of hard currency:

$$R^L = \frac{X_T}{\mathcal{E}_T P_0^L} \qquad R^H = \frac{X_T}{P_0^H} \tag{28}$$

It is also useful to define ex-post gross payoffs per par unit of bond purchased. For bond c in $\{L, H\}$ we write

$$X^c = P_0^c R^c \tag{29}$$

The total of debt repayments made to all investors in T, stated in local currency, is

[65]In this sense, we assume a strict case of pari-passu bond repayments. This is a natural assumption to start from since the allocations of repayments across creditors are the same in both repayment and default states of the world. That is, m^L and m^H given in **??** also describe the allocation of resources in the non-default state of the world. This has the implication that hard-currency debt is effectively senior to local-currency debt if exchange rates depreciate.

$$Y_T = \min\{\kappa^L\theta + (1-\theta)\kappa^H\mathcal{E}_T, Z_T\} = \boldsymbol{\kappa}'\mathbf{b}_T - \max\{\boldsymbol{\kappa}'\mathbf{b}_T - Z_T, 0\} \tag{30}$$

The dollars invested in each bond market are $\theta P_0^L, (1-\theta)P_0^H$, respectively. Therefore, the payoff per dollar-invested in each bond is given by

$$R^L = \frac{1}{\mathcal{E}_T}\frac{M^L}{\theta P_0^L}\cdot Y_T = \frac{1}{\mathcal{E}_T}\frac{Y_T}{\theta P_0^L}\frac{\kappa^L\theta}{\boldsymbol{\kappa}'\mathbf{b}_T} = X_T \cdot \frac{\kappa^L}{\mathcal{E}_T P_0^L}$$
$$R^H = \frac{1}{\mathcal{E}_T}\frac{M^H}{(1-\theta)P_0^H}\cdot Y_T = \frac{1}{\mathcal{E}_T}\frac{Y_T}{(1-\theta)P_0^L}\frac{(1-\theta)\mathcal{E}_T\kappa^L}{\boldsymbol{\kappa}'\mathbf{b}_T} = X_T \cdot \frac{\kappa^H}{P_0^H}$$

A.1.2 Proof of Proposition 1

Proof. By market clearing in the bad-news state of the world, the intermediation share μ^c is a linear function of ζ^c. We have

$$\mu^c = \min\{1, \eta(1-\zeta^c)\}$$

We first consider interior solutions $\mu^c \in (0,1)$ but discuss the conditions for corner solutions below. At an interior solution, the free-entry condition gives us

$$\zeta^c = w_0\mathbb{E}_b[X^c]^{-1} + w_1 \quad \in (0,1) \tag{31}$$

where

$$w_0 \equiv \frac{\gamma\underline{X}^c}{\gamma+\beta b}, \quad w_1 \equiv \frac{b\beta}{\gamma+b\beta} \tag{32}$$

We then have have

$$\mu^c = \eta\left(1 - w_1 - w_0\mathbb{E}_b[X^c]^{-1}\right)$$

And therefore,

$$\mu^L - \mu^H \propto \gamma \left(\frac{\underline{X}^H}{\mathbb{E}_b[X^H]} - \frac{\underline{X}^L}{\mathbb{E}_b[X^L]} \right)$$

Which we can sign using the fact that

$$\mathbb{E}_\lambda[X^L] = \mathbb{E}\left[\frac{X_T}{\mathcal{E}}\right] = \mathbb{E}_\lambda\left[\frac{X^H}{\mathcal{E}}\right] \quad \text{and} \quad \underline{X}^L = \frac{\underline{X}^H}{\bar{\mathcal{E}}}$$

And therefore

$$\mathbb{E}_\lambda[X^H] \cdot \underline{X}^L = \mathbb{E}_\lambda\left[\frac{X^H}{\bar{\mathcal{E}}}\right] \cdot \underline{X}^H < \mathbb{E}_\lambda\left[\frac{X^H}{\mathcal{E}}\right] \cdot \underline{X}^H = \mathbb{E}_\lambda[X^L] \cdot \underline{X}^H$$

(i) We have also that

$$\begin{aligned} \frac{\partial \mu^L - \mu^H}{\partial \bar{e}} &\propto \frac{\partial}{\partial \bar{\mathcal{E}}}\left(-\frac{\gamma \underline{X}^L}{\mathbb{E}_b[X^L]}\right) \\ &= \frac{\gamma \underline{X}}{\mathbb{E}_b[X^L]} > 0 \end{aligned}$$

The degree of sorting is rising in the variance of the exchange rate. This result holds as well if we write the model such that insurers and banks choose $\underline{X}^L$ under a deposit insurance scheme. We do this below.

(ii) By the first result,

$$\frac{\partial \mu^L - \mu^H}{\partial \eta} \propto \frac{\gamma \underline{X}^H}{\mathbb{E}_b[X^H]} - \frac{\gamma \underline{X}^L}{\mathbb{E}_b[X^L]} > 0$$

The proof of Corollary 1 follows directly from the proof above together with the no-long-run arbitrage condition in Definition 1. Defining intermediary revenues to be $V_i^c = \Pi_i^c + P_0^c$ for $i \in \{U, S\}$ and $c \in \{L, H\}$, we have that $V_S^L < V_S^H$ by Proposition 1, so the proof is immediate by the equilibrium requirement of no-long-run arbitrage. To be clear, we have

$$
\begin{aligned}
V_S^H - V_S^L &= \gamma \underline{X}^H + \beta \mathbb{E}[X^H] - \gamma \cdot \underline{X}^L - \beta \mathbb{E}[X^L] \\
&\propto \gamma(\underbrace{\bar{\mathcal{E}} \underline{X}^H - \underline{X}^H}_{+}) - \beta \underbrace{\mathbb{E}[\frac{\bar{\mathcal{E}}}{\mathcal{E}} X^H - \bar{\mathcal{E}} X^H]}_{-} > 0
\end{aligned}
$$

A.2 Derivations for the Issuer's Problem in Section 7

We condense notation in what follows using the vectors

$$
\mathbf{p}_t = \begin{bmatrix} P_t^L \\ P_t^H \end{bmatrix}, \quad \mathbf{b}_t = \begin{bmatrix} B_t^L \\ B_t^H \end{bmatrix}, \quad \mathbf{X} = \begin{bmatrix} X^L \\ X^H \end{bmatrix},
$$

$$
\underline{\mathbf{X}} = \begin{bmatrix} \underline{X}^L \\ \underline{X}^H \end{bmatrix}, \quad \boldsymbol{\theta}_t = \begin{bmatrix} \theta \\ 1-\theta \end{bmatrix}, \quad \mathbf{s}_t = \begin{bmatrix} 1 \\ -1 \end{bmatrix}
$$

We also use

$$
X \equiv X_T(\theta) = \min \left\{ 1, \frac{Z_T}{\boldsymbol{\kappa}' \mathbf{b}_T} \right\}
$$

A.2.1 Government Budget and Proof of Proposition 2

We have the following government budget constraints:

$$
\begin{aligned}
G_0 &= Z_0 + \mathbf{p}_0^\top \mathbf{b}_1, \\
G_1 &= Z_1, \\
G_2 &= Z_2 - \boldsymbol{\kappa}_2' \mathbf{b}_2.
\end{aligned}
$$

What we show below is that the policy-dependent portion of government consumption simplifies to the expression

$$
\text{Net Revenue} = \boldsymbol{\theta}^\top \left(\gamma \underline{\mathbf{X}} + \beta \mathbb{E}\left[(1 - \mathcal{E}_T) \mathbf{X} \right] \right)
$$

Note that

$$G_2 = \max(Z_2 - \boldsymbol{\kappa}_2' \mathbf{b}_2, 0) = Z_2 - Y_2$$

The last equality follows from 30:

$$\begin{aligned} Y_2 &= \boldsymbol{\kappa}_2' \mathbf{b}_2 - \max\{\boldsymbol{\kappa}_2' \mathbf{b}_2 - Z_2, 0\} \\ &= \chi \boldsymbol{\kappa}_2' \mathbf{b}_2 + Z_2 - \chi Z_2. \end{aligned}$$

Therefore,

$$\sum_{t=0}^{T} \mathbb{E}[G_t] = \sum_{t=0}^{T} \mathbb{E}[Z_t] + \mathbf{p}_0^{\top} \mathbf{b}_1 - \mathbb{E}[Y_2]$$

Where, by definition,

$$\mathbb{E}[Y_2] = \mathbb{E}[\boldsymbol{\kappa}_2' \mathbf{b}_2 \cdot X_2] = \boldsymbol{\theta}^{\top} \mathbb{E}[\mathcal{E} \mathbf{X}]$$

And by Corollary 1,

$$\mathbf{p}_0^{\top} \mathbf{b}_1 = \boldsymbol{\theta}^{\top} \left(\gamma \underline{\mathbf{X}} + \beta \mathbb{E}\left[\mathbf{X} \right] \right)$$

Therefore the policy-dependent portion of government consumption, which we call the net revenue curve, is

$$\text{Net Revenue} = \boldsymbol{\theta}^{\top} \left(\gamma \underline{\mathbf{X}} + \beta \mathbb{E}\left[\left(1 - \mathcal{E}\right) \mathbf{X} \right] \right)$$

Change of Numeraire. The state-by-state change of numeraire from the risk-neutral hard-currency numeraire $\mathbb{H}$ to the risk-neutral local-currency numeraire $\mathbb{L}$ is

$$\frac{d\mathbb{H}}{d\mathbb{L}} = \frac{\beta^L \mathcal{E}}{\beta^H}$$

This implies

$$\mathbb{E}^{\mathbb{H}}[\mathbf{X}] = \mathbb{E}^{\mathbb{H}}\begin{bmatrix} X\mathcal{E}^{-1} \\ X \end{bmatrix} = \frac{\beta^L}{\beta^H}\mathbb{E}^{\mathbb{L}}\begin{bmatrix} X \\ X\mathcal{E} \end{bmatrix} = \frac{\beta^L}{\beta^H}\mathbb{E}^{\mathbb{L}}[\mathcal{E}\mathbf{X}]$$

And therefore

$$\text{Net Revenue} = \boldsymbol{\theta}^\top \left(\gamma \underline{\mathbf{X}} + \frac{\beta^L - \beta^H}{\beta^H}\mathbb{E}^{\mathbb{L}}[\mathcal{E}\mathbf{X}] \right)$$

Defining $\rho \equiv \frac{\beta^L - \beta^H}{\beta^H}$, and making Assumption 4, Proposition 2 follows.

A.2.2 Revisiting Bond-Pricing Assumptions

[To be added].

A.2.3 Further Details on Domestic Investment

In the bad-news state, domestic investors take fire-sale discounts ζ^c on sovereign bonds in currency c as given, and choose how to allocate wealth between sovereign bonds and real domestic projects. We wrote down the profit problem for domestic-investors in local-currency bonds in 20. Secondary-market investors in *hard-currency projects* have profit function

$$\max_{q^H} \quad \pi_b^H = \mathbb{E}^{\mathbb{L}}[\mathcal{E}R(\iota^H)] + q^H \mathbb{E}_b^{\mathbb{L}}[X^H] \quad \text{subject to} \quad \iota^H + P_b^H q^H = 1$$

The sovereign computes all proceeds, both public and private, from investment in all opportunities. This is given by 21 in the main text. However, the only period in which the policy θ matters is the bad-news state. We denote the policy-dependent portion of investment proceeds as simply $\mathcal{I}$, where

$$\mathcal{I} = \underbrace{\sum_{c \in \{L,H\}} \eta^c \pi_b^c}_{\text{private returns}} + \underbrace{\alpha \sum_{c \in \{L,H\}} \eta^c R(\iota_b^c)}_{\text{social investment spillovers}} \tag{33}$$

Solving 20 and 33, total social proceeds from domestic investment are

$$\mathcal{I} = \sum_{c \in \{L,H\}} \eta^c \left(\frac{\alpha + \rho}{1 - \rho} (\zeta^c)^{\frac{1-\rho}{\rho}} + \frac{1}{\zeta^c} \right) \tag{34}$$

Note that $\mathcal{I}$ is implicitly a function of the policy variable θ, which affects the fire-sale discount ζ^c. In the main text, we assume that the sovereign issuer only internalizes the value of proceeds to domestic local-currency investors.

A.3 Proofs of Propositions 2 and 3

We start this section with a useful corollary to Proposition 1. In what follows, we simplify notation by defining

$$X_b^{\mathbb{L}} \equiv \mathbb{E}_b^{\mathbb{L}}[X_T]$$

where, as before, $X_T = \min\{1, \frac{Z_T}{B_T}\}$. $X_b^{\mathbb{L}}$ refers to the expectation of debt repayments per unit invested, conditional on realizing bad news, stated in local-currency units, and *under* the local-currency numeraire $\mathbb{L}$. We also simplify the derivations of the comparative statics significantly by assuming the functional form $R = \log$, whereas in the main text we assume $R = \frac{I^{1-\rho}}{1-\rho}$. This is without loss of generality, and the results remain with the latter case.

