

The Original Sin Revisited: Investor Composition and Sovereign Risk*

Sage Belz

Northwestern University

Johannes Breckenfelder

European Central Bank

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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 two sets of facts. First, investors with open-end funding structures 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 redemptions, local-currency bond prices fall differentially and issuers reallocate by issuing in hard currency. 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. Intermediary 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.

JEL: F30, F31, F34, G15, G23 **Keywords:** Sovereign debt, Exchange-rate risk, Financial Intermediaries, Fire sales

*Belz, corresponding author: sage.belz@kellogg.northwestern.edu. Breckenfelder: johannes.breckenfelder@ecb.europa.eu Please find the latest draft [here](#). This paper should not be reported as representing the views of the European Central Bank (ECB). The views expressed are those of the authors and do not necessarily reflect those of the ECB or the Eurosystem. We are immensely grateful to Sam Hanson, Oleg Itskhoki, Ken Rogoff, Jeremy Stein, and Adi Sunderam for invaluable guidance and support. We also thank Ben Bernanke, John Campbell, Gabriel Chodorow-Reich, Wenxin Du, Paul Fontanier, Benjamin Friedman, Gita Gopinath, Daniel Graves, Robin Greenwood, Victoria Ivashina, Nathan Kaplan, Laura Nicolae, Ludwig Straub, and Jennifer Walsh for many insightful and helpful discussions. We thank Constantin Oprea, Ella Patelli, and Sophia Si for excellent research assistance. This research was supported by the Molly and Dominic Ferrante Economics Research Fund at Harvard University.

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 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 sovereign debt solved the problems associated with the Original Sin?

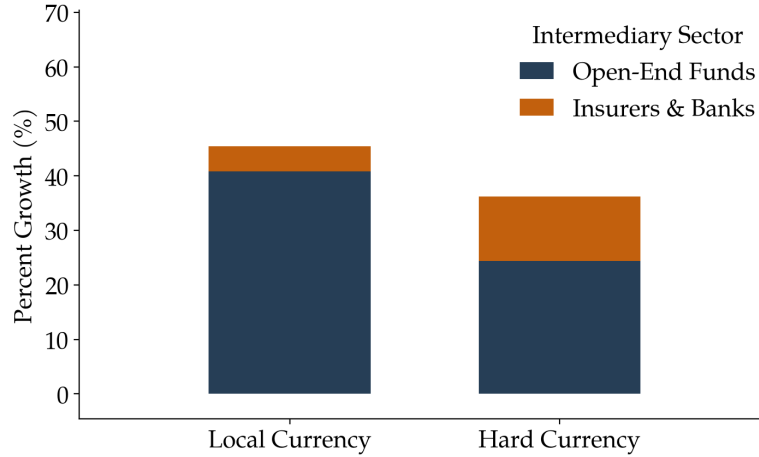
This paper documents that local-currency bonds held outside the domestic economy sort into the portfolios of open-ended intermediaries, subjecting them to fire sales. Intermediaries with long-term and stable funding hold very little local-currency debt. Sorting of local-currency debt into open-ended vehicles disproportionately exposes it to fire sales which depress prices below fundamental values. We hypothesize 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 90 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 50 and 24 percent of the cross-section of sovereign bond holdings for insurers and banks, respectively, 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.

¹This 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).

²Refer to Appendix Table A.3 for more detail.

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



Sources: Securities Holdings Statistics (ECB) and Arslanalp and Tsuda (2014). *Notes:* Decomposition of the growth in external debt outstanding of the emerging-market sovereign issuers in the sample of Section 2 over 2013–2018, in percentage points of total growth. In this figure, we impute the investor composition we observe in the SHS to the growth of external local- and hard-currency growth reported in Arslanalp and Tsuda (2014). We report the in-sample growth, without imputation to overall external debt, in Appendix Table A.1. The sectoral split assumes that the composition of holdings in the SHS is representative of all external holdings, an assumption we discuss in Appendix A.2.1. In the appendix, Table A.1 reports the decomposition of holdings in levels, as well as the same decomposition for the 2019–2024 period of growth.

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 downside risk to foreign portfolios over long horizons, even when sovereign credit risk is low. One unit of 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 *debt 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-ended funding.