Corollary 2 (Slope and curvature of expected bond payoffs with respect to policy θ)**.** *Under the local-currency risk-neutral numeraire $\mathbb{L}$, and assuming that the unconditional expectation of default in normal fiscal times is sufficiently low, the expected payoff on the local-currency bond is strictly increasing and convex in θ. As the sovereign selects more local-currency, the expected payoffs on the bond rise. The fire-sale discount factor on local-currency bonds ζ^L is decreasing in θ. We write*

$$X_{b,\theta}^{\mathbb{L}} \equiv \frac{\partial X_b^{\mathbb{L}}}{\partial \theta} > 0, \quad X_{b,\theta\theta}^{\mathbb{L}} \equiv \frac{\partial^2 X_b^{\mathbb{L}}}{\partial \theta^2} > 0$$

Proof. Defining the threshold value $B_{\max} := \theta + (1-\theta)\mathcal{E}$ we have

$$X_{b,\theta}^{\mathbb{L}} = \frac{\beta^L}{\beta^H} \int_{-\infty}^{\infty} \int_{-\infty}^{B_{\max}} \frac{Z(\mathcal{E}-1)}{B_{\max}^2} f(Z,\mathcal{E}) dZ d\mathcal{E} = \frac{\beta^L}{\beta^H} \mathbb{E}\left[\frac{Z(\mathcal{E}-1)}{B_{\max}^2} \mathbb{I}\{Z < B_{\max}\}\right]$$

and likewise,

$$X_{b,\theta\theta}^{\mathbb{L}} = \frac{\beta^L}{\beta^H} \mathbb{E}\left[\frac{Z(\mathcal{E}-1)^2}{B_{\max}^3} \mathbb{I}\{Z < B_{\max}\}\right]$$

The sign of the latter is unambiguously positive. To sign the former, given $B_{\max}^2$ is point-wise positive, it's sufficient to define the risk-neutral measure $\frac{1}{B_{\max}^2}$ and show that under this measure, $\mathbb{E}\left[Z(\mathcal{E}-1)\mathbb{I}\{Z < B_{\max}\}\right] \geq 0$. The sign is intuitively positive under the assumption that exchange rates depreciate in states of the world where Z is low. Formally, given that z, e are jointly normal, we define $b_{\max} = \log(B_{\max})$ and then have

$$
\begin{aligned}
X_{b,\theta}^{\mathbb{L}} &\sim \mathbb{E}\left[Z(\mathcal{E}-1)\mathbb{I}\{Z < B_{\max}\}\right] \text{ in sign} \\
&= \mathbb{E}[Z\mathbb{E}[(\mathcal{E}-1) \mid Z = Z_0]\mathbb{I}\{Z < B_{\max}\}] \\
&= \mathbb{E}[\exp z \cdot \mathbb{E}[\exp\left(\Xi(z_0)\right) - 1 \mid z = z_0] \mid z < b_{\max}] \Pr(z < b_{\max})
\end{aligned}
$$

where $\Xi(z_0) = \mu_e + \frac{\sigma_{ez}}{\sigma_z^2}(z_0 - \mu_z) + \frac{1}{2}\sigma_e^2(1 - \rho_{ze}^2)$. Since $\sigma_{ze} \leq 0$, the conditional expectation is positive if μ_z is sufficiently positive, or equivalently, if z, e sufficiently negatively correlated. By sufficiently, we mean, such that the sovereign is not expected to default in periods where there are good (above-mean) fiscal innovations. Under this assumption, the first result of the proposition follows. To see this, note that at $\theta = 1$, we have the result without ambiguity:

$$
\Xi(z_0) > 0 \quad \text{for} \quad z_0 < b_{\max}
$$

while at $\theta = 0$, the sign depends on the sign of the expectation

$$
\mathbb{E}\left[\mathbb{E}[\exp\left(\frac{\sigma_{ez}}{\sigma_z}\left(\frac{z_0 - \mu_z}{\sigma_z}\right)\right) \mid z = z_0] \mid z < e\right] - 1
$$

If in expectation the sovereign must experience poor innovations to the fiscal position $z_0 < \mu_z$ in order to default, then the result holds. Now, given $X_{b,\theta}^{\mathbb{L}} > 0$, we have

$$
\zeta^L = w_0 \frac{1}{X_b^{\mathbb{L}}} + w_1
$$

for constants w_0, w_1, and therefore

$$
\zeta_\theta^L = -w_0 \frac{X_{b,\theta}^{\mathbb{L}}}{\left(X_b^{\mathbb{L}}\right)^2}
$$

is strictly negative. The intuition for this result is that lowering the default risk profile of the bonds has greater effects on the expected fundamental values of the bond than on the money-creation value of the bond to foreign intermediaries, and so the fire-sale discount on the bond must decline in order for foreign intermediaries to be competitive.

A.3.1 Proof of Proposition 3

For exposition, we start by assuming that the sovereign's problem admits interior solutions for θ^* and that the implicit function theorem applies, in order to derive the comparative statics stated in the proposition. In the second part of the proof, we show that the sovereign's problem admits interior solutions for θ^* under reasonable assumptions about the domestic production function R and the volatility of innovations to the exchange rate σ_e. The sovereign's problem simplifies to

$$\max_{\theta} \sum_{t=0}^{T} \mathbb{E}[\mathcal{C}_t + G_t + \mathcal{I}_t] = \theta \underline{X}^L + (1-\theta)\underline{X}^H + \mathcal{I}(\theta) + \mathcal{L}(\theta)$$

where $\mathcal{I}(\theta), \mathcal{L}(\theta)$ are given by 21 and 19, respectively. We define the sovereign's first-order condition implicitly as a function of the parameter m

$$\mathcal{F}(\theta(m), m) = \gamma^H(\underline{X}^L - \underline{X}^H) + \mathcal{I}_\theta + \mathcal{L}_\theta = 0$$

Assuming the second-order condition holds – again, we show this in the second part of the proof – we have that $\partial\theta^*/\partial m$ has the sign of $\mathcal{F}_{\theta m}$. We compute this cross-partial using the cross-partials $I_{\theta m}, \mathcal{L}_{\theta m}$ separately. We have that in general for some parameter m,

$$\mathcal{I}_{\theta m} \propto \zeta_{\theta m} + a_2 \times \zeta_\theta \zeta_m$$

where a_2 is strictly negative value which depends on θ. The proof is as follows. Using the equilibrium expression for $\mathcal{I}$ given in 34, we obtain the term

$$\mathcal{I}_\theta = \underbrace{-\frac{\zeta_\theta}{\zeta^2}}_{\text{marg. private return on fire sale, +}} \Big(\underbrace{1}_{\text{marg inv. in fire sale}} - \underbrace{\frac{\alpha+\rho}{\rho} \times \zeta^{\frac{1}{\rho}}}_{\text{marg. foregone real inv.}} \Big)$$

We define the terms

$$a_0 \equiv \frac{\alpha+\rho}{\rho}\zeta^{\frac{1}{\rho}} - 1, \quad a_1 \equiv \frac{a_0+1}{\rho} > 0, \quad a_2 = \frac{\frac{a_1}{a_0} - 2}{\zeta}$$

which will simply serve us to simplify the notation in the derivations that follow. If ρ is sufficiently large–that is, under the proposition's assumption of sufficient curvature in the production function–we obtain that $a_0 > 0$, $a_2 < 0$. The proofs are provided below, in section A.3.1. Note that $a_0 > 0$ together with Corollary 2 implies $\mathcal{I}_\theta < 0$: The total social proceeds from domestic investment are declining in the local-currency share θ. Therefore, we obtain

$$\begin{aligned}\mathcal{I}_{\theta m} &= a_0\left(\frac{\zeta_{\theta m}}{\zeta^2} - 2\frac{\zeta_\theta \zeta_m}{\zeta^3}\right) + \frac{\partial a_0}{\partial m}\frac{\zeta_\theta}{\zeta^2} \\ &\propto \frac{\zeta_{\theta m}}{\zeta^2} + \frac{\zeta_\theta \zeta_m}{\zeta^3}\left(\frac{a_1}{a_0} - 2\right)\end{aligned}$$

Multiplying through the last line by the positive constant ζ^2 and employing the definition of a_2, the result follows. Next, we have

$$\mathcal{L}_\theta = -\phi \times \mathbb{E}[(1-\mathcal{E}) \cdot \mathbb{I}\{Z < B_{\max}\}]$$

and

$$\mathcal{L}_{\theta m} = \frac{\partial}{\partial m}\left(-\phi \times \mathbb{E}[(1-\mathcal{E}) \cdot \mathbb{I}\{Z < B_{\max}\}]\right)$$

We can now derive the following cross-partials of $\mathcal{F}$ for parameters $m \in \{\gamma^H, \bar{e}, \eta^L, \phi, \sigma_{ze}\}$:

(i) For the safety premium γ^H, we obtain

$$\mathcal{F}_{\theta\gamma} = \underline{X}^L - \underline{X}^H + \mathcal{I}_{\theta\gamma}$$

where we know $\underline{X}^L - \underline{X}^H < 0$ and then have

$$\mathcal{I}_{\theta\gamma} = \zeta_{\theta\gamma} + a_2 \times \zeta_\gamma \zeta_\theta$$

using

$$\zeta_\gamma = \frac{\partial w_0}{\partial \gamma^H}\frac{1}{X_b^{\mathbb{L}}} + \frac{\partial w_1}{\partial \gamma^H}, \quad \zeta_{\theta\gamma} = -\frac{\partial w_0}{\partial \gamma^H}\frac{X_{b,\theta}^{\mathbb{L}}}{\left(X_b^{\mathbb{L}}\right)^2}$$

and

$$\frac{\partial w_0}{\partial \gamma^H} = \frac{\beta^L}{\beta^H}\frac{\beta^H \lambda}{(\gamma^H + \beta^H \lambda)^2}, \quad \frac{\partial w_1}{\partial \gamma^H} = -\frac{\partial w_0}{\partial \gamma^H} \cdot \frac{1}{\underline{X}}$$

The cross-partials for the fire-sale discount ζ evaluate to

$$\zeta_\gamma = \frac{\partial w_0}{\partial \gamma^H}\left(\frac{1}{X^B} - \frac{1}{\underline{X}}\right) < 0, \quad \zeta_{\theta\gamma} = -\frac{\partial w_0}{\partial \gamma^H}\frac{X^B_\theta}{(X^B)^2} < 0$$

Given $a_2 < 0$, we obtain $\mathcal{F}_{\theta\gamma} < 0$.

(ii) For value-at-risk in exchange rates, we examine $\bar{e} = \log \bar{\mathcal{E}}$ and obtain

$$\mathcal{F}_{\theta\bar{e}} = -\gamma^H \underline{X}^L + \mathcal{I}_{\theta\bar{e}}$$

We have

$$\zeta_{\bar{e}} = \frac{\partial w_0}{\partial \bar{e}}\frac{1}{X^{\mathbb{L}}_b} = \frac{-w_0}{X^{\mathbb{L}}_b}, \quad \zeta_{\theta\bar{e}} = -\frac{\partial w_0}{\partial \bar{e}}\frac{X^{\mathbb{L}}_{b,\theta}}{(X^{\mathbb{L}}_b)^2} = w_0\frac{X^{\mathbb{L}}_{b,\theta}}{(X^{\mathbb{L}}_b)^2}$$

Therefore,

$$\mathcal{I}_{\theta\bar{e}} = -\zeta_\theta\left(1 + a_2\frac{w_0}{X^B}\right)$$

As the currency becomes more crash-prone, fire sales become larger. Domestic investors can reap greater profits from fire sales, but forego more domestic projects. For sufficiently large ρ, we have that a_2 is sufficiently negative and the terms inside parentheses net to something below zero. Again, this is the case, and therefore whether the optimal local-currency share is decreasing or increasing in $\bar{e}$ depends on the curvature of the production function–which is, how the profits from domestic investment are distributed, or whether marginal returns to domestic investment are sufficiently steep. If this is the case, the optimal local-currency share of debt is *decreasing* in the right tail of exchange rates, holding all other channels fixed. However, we need to remember the linear term in the utility function: $\gamma^H \cdot \theta\underline{X}^L + (1-\theta)\underline{X}^H$. Recalling the first order condition $\mathcal{F}$ we have

$$\frac{\partial \mathcal{F}(\theta(\bar{e}), \bar{e})}{\partial \bar{e}} = -\gamma^H \underline{X}^L + \mathcal{I}_{\theta\bar{e}} < 0$$

Sovereigns with crash-prone currencies, (a) face a bigger safety premium on hard-currency debt, and (b) experience bigger fire sales in local-currency debt. So, the optimal local currency share is decreasing in the left tail of exchange rates. This may be a counterintuitive result to some, since crash-prone currencies seem especially should probably avoid currency mismatch. But our model says that foreigner intermediation generates two strong forces that go in the other direction: Foreigners will "punish" the local currency debt price for that tail risk, and (b) local debt into open-ended portfolios and experience larger investment spillovers because of flighty capital outflows. Now, this result comes with a caveat: In our model, it partly comes from a simplification. $\underline{X}$ as a constant is a simplification of the model. But one could think of $\underline{X}$ as foreigners' perceived tail risk; it's whatever risk weight regulators put on your bonds when they compute Tier I capital requirements, so, as long as changes in the underlying distribution of exchange rates that improve $\mathcal{L}$ are not perfectly reflected in the regulator's risk weight, this intuition holds.

(iii) For the wealth of domestic investors η^L we have

$$\mathcal{F}_{\theta\eta} = \mathcal{I}_{\theta\eta}$$

which is to say, the deployable wealth of domestic investors only changes the domestic consumption in our model insofar as it changes the proceeds to investment in the fire-sale state of the world. this term is given by the sign of $\mathcal{I}_{\theta}$, which under our assumptions about the curvature of R, is negative.

(iv) For the costliness of default ϕ, we have

$$\mathcal{F}_{\theta\phi} = \mathcal{L}_{\theta\phi}$$

which is

$$-\mathbb{E}\left[(1 - \mathcal{E} \cdot \mathbb{I}\{Z < B_{\max}\}\right] > 0$$

by Corollary 2.

(v) For the covariance σ_{ze}, we write

$$\mathcal{F}_{\theta\sigma} = \mathcal{I}_{\theta\sigma} + \mathcal{L}_{\theta\sigma}$$

We have

$$\zeta_\sigma = \frac{-w_0}{(X_b^{\mathbb{L}})^2} X_{b,\sigma}^{\mathbb{L}}$$

It's sufficient to sign $X_{b,\sigma}^{\mathbb{L}}$, which we can do quite simply using Jensen's inequality. We can write

$$X_b^{\mathbb{L}} = \mathbb{E}^{\mathbb{L}}\left[\min\{1, Z/B\}\right] = \mathbb{E}^{\mathbb{L}}\left[\frac{1}{B}\min\{B, Z\}\right]$$

Since $B > 0$ we use a change of measure to write

$$X_b^{\mathbb{L}} = 1 - \mathbb{E}^{\mathbb{L}}\left[\frac{1}{B}\right]\mathbb{E}^{\tilde{\mathbb{L}}}\left[\max\{B - Z, 0\}\right]$$

The change of measure is $\frac{d\tilde{\mathbb{L}}}{d\mathbb{L}} = \frac{1/B}{\mathbb{E}^{\mathbb{L}}[1/B]}$. Therefore, $X_b^{\mathbb{L}}$ is decreasing in the variance of $B - Z$ by Jensen's Inequality. Given the variance of $B - Z$ is decreasing in the covariance of B and Z, we have that $X_b^{\mathbb{L}}$ is increasing in this covariance, and therefore also increasing in σ_{ez}. This implies

$$\zeta_\sigma = \frac{-w_0}{(X_b^{\mathbb{L}})^2} X_{b,\sigma}^{\mathbb{L}} \leq 0$$

Next, we compute

$$\zeta_{\theta\sigma} = -w_0 \frac{X_{b,\theta\sigma}^{\mathbb{L}}}{(X_b^{\mathbb{L}})^2} + 2w_0 \frac{X_{b,\sigma}^{\mathbb{L}} X_{b,\theta}^{\mathbb{L}}}{(X_b^{\mathbb{L}})^3}.$$

Note that we can sign the second term as we did above. For the first term, we compute the cross-partial for the bond payoff in full. We have that

$$X_{b,\theta}^{\mathbb{L}} = \mathbb{E}^{\mathbb{L}}\left[\frac{Z(\mathcal{E} - 1)}{B^2}\mathbb{I}\{Z < B\}\right]$$

Define

$$h(z, e) = \frac{Z(\mathcal{E}-1)}{B^2}\mathbb{I}\{Z < B\} = \begin{cases} 0 & z \geq b \\ \exp(z + e - 2b) - \exp(z - 2b) & z < b \end{cases}$$

where $b = \log(\theta + (1 - \theta)\exp e)$. Thus $b' \equiv \frac{\partial b}{\partial e} = \frac{(1-\theta)\exp e}{\exp b}$. We then use the result

$$\frac{\partial \mathbb{E}[h(z, e)]}{\partial \sigma_{ze}} = \mathbb{E}\left[\frac{\partial^2 h(z, e)}{\partial z \partial e}\right]$$

Then we have, for $z < b$,

$$\frac{\partial^2 h(z,e)}{\partial z \partial e} = \exp(z-2b)(\exp(e) + 2b'(1-\exp(e)))$$

(By Leibniz, the boundaries don't matter). We can rewrite as

$$\frac{Z\mathcal{E}}{B^2}\left(1 + \frac{2(1-\theta)}{B}(1-\mathcal{E})\right)$$

and

$$X^{\mathbb{L}}_{b,\theta\sigma} = \mathbb{E}[h_{ze}] = \mathbb{E}\left[\frac{Z\mathcal{E}}{B^2}\mathbb{I}\{Z<B\}\right] + 2(1-\theta)\mathbb{E}\left[\frac{Z\mathcal{E}}{B^2}\left(\frac{1-\mathcal{E}}{B}\right)\mathbb{I}\{Z<B\}\right]$$

The first term is unambiguously positive; the second is a probability-tilted version of the expectation we proved to be negative in Corollary 1. Therefore, the sign of the whole term is ambiguous. Therefore

$$\underbrace{\zeta_{\theta\sigma}}_{-} = -\underbrace{\frac{w_0 X^{\mathbb{L}}_{b,\theta\sigma}}{(X^{\mathbb{L}}_b)^2}}_{+} + 2\underbrace{X^{\mathbb{L}}_{b,\sigma}}_{-}\underbrace{\frac{w_0 X^{\mathbb{L}}_{b,\theta}}{(X^{\mathbb{L}}_b)^4}}_{+}.$$

And finally,

$$\mathcal{S}_{\theta\sigma} = \underbrace{\frac{\zeta_\theta}{\zeta}}_{-}\left(\underbrace{\frac{X^{\mathbb{L}}_{b,\theta\sigma}}{X^{\mathbb{L}}_{b,\theta}}}_{+} - 2\underbrace{\frac{X^{\mathbb{L}}_{b,\sigma}}{(X^{\mathbb{L}}_b)^2}}_{-}\left(\underbrace{1-\frac{w_0}{\zeta}}_{?}\right)\right)$$

where

$$\frac{w_0}{\zeta} = \frac{w_0 X^{\mathbb{L}}_b}{w_0 + w_1 X^{\mathbb{L}}_b} = X^{\mathbb{L}}_b \frac{\gamma^H \underline{X}^L}{\gamma^H \underline{X}^L + \lambda X^{\mathbb{L}}_b} < 1.$$

Therefore,

$$\mathcal{S}_{\theta\sigma} < 0.$$

Then, we re-write

$$\frac{\partial \mathcal{L}}{\partial \theta} = \phi \int_{\mathcal{E}} \left(\mathbb{E}[\mathcal{E}] \cdot \Phi\left(\frac{b - \mu_z - \sigma_{ze}}{\sigma_z}\right) - \Phi\left(\frac{b - \mu_z}{\sigma_z}\right)\right) f(\mathcal{E})\, d\mathcal{E}.$$

We have

$$\mathcal{L}_{\theta\gamma} = 0, \quad \mathcal{L}_{\theta\underline{X}} = 0,$$

that is, default does not depend on the intermediation frictions in the model by construction. We also have

$$\frac{\partial^2 \mathcal{L}}{\partial \theta\, \partial \sigma_{ez}} = \phi\, \mathbb{E}[\mathcal{E}] \int_{\mathcal{E}} \frac{\partial}{\partial \sigma_{ze}} \Phi\left(\frac{b - \mu_z - \sigma_{ze}}{\sigma_z}\right) f(\mathcal{E})\, d\mathcal{E},$$

where

$$\frac{\partial}{\partial \sigma_{ze}} \Phi\left(\frac{b - \mu_z - \sigma_{ze}}{\sigma_z}\right) = -\frac{1}{\sigma_z}\, \varphi\left(\frac{b - \mu_z - \sigma_{ze}}{\sigma_z}\right) < 0.$$

Hence,

$$\mathcal{L}_{\theta\sigma} < 0.$$

This implies that the optimal local currency share, ignoring all other channels except default risk, is decreasing in the covariance of exchange rates with fiscal surpluses σ_{ze}. In other words, if exchange rates provide a better hedge against income losses, then one should issue more hard currency. Usually, this is not the case: exchange rates provide a poor hedge ($\sigma_{ez} < 0$), and this motivates governments to issue in local currency.

Finally, we show that the sovereign's problem admits interior solutions for θ^* under reasonable assumptions about the domestic production function R and the volatility of innovations to the exchange rate σ_e. For a parameter m, we sign $\frac{\partial \mathcal{F}(\theta(m),m)}{\partial \theta} = \frac{\partial^2 \mathcal{S}(\theta(m),m)}{\partial \theta} + \frac{\partial^2 \mathcal{L}(\theta(m),m)}{\partial \theta}$.

(i) First, we have that $\frac{\partial^2 \mathcal{L}(\theta(m),m)}{\partial \theta} < 0$. This is shown by

$$\mathcal{L} = -\phi \int_{\mathcal{E}} \int_{Z < \theta + (1-\theta)\mathcal{E}} (\theta + (1-\theta)\mathcal{E} - Z) f(Z, \mathcal{E}) dZ d\mathcal{E}$$

Defining $B_{\max} := \theta + (1-\theta)\mathcal{E}$ we can write

$$\frac{\partial \mathcal{L}}{\partial \theta} = -\phi \mathbb{E}[(1-\mathcal{E}) \cdot \mathbb{I}\{Z < B_{\max}\}] = -\phi \int_{\mathcal{E}} (\mathbb{E}[\mathcal{E} \mid Z < B, \mathcal{E}] - 1) \cdot \Pr[Z < B \mid \mathcal{E}] \cdot f(\mathcal{E}) d\mathcal{E}$$

Given z, e jointly normal with $\text{Cov}(z, e) \leq 0$, we have that

$$\mathbb{E}[\mathcal{E} \mid Z < B, \mathcal{E}] \cdot \Pr[Z < B \mid \mathcal{E}] = \mathbb{E}[\mathcal{E}] \frac{\Phi(\frac{b_{\max} - \mu_z - \sigma_{ze}}{\sigma_z})}{\Phi(\frac{b_{\max} - \mu_z}{\sigma_z})}$$

where $b_{\max} = \log(B_{\max})$, and $\mu_z, \sigma_z, \sigma_{ez}$ parameterize the joint distribution of innovations z and e. A proof is provided below. Given $\sigma_{ze} \leq 0$ and Φ monotonic, the result $\frac{\partial \mathcal{L}}{\partial \theta} > 0$ follows. Finally, we have

$$\frac{\partial^2 \mathcal{L}}{\partial \theta^2} = -\phi \int_{\mathcal{E}} (1-\mathcal{E})^2 f(B_{\max}, \mathcal{E}) d\mathcal{E}$$

which is unambiguously negative.

(ii) From **??** we have that $\mathcal{S}$ is a linear transformation of $R(I)$ where R is the production function with $R' > 0, R'' < 0$. Aggregate investment is pinned down by the optimization problem of domestic firms, who solve 7.

*Necessary conditions for interior solutions

Now, we turn to showing that the problem is well-defined for interior solutions and first-order terms are of expected signs under assumptions about ρ.

A.3.2 Details of the Risk-Based Capital Regime for Long-Term Intermediaries

In the main version of the model presented in Section 4, we make a simplification of the risk-based capital regime to express the profits to the long-term intermediary strategy in the main body of the paper. We do this because deriving the insurance premiums requires specifying the entire distribution of bond payoffs as a function of the parameter θ, and complicates the expressions without enhancing the intuition of the main results. Here, we derive how one might obtain the same intuitive result of Proposition 1 under an explicit insurance scheme as we do with the simplification.

Financiers have access to a government guarantee or "deposit insurance" scheme which provides indemnities against losses on the portfolio. This program allows intermediaries to guarantee some claims backed by risky bonds. We require, like many real-world examples of such schemes, that financiers meet capital requirements in order to participate in such scheme. Specifically, we assume that the deposit insurance scheme has been set up by a tax authority which only accepts bearing losses on through the insurance fund with some fixed probability π.

This is a crude assumption: We say that behind the scenes of the households we detail in equation 6, there is some additional risk-bearing capacity in the tax system. This risk-bearing capacity is fixed and unrelated to the risk preferences of households we detail in the main body of the paper. As crude as this assumption is, it is a simple way to capture the complex schemes through which taxpayers bear financial risk in the real-world setting we study. In the euro area and the United States, both insurers and banks participate in explicit guarantee schemes, like traditional deposit insurance, but the liabilities of insurers and pensions are also in many cases implicitly guaranteed by government programs in exchange for submitting to capital regulation and supervision. In the euro area, both explicit and implicit guarantees exist at both the supra- and national levels.

The foreign tax authority is only willing to suffer losses with some probability π. They require banks under their supervision to hold risk-based capital against losses which occur with probability P or greater: I.e., this is a risk-based capital regime. Another way of saying this is, the banks are required to fund any asset purchases which experience losses with probability P or greater using equity, not deposits. The capital required to finance the purchase of an asset with risky payoff X is 1-$\underline{X}$, where $\underline{X}$ is a constant satisfying

$$\Pr(X < \underline{X}) = \pi$$

We denote logs of bond payoffs $x^c = \log(X^c)$, and logs of random variables $z = \log(Z)$, etc. We denote the distributions of the log-payoffs on local- and hard-currency bonds as

$$F_L(x;\theta), F_H(x;\theta)$$

respectively. We derive the values of capital required for the local-and hard-currency bonds under the foreign-investor risk-neutral measure here, at discrete values of θ.[66] We then gener-

[66]At the corner values $\theta = 0, 1$, the bond payoffs can be characterized as linear in lognormal random variables. For intermediate values of θ, the bond payoffs do not have this simple characterization. We rely on the intuitions provided by the corner-value solutions, and approximate the full distribution of bond payoffs as functions of θ in

alize the main result, which is that local currency bonds require more capital and are therefore relatively inefficient for backing claims under the long-term strategy. We show now that under reasonable and relatively weak assumptions about the distributions F_z, F_e and the value P, the distribution of payoffs on the hard-currency bond first-order stochastically dominates the distribution of payoffs on local-currency bonds, and as a result, the quantity of safe claims which can be backed by local-currency bonds under this capital regime is smaller than that which can be backed by hard-currency bonds. We begin by assuming that fiscal surpluses Z and nominal exchange rates $\mathcal{E}$ are drawn from general joint lognormal distributions:

$$\begin{bmatrix} \mathcal{E} \\ Z \end{bmatrix} = \begin{bmatrix} \exp(e) \\ \exp(z) \end{bmatrix}, \begin{bmatrix} e \\ z \end{bmatrix} \sim \mathcal{N}\left(\begin{bmatrix} \mu_e \\ \mu_z \end{bmatrix}, \begin{bmatrix} \sigma_e^2 & \sigma_{ze} \\ \sigma_{ez} & \sigma_z^2 \end{bmatrix} \right)$$

To summarize the results from the derivations below, we show that

$$F_L(x;\theta = 0) = \Pr(\nu \geq 0, s < x) + \Pr(\nu < 0, \nu < x), \qquad F_H(x;\theta = 0) = \Pr(z - e < x)$$
$$F_L(x;\theta = 1) = \Pr(z \geq 0, s < x) + \Pr(z < 0, \nu < x), \qquad F_H(x;\theta = 1) = \Pr(z < x)$$

where

$$s = -e$$
$$\nu = z - e$$

The log-quantity of safe claims $\underline{x}^L$ which can finance the purchase of local-currency bonds satisfies

$$\underline{x}^L = \inf\{x : F_L(x;\theta) \geq \pi\}$$

Likewise, the log-quantity of safe claims $\underline{x}^H$ which can be backed by hard-currency bonds satisfies

$$\underline{x}^H = \inf\{x : F_H(x;\theta) \geq \pi\}$$

Appendix A.1

Therefore, to show $\underline{x}^L < \underline{x}^H$ for fixed π and θ, it is sufficient to show $F_L(x;\theta) \geq F_H(x;\theta)$ for all x, and strict inequality for some x: $F_L(x;\theta)$ stochastically dominates $F_H(x;\theta)$ to a first order. We assume $\underline{x}^H < 0$ at all values of θ, which is to say, the bonds are never riskless and $\pi < 1$.

At $\theta = 0$: $\underline{x}^L = \inf\{x : F_L(x;0) \geq \pi\}$ where

$$F_L(\underline{x}^H;0) = \Pr(v \geq 0, s < x) + F_H(\underline{x}^H;0)$$

And therefore $F_H(\underline{x}^H;0) < F_L(\underline{x}^H;0)$ which implies $\underline{x}^L < \underline{x}^H$. Considering the case $\theta = 1$, note that

$$\Pr(z \geq 0, s < \underline{x}^H) = \Pr(s < \underline{x}^H) - \Pr(z < 0, s < \underline{x}^H)$$

And therefore we can write

$$\begin{aligned} F_L(\underline{x}^H;1) - F_H(\underline{x}^H;1) = \Pr(z < 0, z + s < \underline{x}^H) - \Pr(z < 0, s < \underline{x}^H) \\ + \Pr(s < \underline{x}^H) - \Pr(z < \underline{x}^H) \end{aligned}$$

That is,

$$F_L(\underline{x}^H;1) - F_H(\underline{x}^H;1) = \frac{1}{\sigma_z} \int_{u < \frac{-\mu_z}{\sigma_z}} (\Phi(\frac{t_v - \rho_v u}{\sqrt{1-\rho_v^2}}) - \Phi(\frac{t_s - \rho_s u}{\sqrt{1-\rho_s^2}}))\varphi(u)du + \Phi(t_s) - \Phi(t_z)$$

where

$$t_j = \frac{\underline{x}^H - \mu_j}{\sigma_j} \quad u = \frac{z_0 - \mu_z}{\sigma_z}$$

for $j = v, s, z$, etc. We use ρ_j here to denote the correlation coefficient between Guassian variable j and z, etc., and we use $\Phi(\cdot), \varphi(\cdot)$ to denote the cumulative and marginal density functions of the standard normal distribution, respectively. To preview the assumptions we make below and the result that follows, consider the first two terms in the above equation. The first two terms compute the difference in probabilities that, given a bad fiscal shock, the foreign intermediary holding exchange rate and credit risk needs to tap the insurance fund, less the probability that the intermediary holding pure exchange rate risk needs to tap the insurance fund. Intuitively, the first term should dominate: the additional exposure to the fiscal shocks in the first term should raise the probability of a bond disaster relative to the second. However, this is not necessarily the case given that z could provide some hedge to holders of risk in e.