We develop this hypothesis in a model of financial intermediation and sovereign default. We model competitive foreign intermediaries who issue claims to households and hold portfolios of risky bonds. Given supplies of bonds in different currencies, these intermediaries choose how to set up shop: what claims to offer households, and what bonds to hold in their portfolios. The core friction in the model is that households are willing to pay a premium for claims that are safe or liquid. For simplicity, we refer to this premium as a money premium, but our results do not depend on interpreting such claims as being contractually debt- or money-like. Rather, the core assumption is that households fund intermediaries at a lower cost when funds are backed

by either safer assets or an open-ended contract.³

To manufacture these claims, intermediaries adopt one of two strategies. One strategy is to issue debt backed by bonds with little fundamental, downside risk. 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 premium by issuing redeemable claims backed by the liquidation value of their bonds. In bad states, households redeem these claims and force the sale of sovereign bonds back to domestic investors.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 first insight of the model is that intermediaries sort into financing local-currency bonds based on their funding structures. Intermediaries with open-ended funding have a comparative advantage in financing bonds with fundamental downside risk, as financing such bonds is relatively costly for intermediaries with stable, long-term funding. Conversely, intermediaries with stable funding have a comparative advantage in financing bonds that have low liquidation values in bad states. In equilibrium, local-currency bonds are disproportionately held by open-ended intermediaries, and conversely, hard-currency bonds are disproportionately held by stable-funded intermediaries.

³One could reach the same intuitions in a model that starts from asymmetric information between intermediaries and households. In that case, both verifiable investment decisions (e.g., through the use of capital regulation) and redeemable contracts help to overcome asymmetric information and enable households to delegate more funding to intermediaries. In D. W. Diamond (1991), Chevalier and Ellison (1997), Myers and Rajan (1998), D. W. Diamond and Rajan (2001), and Stein (2005), the same ideas arise due to limited commitment, information asymmetries, and moral hazard. Redeemable funding in these models allows lenders to hold intermediary behavior to account or to extract signals about intermediary quality. In Appendix B.2.2, we generalize our baseline model to one in which households pay a premium for contractually safe claims, and a smaller premium for claims which are redeemable, and therefore have some de facto safety. This means even intermediaries which issue equity-like redeemable claims (open-end bond funds) can compete with intermediaries that issue safe, money-like claims. 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 B.2.1.

⁴Specifically, 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 (Kojen & Yogo, 2014; Du et al., 2023). We discuss this distinction and the analogies we draw to intermediaries in the data more in Section 4.

⁵We draw an analogy between these intermediaries in the model and open-ended bond mutual funds in the data. We discuss this analogy in detail in Section 4. In both cases, the key point is that some of the funding for this intermediary is vulnerable to redemptions in bad states.

The second insight of the model is that intermediaries' funding structures determine their propensities to sell bonds in bad states. 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 states. In the model, local-currency bonds are endogenously more exposed to fire sales and exhibit greater betas with capital outflows than hard-currency bonds.

The core hypothesis is best understood by considering an exogenous reallocation of one unit of bond supply from hard-currency denomination to local-currency, holding the overall supply of sovereign bonds fixed. In a frictionless setting, this change simply reallocates exchange-rate risk from the borrower (sovereign) to the lender (foreign intermediary), is fully capitalized in ex-ante bond prices, and has no effect on capital flows. In our setting, this change not only reallocates risk, but also changes the funding structure of the bond supply and subjects a greater share of the sovereign's bonds to a fire sale in the event of bad news. Expected returns to foreign intermediaries in local and hard-currency bonds are not equated even after accounting for expected exchange-rate appreciations and default risk.⁶

In Section 5, we use security-level holdings data to test the model and validate its key assumptions. First, we test the assumption that foreign intermediaries face different value-at-risk 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-currency bonds exhibit substantially larger value-at-risk even within bonds of the same issuer, duration, size, and payment structure. For a euro-based investor, the gap in VaR between local-currency bonds and comparable hard-currency bonds from the same issuer is -4.8 percentage points over a one-year horizon, -2.3 at three years and -3.3 at five.⁷

We then test the model's predictions about the cross-section of bond holdings directly. The model predicts that the degree to which open-end funds disproportionately finance local-currency bonds is increasing in the value-at-risk in the currency, and the relative depth of the secondary market for local-currency bonds, as both of these forces increase open-end funds' comparative advantage in local-currency. Consistent with the model predictions, we find strong associations in the data between open-end holdings, estimated value-at-risk in local-currency, and the size of the domestic investor base for local-currency bonds, which we use to proxy market depth.

In the third part of the paper, we provide causal evidence for the model's main mechanism. We show that outflows from open-end funds depress sovereign bond prices and asymmetrically

⁶Throughout, 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.

⁷These differences are estimated as the coefficient on an indicator for bond currency in a quantile regression for the 25th percentile Value-at-Risk, stated in annualized returns, after absorbing issuer- and bond-characteristic variation. See Appendix Table A.9 for more detail.

depress local-currency bond prices. To identify the effects of redemptions from open-end funds on bond prices, we exploit quasi-random variation across bonds in exposure to fund redemptions following the February 2022 invasion of Ukraine. This event prompted large redemptions from European bond funds. However, redemptions were concentrated at funds exposed to issuers with geographic and geopolitical proximity to the war. We exploit the fact that some individual bonds were more exposed to these outflows solely through co-holdings with proximate issuers but not through changes in fundamentals.⁸ 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 outflows.⁹ Local-currency bonds experience significantly larger price declines than similarly treated hard-currency bonds. Allowing for heterogeneous average treatment effects across the two bond types in the event study, we find that nearly all of the price treatment effect in the pooled bond sample is concentrated in local-currency bonds.