The third and fourth terms compute the difference in unconditional probabilities that the realization of the exchange rate alone results in a loss below the threshold $\underline{x}^H$, and the unconditional probability that the realization of the fiscal state alone results in such a loss. Given the evidence we presented in Section 6, the evidence in other papers on currency tail risks, and the historical incidence of default in our sample, we consider it to be an empirically plausible assumption that the difference between the third and fourth terms is positive, in general. For example,

$$t_s - t_z = \frac{\underline{x}^H - \mu_s}{\sigma_s} - \frac{\underline{x}^H - \mu_z}{\sigma_z} = (\sigma_z - \sigma_e)\underline{x}^H + \mu_z\sigma_z - \mu_s\sigma_s$$

A sufficient set of assumptions for this difference in unconditional probabilities to be positive is

$$\sigma_z < \sigma_e, \quad \mu_s \leq 0$$

In words: nominal exchange rates have a higher variance that the fiscal resources available to repay the debt stated in local-currency terms; and exchange rates are weakly expected to appreciate under the hard-currency investor's numeraire.

$$\Phi(\frac{\underline{x}^H - \mu_s}{\sigma_s}) > \Phi(\frac{\underline{x}^H - \mu_z}{\sigma_z})$$

The key parameters to delivering the result are the covariance terms. We have assumed throughout the paper that z,e weakly negatively covary: exchange rates are weakly expected to depreciate in low-endowment states. Under this assumption, we have

$$\rho_s \leq 0 < \rho_v$$

Given $u < 0$ for all $z_0 < 0$, we therefore have

$$\begin{aligned}\frac{t_v - \rho_v u}{\sqrt{1-\rho_v^2}} - \frac{t_s - \rho_s u}{\sqrt{1-\rho_s^2}} &\propto (t_v - \rho_v u)\sqrt{1-\rho_s^2} - (t_s - \rho_s u)\sqrt{1-\rho_v^2} \\ &= \underbrace{t_v\sqrt{1-\rho_s^2} - t_s\sqrt{1-\rho_v^2}}_{\text{constant}} \underbrace{-\rho_v u\sqrt{1-\rho_s^2} + \rho_s u\sqrt{1-\rho_v^2}}_{\text{varies with } z_0}\end{aligned}$$

For the constant term, we have

$$t_v\sqrt{1-\rho_s^2}-t_s\sqrt{1-\rho_v^2}=(\underline{x}^H-\mu_z-\mu_s)\sqrt{\frac{1-\rho_s^2}{\sigma_v^2}}-(\underline{x}^H-\mu_s)\sqrt{\frac{1-\rho_v^2}{\sigma_s^2}}$$

which is not immediately signable under our assumptions. Given $u<0, \rho_v>0$,and $\rho_s<0$, the variable second term reaches its minimum at $u_{max}=-\mu_z/\sigma_z$, so we evaluate it at that point. The condition for the whole term in A.3.2 to be strictly positive is therefore

$$-\rho_v u_{max}\sqrt{1-\rho_s^2}+\rho_s u_{max}\sqrt{1-\rho_v^2}>-(t_v\sqrt{1-\rho_s^2}-t_s\sqrt{1-\rho_v^2}) \tag{35}$$

By Cauchy-Schwartz:

$$-\rho_v u\geq\frac{\rho_v\mu_z}{\sigma_z}\geq\frac{\mu_z}{\sigma_z},\quad \rho_s u_{max}\geq\frac{-\rho_s\mu_z}{\sigma_z}\geq\frac{\mu_z}{\sigma_z}$$

and therefore

$$-\rho_v u_{max}\sqrt{1-\rho_s^2}+\rho_s u_{max}\sqrt{1-\rho_v^2}\geq\frac{\mu_z}{\sigma_z}(\sqrt{1-\rho_s^2}+\sqrt{1-\rho_v^2})$$

Using the fact that

$$\begin{aligned}-t_v\sqrt{1-\rho_s^2}+t_s\sqrt{1-\rho_v^2}&<-t_v(\sqrt{1-\rho_s^2}+\sqrt{1-\rho_v^2})\\&=\frac{\mu_z-\underline{x}^H+\mu_e}{\sigma_v}(\sqrt{1-\rho_s^2}+\sqrt{1-\rho_v^2})\end{aligned}$$

A sufficient condition for first-order stochastic dominance at $\theta=1$ is

$$\frac{\mu_z}{\sigma_z}>\frac{\mu_z-\underline{x}^H+\mu_e}{\sigma_v}$$

Or more intuitively

$$\frac{\sigma_v}{\sigma_z}-\frac{\mu_e-\underline{x}^H}{\mu_z}>1$$

We find this constraint on the parameters of the shocks to the resources to repay the debt and the exchange rate to be reasonable. The first term on the left-hand side is the ratio of the standard deviation of $z - e$, the real value of bond repayments indexed to the exchange rate in default, relative to the standard deviation of z, the real value of resources available to repay (stated in local currency) in default. With exchange rate risk, this ratio is strictly greater than 1. We have assumed the second term is also strictly negative, by $\underline{x}^H < 0$. Intuitively, the second term should be small: Unconditional expected default at $\theta = 1$ is low (μ_z large), $\underline{x}^H$ is small, and μ_e is the unconditional expected exchange rate depreciation.

To summarize, the assumptions we've taken are (i) exchange rates have more variance than the budget surplus, $\sigma_z < \sigma_e$, (ii), $\mu_s \leq 0$, the local currency is weakly expected to appreciate, (iii) $\sigma_{ez} \leq 0$, exchange rates and fiscal surpluses are weakly negatively correlated (exchange rates depreciate in bad times); and (iv) $\frac{\sigma_v}{\sigma_z} - \frac{\mu_e - \underline{x}^H}{\mu_z} > 1$, which is to say, the ratio of the variance on local-currency debt repayments to hard-currency debt repayments is sufficiently large relative to risk-taking capacity of the foreign fiscal authority. The last assumption just says the capital requirements are sufficiently stringent relative to the tail risks in x, e.

Derivation of distributions $F_L(x;\theta), F_H(x;\theta)$

For hard-currency bonds, the payoff is

$$X^H = X_T(\theta) = \min\{1, \frac{Z}{\theta + (1-\theta)\mathcal{E}}\}$$

where $Z, \mathcal{E}$ are jointly lognormally distributed. $X_T(\theta)$ is defined in 5. The required capital is $1 - \underline{X^H}$ which solves

$$\Pr(X_T(\theta) < \underline{X^H}) = \pi$$

Where

$$\Pr(X_T(\theta) < \underline{X}^H) = \int_{-\infty}^{\infty} \int_{-\infty}^{\underline{X}} f(Z, X_T(\theta)) dZ dX_T(\theta)$$

We denote the distributions of the payoffs on local- and hard-currency bonds as

$$F^L(x;\theta), F^H(x;\theta)$$

respectively. We evaluate at $\theta = 1, 0$. At $\theta = 1$ we have

$$F^H(\underline{X}^H; \theta = 1) = \Pr(X_T(1) < \underline{X}^H) = \Pr(Z < \underline{X}^H) = \int_{-\infty}^{\infty} \int_{-\infty}^{\underline{X}} f(Z, \mathcal{E}) dZ d\mathcal{E}$$

At $\theta = 0$,we have

$$F^H(\underline{X}^H; \theta = 0) = \Pr(X_T(0) < \underline{X}^H) = \Pr(Z\mathcal{E}^{-1} < \underline{X}^H) = \int_{-\infty}^{\infty} \int_{-\infty}^{\underline{X}} f(Z, \mathcal{E}) dZ d\mathcal{E}$$

To evaluate, we define

$$x(\theta) = \log(X_T(\theta)) = \log(Z) - \log(\theta + (1-\theta)\mathcal{E})$$

At $\theta = 1$, have

$$x_1 = x(1) = z, x_0 = x(0) = z - e$$

Conveniently, both are normally distributed. We will write conditional expectations using the fact that for two jointly normal variable w, x,

$$w \mid x = x_0 \sim \mathcal{N}(\mu_{w|x}, \sigma_{w|x})$$
$$\mu_{w|x} = \mu_w + \frac{\sigma_{wx}}{\sigma_x^2}(x_0 - \mu_x), \quad \sigma_{w|x} = \sigma_w^2 - \frac{\sigma_{xw}^2}{\sigma_x^2}$$

We can define

$$\Xi_x = \mu_x + \frac{1}{2}\sigma_x^2$$

and

$$\hat{x}(\sigma) = -\frac{\mu_x + \sigma}{\sigma_x}, \hat{x} := \hat{x}(0)$$

where

$$\mu_x = \mathbb{E}[x(\theta)], \quad \sigma_x = \mathrm{Var}(x(\theta))^{1/2}$$

So we have

$$\mu_{x_1} = \mathbb{E}[x(1)] = \mu_z, \quad \sigma_{x_1} = \sigma_z$$

etc. Note that $\hat{x}'(\sigma) < 0$ and write

$$\mathbb{E}[\exp w | x \leq 0] = \exp(\Xi_w) \cdot \frac{\Phi(\hat{x}(\sigma_{xw}))}{\Phi(\hat{x}_0)} \mathbb{E}[\exp w | x > 0] = \exp(\Xi_w) \cdot \frac{1 - \Phi(\hat{w}(\sigma_{xw}))}{1 - \Phi(\hat{x})}$$

We can also write

$$\underline{x} = \log \underline{X}$$

And therefore

$$F(\underline{X})_{|\theta=1} = \Pr(Z < \underline{X}) = \Pr(z < \underline{x}) = F_{x_1}(\underline{x}^H) = \Phi(\frac{\underline{x}^H - \mu_{x_1}}{\sigma_{x_1}}) = \Phi(\frac{\underline{x}^H - \mu_z}{\sigma_z})$$

or

$$\underline{X}^H = \exp(F_{x_1}^{-1}(\underline{x}^H))$$

At $\theta = 0$ we have

$$F^H(\underline{X}^H; \theta = 0) = \Pr(Z\mathcal{E}^{-1} < \underline{X}^H) = \Pr(z - e < \underline{x}^H) = F_{x_0}(\underline{x}^H) = \Phi(\frac{\underline{x}^H - \mu_z + \mu_e}{\sqrt{\sigma_z^2 + \sigma_z^2 - 2\sigma_{ez}}})$$

So we write

$$F^H(x; \theta = 0) = \Pr(z - e < x)$$
$$F^H(x; \theta = 1) = \Pr(z < x)$$

For local-currency bonds the required capital solves

$$\Pr(X_T(\theta)\mathcal{E}_T^{-1} < \underline{X}^L) = \pi$$

where

$$\Pr(X_T(\theta)\mathcal{E}_T^{-1} < \underline{X}^L) = \mathbb{E}[\chi_T \mathbb{I}\{\mathcal{E}_T^{-1} < \underline{X}^L\}] + \mathbb{E}[(1 - \chi_T)\mathbb{I}\{X_T(\theta)\mathcal{E}_T^{-1} < \underline{X}^L\}]$$

We evaluate at $\theta = 1, 0$. At $\theta = 1$ we have

$$X_T(\theta)\mathcal{E}_T^{-1} = \min\{1, Z \cdot \mathcal{E}_T^{-1}\} = \chi_T \mathcal{E}_T^{-1} + (1 - \chi_T) Z_T \mathcal{E}_T^{-1}$$

$$\begin{aligned}\Pr(X_T(1)\mathcal{E}_T^{-1} < \underline{X}^L) &= \Pr(\chi_T = 1) * \Pr(\mathcal{E}_T^{-1} < \underline{X}^L \mid \chi_T = 1) \\ &\quad + \Pr(\chi_T = 0) * \Pr(Z_T\mathcal{E}_T^{-1} < \underline{X}^L \mid \chi_T = 0) \\ &= \Pr(z \geq 0) * \Pr(-e < \underline{x}^L \mid z \geq 0) + \Pr(z < 0) * \Pr(z - e < \underline{x}^L \mid z < 0)\end{aligned}$$

Let

$$s = -e$$
$$\nu = z - e$$

Then write the above as

$$\Pr(X_T(1)\mathcal{E}_T^{-1} < \underline{X}^L) = \Pr(z \geq 0, s < \underline{x}^L) + \Pr(z < 0, \nu < \underline{x}^L)$$

And therefore

$$F^L(x;\theta = 1) = \Pr(z \geq 0, s < x) + \Pr(z < 0, \nu < x)$$

At $\theta = 0$, we have

$$X_T(0)\mathcal{E}_T^{-1} = \min\{1, Z_T\mathcal{E}_T^{-1}\} \cdot \mathcal{E}_T^{-1} = \chi_T\mathcal{E}_T^{-1} + (1 - \chi_T)Z_T\mathcal{E}_T^{-1}$$

But now

$$\chi_T = \mathbb{I}\{Z_T > \mathcal{E}_T\}$$

$$\begin{aligned}\Pr(X_T(0)\mathcal{E}_T^{-1} < \underline{X}^L) &= \Pr(\chi_T = 1) \cdot \Pr(\mathcal{E}_T^{-1} < \underline{X}^L \mid \chi_T = 1) \\ &\quad + \Pr(\chi_T = 0) \cdot \Pr(Z_T\mathcal{E}_T^{-1} < \underline{X}^L \mid \chi_T = 0) \\ &= \Pr(\nu \geq 0, s < \underline{x}^L) + \Pr(\nu < 0, \nu < \underline{x}^L)\end{aligned}$$

So we have

$$F_L(x;\theta = 0) = \Pr(\nu \geq 0, s < x) + \Pr(\nu < 0, \nu < x)$$

To summarize, we have

$$F_L(x;\theta=0) = \Pr(\nu \geq 0, s < x) + \Pr(\nu < 0, \nu < x)$$
$$F_L(x;\theta=1) = \Pr(z \geq 0, s < x) + \Pr(z < 0, \nu < x)$$

and

$$F_H(x;\theta=0) = \Pr(z - e < x)$$
$$F_H(x;\theta=1) = \Pr(z < x)$$

For the purpose of signing the conditional probabilities under specific assumptions on the parameters of the distributions F_z, F_e, we write them here in their integral forms. We know that

$$\Pr(w < a \mid x = x_0) = F_{w|x}(a) = \Phi(\frac{a - \mu_{w|x}}{\sigma_{w|x}})$$

which is a function of x_0 – see above. So, we have

$$\Pr(w < a, x < 0) = \int_{-\infty}^{0} F_{w|x}(a) f_x(x) dx$$

where, since x normal, we have

$$f_x(x) = \frac{1}{\sigma_x}\varphi(\frac{x - \mu_x}{\sigma_x})$$

And

$$\Pr(w < a, x < 0) = \frac{1}{\sigma_x}\int_{-\infty}^{0} \Phi(\frac{a - \mu_{w|x}}{\sigma_{w|x}})\varphi(\frac{x - \mu_x}{\sigma_x}) dx$$

Note $\rho_{wx} = \frac{\sigma_{wx}}{\sigma_w \sigma_x}$. Therefore

$$\sigma^2_{w|x} = \sigma^2_w + \frac{\sigma^2_{xw}}{\sigma^2_w} = \sigma^2_w(1 - \rho^2_{wx})$$
$$\mu_{w|x} = \mu_w + \frac{\sigma_{xw}}{\sigma^2_w}(x_0 - \mu_x) = \mu_w + \sigma_w \rho_{xw}(\frac{x_0 - \mu_x}{\sigma_x})$$

So we can standardize $\Pr(w < a, x < 0)$ to

$$\Pr(w < a, x < 0) = \frac{1}{\sigma_x} \int_{-\infty}^{\frac{-\mu_x}{\sigma_x}} \Phi(\frac{t - \rho_{xw} u}{\sqrt{1 - \rho_{xw}^2}}) \varphi(u) du$$

where

$$t = \frac{a - \mu_w}{\sigma_w} \quad u = \frac{x_0 - \mu_x}{\sigma_x}$$

A.3.3 Incentive compatible claims on the open-end fund

In the main body of the paper, we make the simplifying assumption that foreign households liquidate all of their claims on the mutual fund when the bad news state occurs. This is a stark assumption intended to highlight the key friction in the model: That in some states of the world, demand for safety can overwhelm investors' risk-neutral expectations about future consumption and lead to capital outflows, which are disproportionately affect bonds with greater fundamental risk (i.e., local-currency bonds). Here, we derive the conditions under which this behavior of converting the equity claim on the mutual fund after bad news is incentive compatible for the foreign household.

Recall that the household utility function is linear in safe claims (equation 6).[67] Suppose that in any state of the world, households can redeem their claims from any of the intermediaries in the model, and place them in a safe bond which pays out zero interest between times $t = 1, 2$. By definition, the household's willingness to pay for such a bond is $\gamma + \beta$. In the event of that bad news about the sovereign bond arrives, their indifference condition between redeeming their equity in the mutual fund (i.e., "converting" their claims) and leaving their equity in the fund is

$$(\gamma + \beta) P_b^c = \beta \mathbb{E}_b[X^c]$$

for $c \in \{L, H\}$, which is to say, it is incentive-compatible to convert the equity claim as long as

[67] This assumption here allows us to introduce an outside means of storing safe assets between $t = 0, 1$ without affecting the intermediation equilibrium we describe in Proposition 1.

$$\frac{\gamma+\beta}{\beta} \geq \frac{1}{\zeta^c}$$

Note that $(\zeta^c)^{-1}$ is the expected return for a risk-neutral arbitrageur in the fire sale. This incentive compatibility constraint serves to highlight the assumptions of limits to arbitrage we make in the model: In assuming foreign households liquidate their equity claims, we implicitly assume their demand for safety is great enough they leave at minimum these risky arbitrage returns on the table. Of course, as the fire sale discount approaches zero, the incentive compatible choice is always to leave the equity in the fund. However, using 31 (see below), note that $(\zeta^c)^{-1}$ is bounded above in equilibrium by

$$\frac{1}{\zeta^c} < \frac{\gamma+\beta b}{\gamma \underline{X}^c + \beta b}$$

We can rearrange this to write that a sufficient condition for full conversion of equity is the assumption

$$\underbrace{(1-b)\beta}_{\text{discounted expected value of equity upside}} < \underbrace{\underline{X}^c(\gamma+\beta)}_{\text{discounted value of safe assets backed by } c}$$

That is, if the premium placed on money is sufficiently large relative to the quantity of safe assets which can be supported by bond i. In contrast, households which have claims in the insurer or "stable funding" intermediary are trivially indifferent between liquidating their claims which pay out $(\gamma+\beta)M_S^c$ in T and the outside safe option which pays the same.

A.3.4 Discussion of alternative microfoundations for the collateral advantage of hard-currency

In this section, we discuss alternative approaches to microfounding the advantage of hard-currency debt in collateralizing long-term claims in hard currencies. This advantage could theoretically arise for many reasons, including demand for safe or convenient assets (as in our setting) and contracting problems between intermediaries and their clients. The former case provides a convenient starting point, and one that we provide some evidence in favor of in Section 5. It allows for agents to have full information about the risks intermediaries take, which is a particularly convenient modeling approach when we extend the model to endogenize the choices of the sovereign issuer.

The important idea behind this friction is that intermediaries capture some rents from contracting to buy and manage an asset on behalf of households. In <**empty citation**>, similar ideas arise due to limited commitment, information asymmetries, and moral hazard. Short-term funding in these models allows lenders to hold manager behavior to account or to extract signals about borrower quality. In <**empty citation**>, short-term funding and fragile capital structures enable intermediaries to hold risky assets. Two themes from these papers are reflected in our setting: (1) Assets with more non-pledgeable risk are harder (easier) to finance in closed-end and long-term (fragile) capital structures, (2) assets with more liquidity are easier to finance with short-term and fragile strategies. Both themes appear in our model as well.

Contracting problems and informational asymmetries could manifest in our setting in meaningful ways. Exchange rate risk in local-currency bonds could also exacerbate agency problems. For example, the limited verifiability of risk-management practices could imply that bonds with currency risk are intermediated through funds providing exit options in equilibrium. Fund managers may promise to hedge the currency risk in the prospectus. In practice, FX hedging is not easily verifiable by outsiders. Fund managers probably face strong incentives to renege on FX-hedging, as in the EM setting, hedging is quite costly to performance. Asset manager fees may also distort incentives towards under-risk adjusting. If currency risk premia drive local-currency bond yields up relative to hard-currency bonds, there may be a correlation in equilibrium between local-currency holdings and the performance-driven flows for funds.

B Empirical Appendix

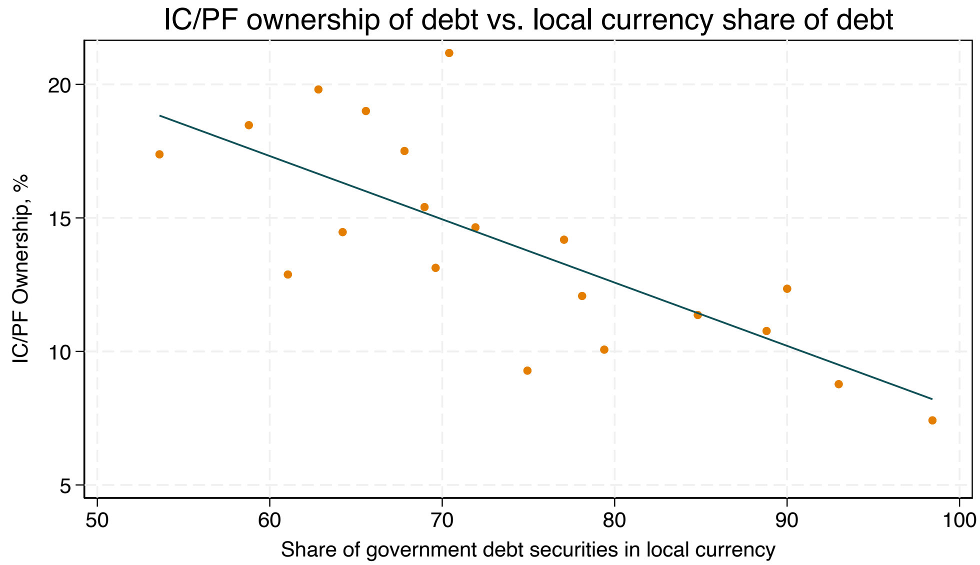
B.1 Appendix to Section 3

Table B.1: Sectoral Holdings of Local- and Hard-Currency Bonds
Mean of Quarterly Observations of Holdings Data

	All Currencies	Hard Currency	Local Currency
Total Holdings (Billions of EUR)	243	131	112
% Banks	18	20	14
% Insurance	11	17	2
% Funds	54	45	67
% Pensions	10	9	13
Subitem: % Dutch pension sector	8	6	13

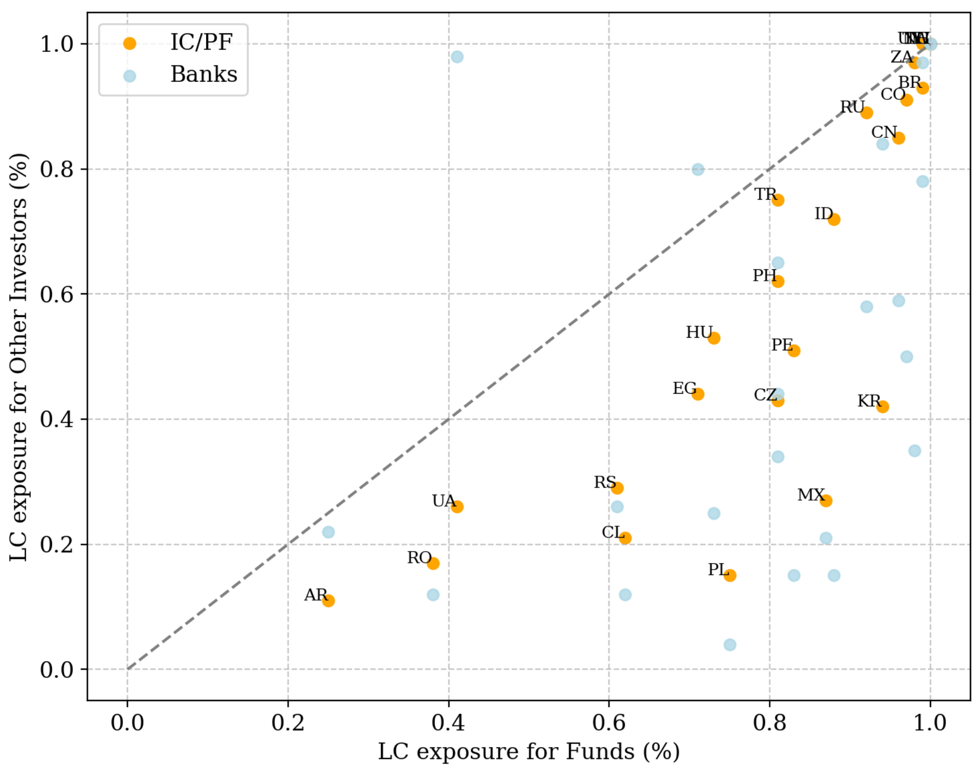
Note: The first row reports the total holdings observed in the SHS sample in an average quarter, split by currency. Subsequent rows report the percent of holdings accounted for by investor-sectors. The sample of bonds is described in section 2.

Figure B.1: Countries with larger insurer and pension investor bases issue less in local currency



Sources: CPIS, Arslanap and Tsuda 2023. *Note*: Binscatter controls for domestic ownership of local currency securities, capital control index (IMF 2024), and foreign ownership of all debt securities.

Figure B.2: Insurance, Pension, and Bank investors hold less Local Ccy exposure than other investors



Sources: ECB-SHS.

Table B.2: Estimates of Investors' Intensive Margin Hard Currency Preference

	Dependent Variable: $h^j_{it}/\text{Amount Out}_{it}$								
	Insurers			Banks			Open-End Funds		
$\mathbb{1}\{\text{Local Currency}\}$	-0.15	-0.14	-0.16	-0.11	-0.07	-0.13	-0.10	-0.13	-0.10
	(0.00)	(0.03)	(0.03)	(0.00)	(0.02)	(0.04)	(0.00)	(0.03)	(0.02)
$\mathbb{1}\{\text{USD}\}$	-0.14	-0.13	-0.15	-0.11	-0.05	-0.12	-0.06	-0.08	-0.05
	(0.00)	(0.03)	(0.03)	(0.00)	(0.01)	(0.04)	(0.00)	(0.02)	(0.02)
Identifying N	25024	24964	17344	25024	24964	17344	25024	24964	17344
Currency R^2		0.30	0.41		0.09	0.35		0.04	0.08
Issuer FE		✓	✓		✓	✓		✓	✓
× Maturity Bucket		✓	✓		✓	✓		✓	✓
× Debt Type		✓	✓		✓	✓		✓	✓
× Size		✓	✓		✓	✓		✓	✓
× Coupon Type		✓	✓		✓	✓		✓	✓
× Bond Rating		✓	✓		✓	✓		✓	✓
× Jurisdiction		✓	✓		✓	✓		✓	✓
Quarter FE			✓			✓			✓

Note: OLS estimates of regression (2), which models the share of bond i held by an intermediary type $j \in \{Insurers, Banks, Open-EndFunds\}$ as a linear function of an indicator for the bond's currency. The leave-out currency is the euro, so estimates should be interpreted as the mean share of a bond denominated in local-currency or USD relative to the share of a similar EUR-denominated bond from the same issuer. Standard errors in parentheses clustered at the bond and date level.

Table B.3: Collapsed Estimates of Investors' Extensive Margin Hard Currency Preference

Note: OLS estimates of the linear probability of holding a bond denominated in issuer's local currency and USD, relative to holding a similar EUR-denominated bond. Standard errors in parentheses clustered at the bond and date level.

Table B.4: Collapsed of Investors' Intensive Margin Hard Currency Preference

Note: OLS estimates of the linear probability of holding a bond denominated in issuer's local currency and USD, relative to holding a similar EUR-denominated bond. Standard errors in parentheses clustered at the bond and date level.

B.2 Appendix to Section 5

Summary Statistics for Sample Described in Section 2

Table B.5: Summary of issuers included in bond sample

	Averages Across Quarters	
Country	Euro Area Holdings (Billions of Euros)	No. ISINS
AR	19.55	196.59
BR	27.17	63.50
CL	10.72	40.89
CO	14.89	48.43
CZ	27.98	49.16
DO	6.12	51.41
EG	7.08	80.30
GE	0.22	8.70
GH	3.83	44.00
HU	14.15	57.25
ID	24.22	116.07
IS	1.22	13.34
KE	1.81	19.84
KR	9.72	80.00
LK	3.79	42.32
MK	0.88	7.36
MX	39.48	91.45
NG	3.06	28.52
PE	9.03	42.66
PH	5.74	80.95
PL	38.58	70.02
RO	31.82	92.05
RS	3.29	46.05
RU	12.41	63.11
TR	21.98	82.73
TW	0.20	10.30
UA	6.44	43.07
UY	4.63	28.25
ZA	20.73	40.32

Notes: Table reports, for each issuer included in the bond sample, the average of the par value of holdings reported in the SHS each quarter, and the average number of distinct bonds (ISINs) reported in the SHS each quarter.