We exploit our granular information on both bond holdings and prices to estimate a decomposition of price impact in local- and hard-currency into the margins implied by the model, which comprise both supply (quantity) margins and residual demand (elasticity) margins. The decomposition suggests that differential price impact is driven primarily by greater ex-ante exposure of local-currency bonds to open-end funds. In fact, our estimates suggest that domestic investors' capacity to absorb bonds sold by open-end funds is greater in local currency than in hard currency. These findings are consistent with the drivers of comparative advantage and fire-sales in our model. We find no evidence that funds holding local-currency bonds faced disproportionate outflows in response to the invasion, nor that local-currency bonds were more exposed to the quasi-random outflows associated with it. Rather, local-currency bonds received a greater dosage of treatment (outflows) primarily through their disproportionate ex-ante exposure to open-end funds.

Our estimates suggest open-end 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, open-end funds sold 1.3 percent of the stock outstanding of local-currency debt securities in our sample, implying open-end fund price impact

⁸The parallel trends assumption we require is that the prices of two similar bonds from the same issuer, would evolve in parallel after the invasion in the absence of co-holdings with these exposed bonds. Importantly, the parallel-trends assumption need not hold for differentially exposed *funds* on the eve of the invasion.

⁹The dynamics of price impact are also consistent with fire sales: Prices of treated bonds revert to those of their untreated counterparts after 5 months.

was about 50 basis points, or one-third of the aggregate increase in local-currency bond yields over the same period.¹⁰

What are the implications of these findings for sovereigns issuing debt to foreigners? In the last part of the paper, we extend our model to consider the problem of a sovereign who chooses what share of a fixed debt to issue in local currency. To model the tradeoffs faced by this sovereign, we introduce two off-the-shelf, policy-relevant frictions. First, sovereign default is costly (Aguilar & Amador, 2014; Ş. Kalemli-Özcan et al., 2016). Second, the fire-sale price of sovereign debt distorts the allocation of domestic investment.¹¹ In this setting, the sovereign trades off the costs of default associated with hard-currency debt against two benefits of hard-currency debt which arise endogenously from the foreign block of the model. First, foreign households' demand for safe claims generates a wedge between the prices of local- and hard-currency bonds, and the sovereign can raise consumption by borrowing more in hard-currency bonds. Second, the local-currency share affects domestic output in our model through fire sales, which crowd out socially valuable domestic investment.

We draw out two qualitative policy implications within this model exercise. First, deepening domestic local-currency markets, while helpful for absorbing capital outflows in a partial equilibrium sense, is ineffective at reducing the costs of fire sales in this setting. Deepening the domestic market makes local-currency bonds more attractive to foreign intermediaries with unstable funding, and the share of unstable intermediation of debt rises while the equilibrium fire-sale price remains unchanged. Second, the optimal share of debt denominated in local-currency may be less than one, and falls with both the value-at-risk in the local currency and the covariance between default and depreciations. This mirrors the outcome in models of commitment, in which a sovereign may borrow in hard currency in order to commit to keeping inflation low. However, the mechanism here is different: sovereigns with a high propensity to depreciate in default in our setting optimally borrow more in hard currency not to commit, but to avoid costly fire sales.

Roadmap. Section 3 documents intermediary sorting on currency, as well as two facts about capital flows that motivate the paper. Section 4 provides the baseline theory of intermediary sorting and bond fire sales. Sections 5 and 6 test the model's predictions about the cross-section of intermediary sorting and provide causal evidence for its main mechanism. Section 7 extends the model to discuss the tradeoffs faced by issuers and policies aimed at ameliorating them.

¹⁰We discuss the computation of these magnitudes in Section 6.2. While the invasion offers a unique natural experiment, past outflow episodes have been larger. Averaging over four discrete episodes of capital outflows from emerging markets, open-end funds sold 3.6 percent of the local-currency debt stock. See Section 3 for more detail on these episodes.

¹¹Fire sales are a pecuniary externality on the domestic economy, but may be costly in real terms by crowding out socially valuable investment. We do not take a stand on the size of the real externality generated by fire sales, but rather, choose to study optimal debt management in a setting where these externalities exist

Related literature. We revisit the literature on the role of the Original Sin in sudden stops. 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 (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.¹² 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.