Table B.6: Summary of bond holdings sample by currency

	Averages Across Quarters	
	Euro Area Holdings (Billions of Euros)	No. ISINS
Hard Currencies	***189.02***	***739***
CHF	0.59	6.32
EUR	83.83	202.52
GBP	0.46	3.48
JPY	1.07	20.05
USD	104.07	506.91
Local Currencies	***220.33***	***1009***
ARS	2.02	24.11
BRL	21.63	43.36
CLF	0.89	9.36
CLP	2.14	15.52
COP	7.93	23.77
CZK	23.43	43.86
DOP	0.64	26.45
EGP	1.69	49.18
GEL	0.03	9.24
GHS	1.22	26.89
HUF	5.63	35.30
IDR	14.69	54.82
ISK	0.20	8.75
KES	0.25	11.80
KRW	8.36	69.11
LKR	0.40	23.25
MXN	23.67	43.36
NGN	0.35	13.45
PEN	4.06	30.00
PHP	1.59	54.86
PLN	12.20	32.73
RON	12.07	45.25
RSD	0.66	20.07
RUB	8.25	38.27
TRY	8.10	43.64
TWD	0.20	10.30
UYU	1.23	14.20
ZAR	15.66	26.39

B.3 Balance Tables for Bond-Level Analyses

Table B.7: Balance Tables for Bond-Level Holdings Regressions

	Hard Currency	Local Currency
Observations		
Unique ISINs	643	474
Unique Issuers	36	36
N	8984	6332
Bond Size		
Amount Outstanding (mil. EUR)	1303	1829
Coupon Type		
Fixed	98.8	99.2
Variable	0.4	0.6
Zero	0.8	0.1
Bond Rating		
aa	1.0	2.7
a	14.4	9.6
bbb	48.7	55.0
bb	12.8	5.1
b	5.9	17.5
ccc	16.8	9.1
cc	0.5	1.0
Remaining Maturity (Bucket)		
30y+	16.4	7.8
20y	19.7	19.0
10y	34.8	28.9
5y	21.0	27.0
2y	7.0	16.2
3m	1.0	1.2
Original Maturity (Bucket)		
30y+	26.1	19.0
20y	29.9	29.8
10y	35.4	37.7
5y	7.8	11.7
2y	0.9	1.9

Table B.8: Balance Tables for Coppola (2024)-Style Regressions

	Bond-Level Treatment: Insurers'+Banks' Share	
	Below Median	Above Median
Observations		
Unique ISINs	202	229
N	300	326
Bond Size		
Amount Outstanding (mil. EUR)	1112	1459
Currency Type		
Local Currency	66.2	30.5
Hard Currency	33.8	69.5
Coupon Type		
Fixed	96.6	98.5
Variable	2.7	1.0
Zero	0.7	0.5
Bond Rating		
aa	0.9	5.1
a	5.7	13.5
bbb	58.7	46.2
bb	11.5	13.3
b	9.9	13.4
ccc	12.4	8.1
cc	0.9	0.3
Remaining Maturity (Bucket)		
30y+	15.4	17.4
20y	22.3	19.4
10y	27.5	35.5
5y	21.9	20.3
2y	12.0	6.8
3m	0.9	0.6
Original Maturity (Bucket)		
30y+	31.2	29.6
20y	26.4	35.3
10y	29.4	29.1
5y	11.3	5.8
2y	1.6	0.3

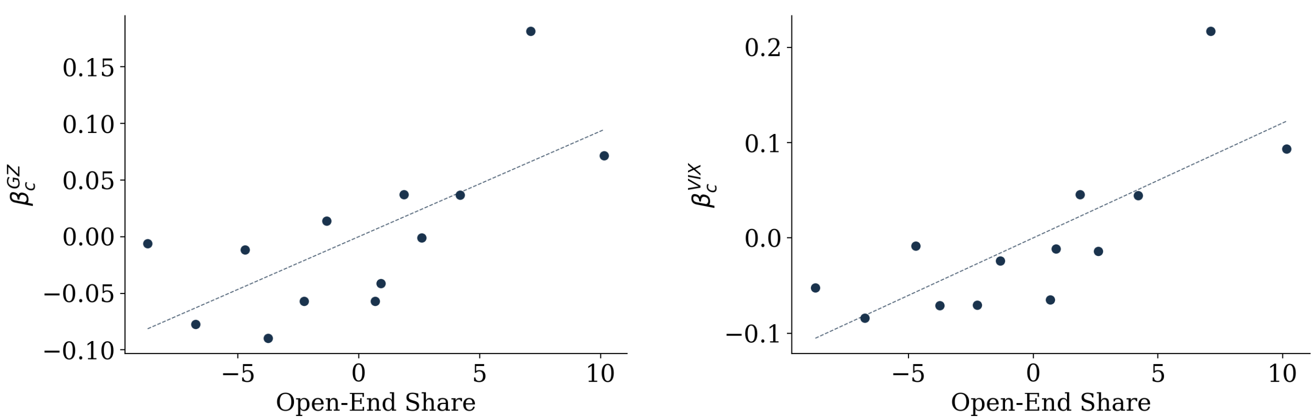
B.3.1 Representativeness of SHS Sample

To be added.

B.4 Cross-Country Evidence of Investor Composition Effects on Bond Risk

We conduct a simple reduced form exercise that uses cross-country variation in the amount of external debt that is held by the investment fund sector. We estimate local-currency bond betas by running monthly time series regression of the change in the local currency credit spread measures of advanced-country credit market conditions. The global variables we consider are the VIX and the US corporate bond market credit spread from Gilchrist and Zakrajšek (2012). The cross-country correlations between our estimated bond betas and the ownership share of open-end funds in local-currency debt reported in Figure B.3 show a tight link between bond covariance with the credit cycle and investor composition. Importantly, this cross-country pattern holds after controlling for foreign participation at large in domestic debt, suggesting a special link between open-end vehicles and this measure of bond risk.

Figure B.3: Investor Composition and Local-Currency Bond Betas



(a) Bond Beta with US Corporate Credit Spread (Gilchrist & Zakrajšek, 2012)

(b) Bond Beta with VIX

Note: Figure displays a binscatter of estimated bond beta coefficients at the issuer level against the share of local-currency bonds held by foreign mutual funds. Bond-betas are estimated from monthly regressions over the sample 2013-2020 of benchmark bond yields on global measures of financial conditions, with controls for the federal funds rate, the forward premium from Du and Schreger (2016), and issuer-level real GDP growth. The two measures of financial conditions are the Gilchrist and Zakrajšek (2012) US corporate credit spread (a) and the VIX (b). The displayed binscatter controls for the share of bonds held by foreigners which comes from Tsuda (n.d.); the units of both X and Y axes are residuals after controling for this variable. The cross-country correlation in panel (a) is 77%; the cross-country correlation in panel (b) is 69%. *Note*: this is a stand-in figure which uses data from the Global Capital Allocation Project. I will replicate the figures with our SHS data.

B.5 Price impact estimates and robustness tests

Table B.9: Pooled Differences-in-Differences of Sovereign Bond Yields on Mutual Fund shock

	Dependent Variable: Bond Yield y_{it}							
	Pooling all Currencies				Interacting with $\mathbb{1}\{\text{Local Currency}\}$			
Post × Treat (δ_i)	-0.0394	0.339	0.265	-0.139	-0.782	-0.286	-0.286	-0.286
	(0.455)	(0.314)	(0.337)	(0.247)	(0.763)	(0.333)	(0.333)	(0.333)
Post × Local Currency × Treat					1.229	1.145	1.149	0.488
					(0.995)	(0.519)	(0.545)	(0.428)
N	29807	27900	26914	27900	29807	27900	26914	27900
Identifying Bonds	848	839	799	839	848	839	799	839
Within R^2	0.00003	0.00551	0.00392	0.00076	0.0168	0.0353	0.0298	0.00273
F stat	0.259	51.49	23.82	7.028	84.65	170.2	116.9	12.74
Mean Y	6.92	6.55	6.44	6.55	6.92	6.55	6.44	6.55
SE Y	6.46	5.22	5.25	5.22	6.46	5.22	5.25	5.22
Mean Treat	0.71	0.73	0.73	0.73	0.71	0.73	0.73	0.73
SE Treat	0.34	0.33	0.32	0.33	0.34	0.33	0.32	0.33
Month FE	✓	✓	✓	✓	✓	✓	✓	✓
ISIN FE	✓	✓	✓	✓	✓	✓	✓	✓
Issuer FE		✓	✓	✓		✓	✓	✓
x Remaining Maturity		✓	✓	✓		✓	✓	✓
x Size		✓	✓	✓		✓	✓	✓
x Coupon Type		✓	✓	✓		✓	✓	✓
x Currency		✓	✓	✓		✓	✓	✓
Currency × Month FE				✓				✓
Δ FX Control			✓				✓	

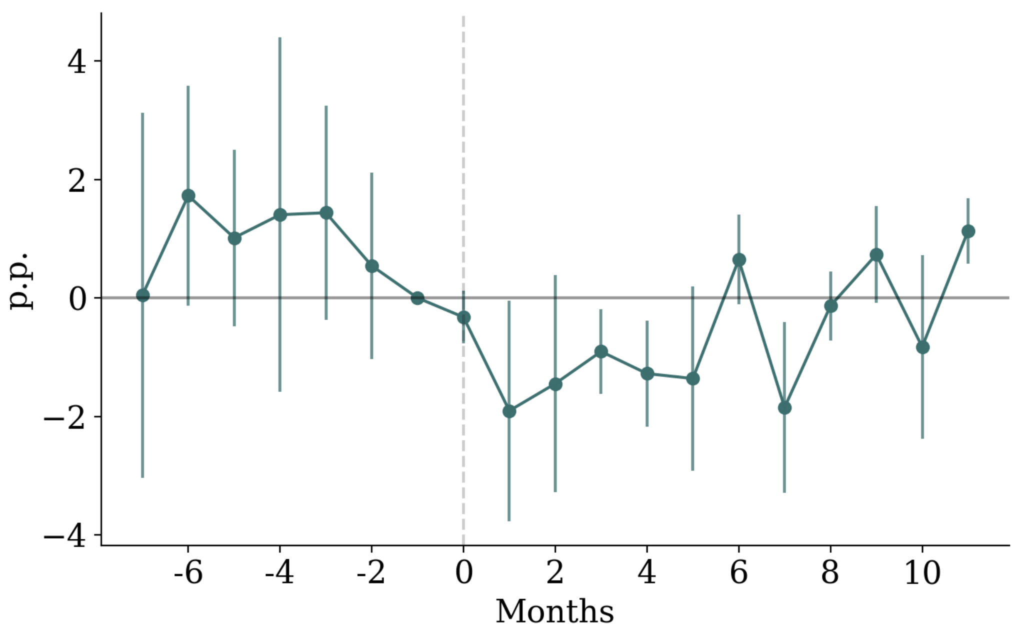
Table reports results from pooled differences-in-differences regressions of the form $y_{it} = \alpha_i + \alpha_t + \gamma\,(\text{Treat}_i \times \mathbb{1}\{t \geq \text{2022m2}\}) + \Gamma' X_{i,t} + \epsilon_{it}$ at the bond$-i$ level for the full sample of bonds, excluding those denominated in Euros. The dependent variable is raw bond yield-to-maturity. Standard errors, in parentheses, are clustered at the bond and date level. All columns use $\hat{\delta}_i$, the pre-invasion exposure of bond i to high-outflow funds, as a treatment. Treatments are scaled in regressions by their in-sample standard deviation, so that regression estimates can be interpreted as the differential pre-to-post yield increase associated with a standard deviation increase in the treatment, stated in percent. Columns (1) through (4) report regressions pooling all bonds together into a two-way fixed-effects Diff-in-Diff. Columns (5) through (8) estimate heterogeneous effects for hard- and local-currency bonds. The first column for each design is the canonical two-way fixed effects estimator; the second column includes interacted fixed effects for bond characteristics and exchange rate controls. The last column supplants FX controls with currency× month fixed effects. Regression is implemented using WLS with bond par amount outstanding, scaled by issuer-level par outstanding, as weights. This weighting scheme treats issuer-level variation equally across issuers, but bond-level variation within issuers unequally. We conduct robustness checks on the weighting scheme in **??**. *Sources:* Lipper, Bloomberg.

Table B.10: Differences-in-Differences Study of Mutual Fund Outflow Price Impact

	Dependent Variable: Bond Yield y_{it}							
	Pooling all Currencies				Interacting with $\mathbb{1}\{\text{Local Currency}\}$			
Post × Treat (ω_i)	0.101	0.0126	0.0126	-0.0565	-2.091	-0.805	-0.807	-0.808
	(0.340)	(0.240)	(0.247)	(0.157)	(1.627)	(0.484)	(0.484)	(0.484)
Post × Local Currency × Treat					2.511	1.201	1.205	0.978
					(1.648)	(0.502)	(0.502)	(0.484)
N	29517	27654	26742	27654	29517	27654	26742	27654
Identifying Bonds	839	830	792	830	839	830	792	830
Within R^2	0.00031	0.00001	0.00081	0.00011	0.0238	0.0237	0.0236	0.00576
F stat	3.021	0.0546	2.569	0.977	119.7	112.0	90.41	26.71
Month FE	✓	✓	✓	✓	✓	✓	✓	✓
ISIN FE	✓	✓	✓	✓	✓	✓	✓	✓
Issuer FE		✓	✓	✓		✓	✓	✓
x Remaining Maturity		✓	✓	✓		✓	✓	✓
x Size		✓	✓	✓		✓	✓	✓
x Coupon Type		✓	✓	✓		✓	✓	✓
x Currency		✓	✓	✓		✓	✓	✓
Currency × Month FE				✓				✓
Δ FX Control			✓				✓	

Table reports results from pooled differences-in-differences regressions of the form $y_{it} = \alpha_i + \alpha_t + \gamma\,(\text{Treat}_i \times \mathbb{1}\{t \geq 2022\text{m}2\}) + \Gamma' X_{i,t} + \epsilon_{it}$ at the bond$-i$ level for the full sample of bonds, excluding those denominated in Euros. The dependent variable is raw bond yield-to-maturity. Standard errors, in parentheses, are clustered at the bond and date level. All columns use ω_i, the pre-invasion exposure of bond i to high-outflow funds, as a treatment. Treatments are scaled in regressions by their in-sample standard deviation, so that regression estimates can be interpreted as the differential pre-to-post yield increase associated with a standard deviation increase in the treatment, stated in percent. Columns (1) through (4) report regressions pooling all bonds together into a two-way fixed-effects Diff-in-Diff. Columns (5) through (8) estimate heterogeneous effects for hard- and local-currency bonds. The first column for each design is the canonical two-way fixed effects estimator; the second column includes interacted fixed effects for bond characteristics and exchange rate controls. The last column supplants FX controls with currency× month fixed effects. *Sources:* Lipper, Bloomberg.

Figure B.4: Dynamic Effect of Exposure to Securities in $\mathcal{J}^R$ on Mutual Fund Flows



Notes: Figure reports estimated coefficients from the regression $f_{jt} = \alpha_j + \alpha_t + \sum_{h=-12,h\neq 0}^{12} \gamma_h (\mathbb{1}\{j \in \mathcal{J}^R\} \times \mathbb{1}\{t = h\}) + \Gamma' X_{j,t} + \varepsilon_{jt}$. The binary treatment variable $\mathbb{1}\{t = h\})$ is an indicator for high-Russia-exposure funds, defined according to being above the median of sample portfolios in the measure ω^R in December 2021.

B.5.1 Placebo tests for differences-in-differences analysis of price impact

In tables B.12 and B.11 we conduct placebo tests for the differences-in-differences design, constructing placebos both for the cross-sectional treatments $\hat{\delta}_i$ and ω_i, as well as placebos for the event date. In table B.13 we re-estimate the baseline price impact on local-currency bonds using two alternative weighting schemes for the cross-sectional bond variation. In table B.14 and figure **??** we test our assumptions of a linear functional form for the differences-in-differences, test for measurement error in the treatments, and test for outlier-driven variation.

Table B.11: Placebo Tests for Differences-in-Differences: Placebo Treatments δ_i^p, ω_i^p

	Dependent Variable: Bond Yield y_{it}					
	Placebo: $\delta_i^{\text{placebo}}$			**Placebo:** $\omega_i^{\text{placebo}}$		
Post × Treat	-0.331*	-0.253*	0.0321	0.501*	-0.0978	0.0802
	(0.162)	(0.130)	(0.0281)	(0.263)	(0.286)	(0.143)
N	14519	11893	12900	14869	12224	13202
Identifying Bonds	414	365	406	423	374	414
Within R^2	0.00658	0.0112	0.000251	0.00881	0.00205	0.000840
F stat	4.161	1.922	1.299	3.621	0.238	0.316
Mean Y	6.41	5.48	5.78	6.39	5.48	5.77
SE Y	5.69	3.78	3.89	5.63	3.74	3.85
Mean Treat	0.06	0.07	0.07	0.00	0.00	0.00
SE Treat	0.13	0.14	0.13	0.01	0.01	0.01
Month FE	✓	✓	✓	✓	✓	✓
ISIN FE	✓	✓	✓	✓	✓	✓
Issuer FE		✓	✓		✓	✓
x Remaining Maturity		✓	✓		✓	✓
x Size		✓	✓		✓	✓
x Coupon Type		✓	✓		✓	✓
x Currency		✓	✓		✓	✓
Currency × Month FE			✓			✓
Δ FX Control		✓			✓	

Table reports results from pooled differences-in-differences regressions of the form $y_{it} = \alpha_i + \alpha_t + \gamma\,(\text{Placebo}_i \times \mathbb{1}\{t \geq 2022\text{m}2\}) + \Gamma' X_{i,t} + \epsilon_{it}$ at the bond$-i$ level for the subsample of local-currency bonds. The dependent variable is raw bond yield-to-maturity. Standard errors, in parentheses, are clustered at the bond and date level. $\delta_i^{\text{placebo}}$ is the share of bond-i held at all mutual funds in December 2021. $\omega_i^{\text{placebo}}$ is the portfolio weight of bond-i in all mutual funds in December 2021. Placebos are scaled in regressions by their in-sample standard deviation, so that regression estimates can be interpreted as the differential pre-to-post yield increase associated with a standard deviation increase in the placebo, stated in percent. *Sources:* Lipper, Bloomberg.

Table B.12: Placebo Tests for DiD: Using the Wrong Event Date for Post

	Dependent Variable: Bond Yield y_{it}			
	Treatment: δ_i		**Treatment:** ω_i	
Placebo Event Date:	- 6 months	+ 6 months	- 6 months	+ 6 months
Placebo Post $\times$ Treat	0.0794	-0.00615	0.0632	0.295***
	(0.0755)	(0.0619)	(0.0508)	(0.0439)
N	12224	12224	12089	12089
Identifying Bonds	374	374	368	368
Within R^2	0.00	0.00	0.00	0.0332
F stat	1.107	0.00989	1.547	45.32
Mean Y	5.48	5.48	5.50	5.50
SE Y	3.74	3.74	3.75	3.75
Mean Treat	0.65	0.65	0.20	0.20
SE Treat	0.36	0.36	0.32	0.32
Month FE	✓	✓	✓	✓
ISIN FE	✓	✓	✓	✓
Issuer FE	✓	✓	✓	✓
x Remaining Maturity	✓	✓	✓	✓
x Size	✓	✓	✓	✓
x Coupon Type	✓	✓	✓	✓
x Currency	✓	✓	✓	✓
Currency $\times$ Month FE	✓	✓	✓	✓

Table reports results from pooled differences-in-differences regressions of the form $y_{it} = \alpha_i + \alpha_t + \gamma\left(\text{Treat}_i \times \mathbb{1}\{t \geq \text{Placebo Date}\}\right) + \Gamma' X_{i,t} + \epsilon_{it}$ at the bond$-i$ level for the subsample of local-currency bonds. Columns (1) and (3) use July 2021 as the placebo event date; Columns (2) and (4) use August 2022 as the placebo event date. The dependent variable is raw bond yield-to-maturity. Standard errors, in parentheses, are clustered at the bond and date level. Columns (1) through (3) report regressions using δ_i, the pre-invasion exposure of bond i to high-outflow funds, as a treatment. Columns (4) through (6) report regressions using ω_i, the pre-invasion weight of bond i to high-outflow funds, as a treatment. Both Treatments are scaled in regressions by their in-sample standard deviation, so that regression estimates can be interpreted as the differential pre-to-post yield increase associated with a standard deviation increase in the treatment, stated in percent. The first column for each treatment is the canonical two-way fixed effects estimator; the second column includes interacted fixed effects for bond characteristics and exchange rate controls. The last column supplants FX controls with currency$\times$ month fixed effects. *Sources:* Lipper, Bloomberg.

B.5.2 Linearity of Treatment Effects, Weighting, Outliers, and Additional Controls

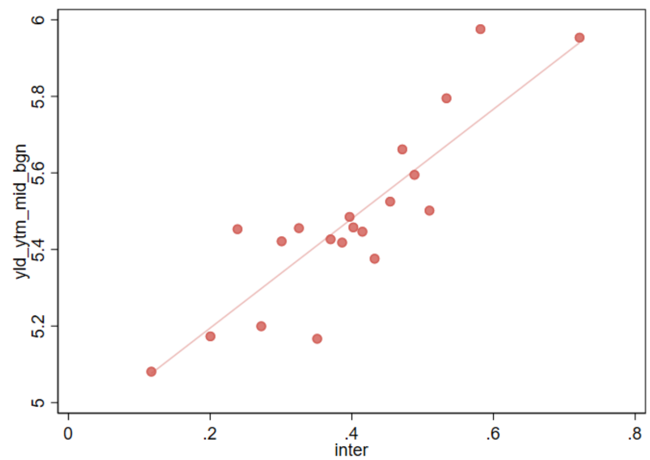
Table B.13: Diff-in-Diff Estimates Various Unit Weighting Schemes

	Dependent Variable: Bond Yield y_{it}		
	WLS (Baseline)	WLS (Uniform Weighting Across Issuers)	OLS
Post × Treat (δ_i)	0.186 (0.0487)	0.257 (0.0631)	0.201 (0.0433)
N	12421	12421	12396
Identifying Bonds	389	389	389
Within R^2	0.0100	0.00864	0.00557
F stat	14.57	16.57	21.44
Mean Y	5.63	5.63	5.63
SE Y	3.73	3.73	3.72
Mean Treat	0.20	0.20	0.20
SE Treat	0.31	0.31	0.31
Month FE	✓	✓	✓
ISIN FE	✓	✓	✓
Issuer FE	✓	✓	✓
x Remaining Maturity Bucket	✓	✓	✓
x Size	✓	✓	✓
x Coupon Type	✓	✓	✓
x Currency	✓	✓	✓
Currency × Month FE	✓	✓	✓

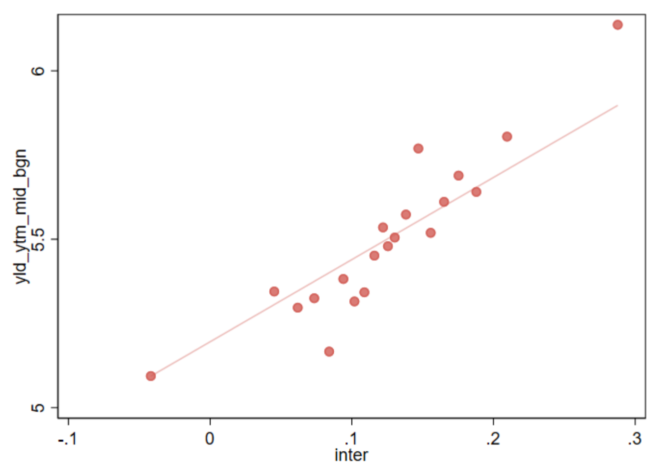
Table reports results from the pooled differences-in-differences using three different weighting schemes. The first column reports the baseline estimates, replicated from Table B.10 in the main text. The second column replaces the bond-level weights with those which treat variation across issuers unequally – that is, bonds are weighted according to their size relative to the overall amount outstanding in the sample. Finally, the last column reports unweighted (OLS) estimates. DiD regressions are of the form $y_{it} = \alpha_i + \alpha_t + \gamma\left(\omega_i \times \mathbb{1}\{t \geq 2022\text{m}2\}\right) + \Gamma' X_{i,t} + \epsilon_{it}$ at the bond$-i$ level for the subsample of local-currency bonds. The dependent variable is raw bond yield-to-maturity. Standard errors, in parentheses, are clustered at the bond and date level. Columns (1) through (3) report regressions using δ_i, the pre-invasion exposure of bond i to high-outflow funds, as a treatment. Columns (4) through (6) report regressions using ω_i, the pre-invasion weight of bond i to high-outflow funds, as a treatment. Both Treatments are scaled in regressions by their in-sample standard deviation, so that regression estimates can be interpreted as the differential pre-to-post yield increase associated with a standard deviation increase in the treatment, stated in percent. The first column for each treatment is the canonical two-way fixed effects estimator; the second column includes interacted fixed effects for bond characteristics and exchange rate controls. The last column supplants FX controls with currency× month fixed effects. *Sources:* Lipper, Bloomberg.

Figure B.5: Binscatter of Outcome y_{it} on Treat $\times$ Post

Treat: δ_i



Treat: ω_i



Note: Figure reports binscatters of raw bond yield against the Treat $\times$ Post, the DiD TWFE estimator. Binscatters reflect the regression specification in Table 4 columns (2) and (5), estimated on the sample of local-currency bonds.

Table B.14: Differences-in-Differences Estimates with Quantile of Dosage as Treatment Local Currency Sovereign Bond Yields on Mutual Fund shock

	Dependent Variable: Bond Yield y_{it}					
Regressor: $\mathbb{1}\{\text{Quantile of Treatment}_i = \tau\}$	Treatment: δ_i			Treatment: ω_i		
$\tau = .20$	-0.808	0.0276	0.401	-1.501	0.324	0.244
	(1.032)	(0.167)	(0.287)	(1.269)	(0.237)	(0.218)
$\tau = .40$	1.142	0.719	1.143	0.550	1.091	0.558
	(1.126)	(0.207)	(0.402)	(1.260)	(0.309)	(0.257)
$\tau = .60$	0.864	1.219	1.131	0.559	1.577	0.670
	(0.957)	(0.435)	(0.397)	(1.210)	(0.460)	(0.187)
$\tau = .80$	2.114	2.664	1.135	0.990	1.759	0.787
	(1.244)	(0.823)	(0.432)	(1.339)	(0.737)	(0.188)
N	14287	12224	13025	14034	12089	12816
Identifying Bonds	400	374	399	392	368	391
F stat	34.23	84.88	16.54	13.65	17.54	6.980
Mean y_{it}	6.02	5.48	5.67	6.04	5.50	5.67
SE y_{it}	5.29	3.74	3.75	5.32	3.75	3.77
Mean $\text{Treat}_i, \tau = .20$		0.00			0.00	
Mean $\text{Treat}_i, \tau = .40$		0.00			0.01	
Mean $\text{Treat}_i, \tau = .60$		0.30			0.06	
Mean $\text{Treat}_i, \tau = .80$		0.78			0.18	
Month FE	✓	✓	✓	✓	✓	✓
ISIN i FE	✓	✓	✓	✓	✓	✓
Issuer FE		✓	✓		✓	✓
× Remaining Maturity		✓	✓		✓	✓
× Size		✓	✓		✓	✓
× Coupon Type		✓	✓		✓	✓
× Currency		✓	✓		✓	✓
Currency × Month FE			✓			✓
Δ FX Control		✓			✓	

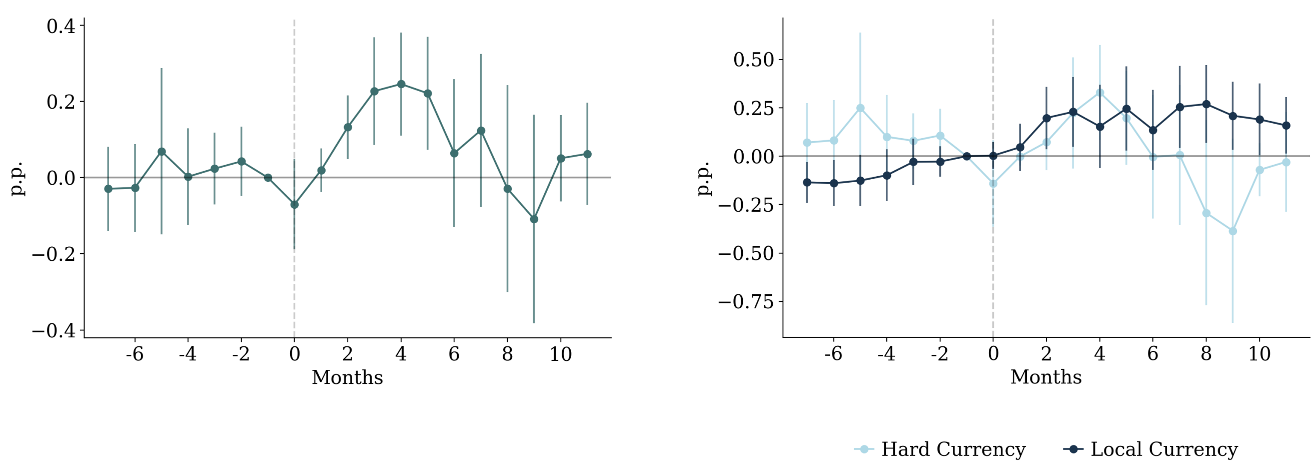
Table reports results from pooled differences-in-differences regressions of the form $y_{it} = \alpha_i + \alpha_t + \gamma\left(\text{Treat}_i \times \mathbb{1}\{t \geq \text{2022m2}\}\right) + \Gamma' X_{i,t} + \epsilon_{it}$ at the bond$-i$ level for the subsample of local-currency bonds. The dependent variable is raw bond yield-to-maturity. Standard errors, in parentheses, are clustered at the bond and date level. Columns (1) through (3) report regressions using δ_i, the pre-invasion exposure of bond i to high-outflow funds, as a treatment. Columns (4) through (6) report regressions using ω_i, the pre-invasion weight of bond i to high-outflow funds, as a treatment. Both Treatments are scaled in regressions by their in-sample standard deviation, so that regression estimates can be interpreted as the differential pre-to-post yield increase associated with a standard deviation increase in the treatment, stated in percent. The first column for each treatment is the canonical two-way fixed effects estimator; the second column includes interacted fixed effects for bond characteristics and exchange rate controls. The last column supplants FX controls with currency× month fixed effects. *Sources:* Lipper, Bloomberg.

Table B.15: Differences-in-Differences Study with More Granular Control for Forward Premia

	Dependent Variable: Bond Yield y_{it}	
	(4) Pooling all Currencies	(8) Interacting with $\mathbb{1}\{\text{Local Currency}\}$
Post × Treat (ω_i)	-0.0135	-0.606
	(0.131)	(0.397)
Post × Local Currency × Treat		0.792**
		(0.399)
N	25442	25442
Identifying Bonds	765	765
F stat	0.0629	20.38
Mean Y	6.24	6.24
SE Y	5.15	5.15
Mean Treat	0.00	0.00
SE Treat	0.00	0.00
Month FE	✓	✓
ISIN FE	✓	✓
Issuer FE	✓	✓
x Remaining Maturity	✓	✓
x Size	✓	✓
x Coupon Type	✓	✓
x Currency	✓	✓
Currency × **Remaining Maturity** × **Month FE**	✓	✓

Table replicates table **??** but replaces Currency×Month fixed effects with Currency×Remaining Maturity×Month fixed effects.

Figure B.6: Dynamic Price Impact with More Granular Control for Forward Premia



(a) Pooled effects (b) Heterogeneous effects by currency

Notes: Figure replicates Figure 4a in the main text but includes Currency×Remaining Maturity×Month fixed effects.

B.6 Discussion of Magnitudes

In the main body of the paper, we;jmh estimate a price impact coefficient which we denote here $\hat{\beta}_z$ from a canonical TWFE regression:

$$y_{it} = \alpha_i + \alpha_t + \beta_{TWFE,z} \left(z_i \times \text{Post}_t \right) + \Gamma' X_{it} + \epsilon_{it} \tag{36}$$

$\hat{\beta}_{TWFE,z}$ is a canonical DiD estimate for a continuous treatment z_i:

$$\hat{\beta}_{TWFE,z} = \int_0^1 u(z) \cdot \mathbb{E}[\Delta y_{it}(z_i = z) - \Delta y_{it}(z_i = 0) \mid \Gamma' X_{it}] \quad dz \tag{37}$$

i.e., a weighted average of the average treatment effects on the treated (ATT). The weights are[68]

$$u(\omega) = \frac{\omega - \mathbb{E}[\omega_i]}{\text{Var}(\omega_i)} f_{\omega_i}(\omega) \tag{38}$$

We interpret $\hat{\beta}_{TWFE,\omega}$ as an average of marginal ATTs (see Callaway et al. (2024) or de Chaisemartin et al. (2024) for a discussion). Then the two-way fixed effects estimator recovers a semi-elasticity of pre-to-post changes in bond yields to treatments z_i, denoted Δy_{it}:

$$\frac{\partial(\mathbb{E}[\Delta y_{it} \mid z = z_i])}{\partial z_i} = \hat{\beta}_z \times z_i \tag{39}$$

We compute semi-elasticities of changes in bond yields to changes in demand using two approaches.

1. We estimate the elasticity directly in a two-stage regression. We compute changes in demand of bond i as the minimum pre-to-post invasion par-holdings of bond i by euro-area mutual funds, relative to the pre-invasion par amount outstanding of bond i:

$$\Delta h_i^{Funds} = \min_{t \geq 2022\text{m}2} \left\{ h_{i,t}^F - h_{i,2021\text{m}12}^F \right\}_t \tag{40}$$

[68] de Chaisemartin et al. (2024)

Then

$$\tilde{h}_i^F = \frac{\Delta h_i^{Funds}}{\text{Amt Out}_{i,\text{Pre}}}$$

We choose this specification because, consistent with fire sale dynamics, many bonds in our sample experience net changes in demand revert to zero for many bonds in our sample. Peak-to-trough changes in demand better reflect the dynamics of net outflows from bonds.

We then estimate 13, replacing z_i with $\tilde{h}_i^F$. We instrument $\tilde{h}_i^F$ with $z_i \times$ Post. The identifying assumptions are:

- $z_i \times$ Post is relevant for changes in demand of bond i, as measured by $\tilde{h}_i$.
- $z_i \times$ Post is excluded from ϵ_{it} in 13. This holds if the parallel trends assumption is met for the baseline Differences-in-Differences.

The results are reported in Tables B.16 and B.17.

2. Second, following Callaway et al. (2024) we cut the continuous treatments z_i at quantiles $\tau \in \{0.33, 0.67, 1\}$ and compute implied elasticities at each quantile. The results are reported in Table B.18 below.

$$\begin{aligned} \varepsilon_q^{\Delta y}(\tau) &= \varepsilon_z^{\Delta y}(\tau)\varepsilon_q^{z}(\tau) \\ &= \sum_{i|z_i \leq \tau} w_i \left(\hat{\beta}_z \times z_i\right) \left(\tilde{h}_i\right)^{-1} \end{aligned}$$

where w_i is a bond weight, with $\sum_i w_i = 1$;[69]. This approach computes mean changes in yields associated with mutual fund outflows and mean changes in demand associated with mutual fund outflows at the quantiles of the treatment distribution given by τ. The results are reported in Table B.18.

[69]We employ the same weights as in our WLS estimator for Tables 4 - B.10

Table B.16: Two-Stage Estimates: Semi-Elasticity of Credit Spread to Bond Purchases

	Dependent Variable: Bond Yield y_{it} (p.p.)					
	Hard-Currency Bonds			Local-Currency Bonds		
	Panel A: δ_i instruments net purchases of bond i, $\tilde{h}^F_{it}$					
$\tilde{h}^F_{it}$ (p.p.)	-17.36	-7.213	-7.213	0.598	-0.299	-0.367**
	(31.62)	(15.90)	(15.90)	(0.687)	(0.359)	(0.162)
N	11490	11302	11302	8339	7835	7835
Identifying Bonds	323	323	323	232	232	232
First-Stage F	0.29	0.19	0.19	5.67	10.47	14.91
Mean Y	6.84	6.58	6.58	6.43	5.98	5.98
SE Y	7.17	5.89	5.89	5.83	4.17	4.17
Mean Treat	-0.56	-0.53	-0.53	0.08	-0.38	-0.38
SE Treat	1.95	1.71	1.71	0.19	1.44	1.44
Month FE	✓	✓	✓	✓	✓	✓
ISIN FE	✓	✓	✓	✓	✓	✓
Issuer FE		✓	✓		✓	✓
x Remaining Maturity		✓	✓		✓	✓
x Size		✓	✓		✓	✓
x Coupon Type		✓	✓		✓	✓
x Currency		✓	✓		✓	✓
Currency × Month FE			✓			✓
	Panel B: ω_i instruments net purchases of bond i, $\tilde{h}^F_{it}$					
$\tilde{h}^F_{it}$ (p.p.)	-26.90	-5.449	-5.449	-0.885	-2.311	-0.790
	(64.00)	(8.889)	(8.889)	(2.222)	(2.841)	(0.492)
N	11453	11265	11265	8282	7778	7778
Identifying Bonds	322	322	322	230	230	230
First-Stage F	0.18	0.39	0.39	1.87	2.26	5.46
Mean Y	6.84	6.59	6.59	6.45	6.00	6.00
SE Y	7.18	5.90	5.90	5.85	4.17	4.17
Mean Treat	-0.57	-0.54	-0.54	0.21	-0.39	-0.39
SE Treat	1.95	1.72	1.72	0.15	1.44	1.44
Month FE	✓	✓	✓	✓	✓	✓
ISIN FE	✓	✓	✓	✓	✓	✓
Issuer FE		✓	✓		✓	✓
x Remaining Maturity		✓	✓		✓	✓
x Size		✓	✓		✓	✓
x Coupon Type		✓	✓		✓	✓
x Currency		✓	✓		✓	✓
Currency × Month FE			✓			✓

Table reports results from pooled differences-in-differences regressions of the form $y_{it} = \alpha_i + \alpha_t + \gamma\,(\text{Placebo}_i \times \mathbb{1}\{t \geq 2022\text{m}2\}) + \Gamma' X_{i,t} + \epsilon_{it}$ at the bond$-i$ level for the subsample of local-currency bonds. The dependent variable is raw bond yield-to-maturity. Standard errors, in parentheses, are clustered at the bond and date level. $\delta_i^{\text{placebo}}$ is the share of bond-i held at all mutual funds in December 2021. $\omega_i^{\text{placebo}}$ is the portfolio weight of bond-i in all mutual funds in December 2021. Placebos are scaled in regressions by their in-sample standard deviation, so that regression estimates can be interpreted as the differential pre-to-post yield increase associated with a standard deviation increase in the placebo, stated in percent. *Sources:* Lipper, Bloomberg.

Table B.17: Two-Stage Estimates: Further Detail of IV Estimates

	Reduced Form (Table 4)	**First Stage**	**Second Stage (2SLS)**
Dependent variable	y_{it} (p.p.)	$\tilde{h}^F_{it}$ (p.p.)	y_{it} (p.p.)
Excluded instrument	δ_i (St.Dev)	δ_i	δ_i
Instrumented variable	–	$\tilde{h}^F_{it}$	$\tilde{h}^F_{it}$
Coefficient	0.157^{**}	-0.372^{***}	-0.367^{**}
	(0.067)	(0.096)	(0.162)
Observations	11,302	7,835	7,835
F-statistic (overall)	0.21	14.91	5.14
p-value (F)	0.655	0.0023	0.0426
Identification Tests:			
Kleibergen–Paap p-value (LM)	–	0.2035	0.2035
Kleibergen–Paap Wald F (Weak ID)	–	14.91	14.91
Anderson–Rubin F	–	5.19	5.19
p-value (AR F)	–	0.0418	0.0418
Endogeneity test (χ^2)	–	–	1.615 ($p = 0.204$)
Fixed Effects:	Issuer × Remaining Maturity × Size × Coupon Type × Currency, Currency × Month, Month		
Standard Errros:	Clustered at Issuer, Month		

Table reports results from pooled differences-in-differences regressions of the form $y_{it} = \alpha_i + \alpha_t + \gamma\,(\text{Placebo}_i \times \mathbb{1}\{t \geq 2022\text{m}2\}) + \Gamma' X_{i,t} + \epsilon_{it}$ at the bond$-i$ level for the subsample of local-currency bonds. The dependent variable is raw bond yield-to-maturity. Standard errors, in parentheses, are clustered at the bond and date level. $\delta_i^{\text{placebo}}$ is the share of bond-i held at all mutual funds in December 2021. $\omega_i^{\text{placebo}}$ is the portfolio weight of bond-i in all mutual funds in December 2021. Placebos are scaled in regressions by their in-sample standard deviation, so that regression estimates can be interpreted as the differential pre-to-post yield increase associated with a standard deviation increase in the placebo, stated in percent. *Sources:* Lipper, Bloomberg.

Table B.18: Alternative semi-elasticity estimates

	Panel A: Local-Currency Bonds	
	Treat δ_m	Treat ω_m
Tercile 1	0.00 [0.00, 0.00]	0.00 [0.00, 0.00]
Mean Treat	0.00	0.00
b_0	2.46	1.75
Δy (p.p.)	0.00	0.00
$\Delta q_W / q_W$ (p.p.)	-0.93	-2.31
Tercile 2	1.08 [1.00, 1.17]	0.15 [0.13, 0.18]
Mean Treat	0.58	0.07
b_0	2.46	1.75
Δy (p.p.)	1.43	0.12
$\Delta q_W / q_W$ (p.p.)	-1.32	-0.81
Tercile 3	0.33 [0.31, 0.36]	0.13 [0.11, 0.15]
Mean Treat	0.71	0.39
b_0	2.46	1.75
Δy (p.p.)	1.75	0.69
$\Delta q_W / q_W$ (p.p.)	-5.24	-5.32

	Panel B: Hard-Currency Bonds	
	Treat δ_m	Treat ω_m
Tercile 1	-0.63 [-0.75, -0.50]	-0.21 [-0.27, -0.16]
Mean Treat	0.59	0.07
b_0	-1.25	-3.10
Δy (p.p.)	-0.74	-0.23
$\Delta q_W / q_W$ (p.p.)	-1.18	-1.06
Tercile 2	-3.37 [-4.04, -2.69]	-1.41 [-1.75, -1.07]
Mean Treat	0.75	0.16
b_0	-1.25	-3.10
Δy (p.p.)	-0.94	-0.50
$\Delta q_W / q_W$ (p.p.)	-0.28	-0.35
Tercile 3	-2.24 [-2.69, -1.80]	-1.74 [-2.16, -1.32]
Mean Treat	0.90	0.27
b_0	-1.25	-3.10
Δy (p.p.)	-1.12	-0.83
$\Delta q_W / q_W$ (p.p.)	-0.50	-0.47

Notes: Each cell reports the estimated semi-elasticity of yields with respect to foreign demand, $\frac{\Delta y}{\Delta q_W / q_W}$, evaluated at terciles of the treatment distribution, with 90% confidence intervals in brackets. δ_m and ω_m denote alternative treatment variables measuring foreign demand shocks. Δy and Δq_W are in percentage points. Results are averaged within terciles of the treatment dosage for local- and hard-currency bonds, respectively.