Authors before us have observed in other or related contexts the tendency of insurers and pensions to hold relatively little local-currency debt (Bertaut et al., 2021; Faia et al., 2022; Bergant et al., 2023; Du & Huber, 2023). Our contributions on this topic are threefold. First, we conduct a systematic study of this sorting across time for a large sample of important issuers and document that this is indeed a fact about bond currency and not other drivers of trends in local-currency markets. We show, for example, that this sorting cannot be explained by differences in credit quality, governing law, or maturity differences across the two markets. Second, we hypothesize and test a theory to explain bond sorting in equilibrium. Finally, the focus of our study is to explain the drivers of sorting in concert with the drivers of differential capital flows between local-and hard-currency markets.

A large literature hypothesizes that the currency mismatch resulting from Original Sin underpins financial fragility in emerging markets.¹³ We instead emphasize that foreign intermediaries 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 sovereign issuers to lenders. We emphasize a channel through which this reallocation of risk exposes sovereign issuers to fric-

¹²Another 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.

¹³See, 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 the 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 in bad times.

tions 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.¹⁴ 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 stable 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.¹⁵

Second, we contribute to the literature studying capital flight and fickle foreign investors.¹⁶ We study how open-end funds contribute to capital outflows and financial fragility.¹⁷ 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 capital controls and covariance between currency and credit risk can explain much of the variance in these 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.

¹⁴e.g., D. W. Diamond (1997), D. W. Diamond and Rajan (2001), Stein (2005), Kojien and Yogo (2014), Hanson et al. (2015), Chodorow-Reich et al. (2021), and Ma et al. (2022a).

¹⁵Our 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 to other sovereign issuers, which could push emerging-market sovereigns to issue in the international currency as well.

¹⁶See Caballero and Krishnamurthy (2009), Mendoza and Smith (2014), Caballero and Simsek (2020), Miranda-Agrippino and Rey (2020), and Kekre and Lenel (2024).

¹⁷See Jotikasthira et al. (2012), Falato et al. (2021), Darmouni et al. (2022), Ma et al. (2022b), Gormsen and Kojien (2023), and Coppola (2024).

2 Bond Holdings Data

Investor holdings. The primary data source for our study is the confidential 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 32 emerging issuers which meet the following two conditions: (i) sovereigns *without* fully-fixed exchange rate regimes (Ilzetzi et al., 2019) and (ii) sovereigns issuing debt in more than one currency at any point in the sample. We observe approximately 2,000 sovereign bonds in the holdings data each quarter after filtering on these criteria. Table A.20 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 and reporting to Lipper, 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, callability, bond-specific ratings, and coupon rates from LSEG/Refinitiv.

We summarize the sample in Appendix A. Table A.20 reports average euro-area holdings and bond counts by issuer, and Table A.21 reports the same by currency. In an average quarter the sample contains about 2,000 bonds with 402 billion euros of par value held by euro-area investors, 194 billion in hard currencies and 208 billion in local currencies. We report balance tables for the set of bond-level regressions of Section 3 in Tables A.22 and A.23. Appendix A.2.1 compares the sample with the CPIS and with the Arslanalp and Tsuda (2014) estimates of foreign holdings.

The sample covers about one-quarter of foreign holdings of long-term debt from these issuers, and its currency composition matches that of aggregate external debt.

3 Three Facts about Investor Composition and Capital Flows

The paper contains two empirical sections. In this section, we document three observations that motivate us to study foreign intermediation of sovereign bonds. In Section 6 we test the hypotheses of the model directly and provide causal evidence of its main mechanisms.

Fact 1: Intermediaries sort on currency. Figure 1 reports that open-end funds disproportionately financed the recent period of local-currency issuance in the aggregate. In this section, we document that this intermediary sorting is systematic and appears in many different cuts of the data. We then establish this is a fact about bond currency, and not other differences between local- and hard-currency bond markets.

Intermediary sorting appears in the decomposition of holdings over time, each year in our sample, in cross-country correlations between investor composition and currency composition, and almost universally across all of the countries in our sample. Appendix Table A.1 reports that on average across our sample, intermediaries with open-end fund structures have accounted for 46 percent of hard-currency holdings but 67 percent of local-currency holdings. Investors in pension, insurance, and banking sectors hold ten times as much hard- than local-currency debt, on average.¹⁸ We find that in the cross-section of countries, aggregate local-currency share of debt correlates negatively with the share of external debt held by insurers and banks (Appendix Figure A.2). This correlation holds both across countries on average (Panel A), and within countries across time (Panel B).

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), that local-currency bonds tend to be of longer maturity (Bertaut et al., 2021), and that local-currency bonds are almost universally issued under local law. We pool individual bonds i and estimate the following

¹⁸The exception to this statement is the Dutch pension sector, which accounts for 6 percent of hard-currency holdings on average across our sample, but 14 of local-currency holdings. See Appendix A.3 for more detail.

regression separately for investor-types $j = \{\text{Funds, Insurers and Pensions, Banks}\}$

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

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 type, and coupon structure. 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.¹⁹ In the baseline tests, we estimate two currency coefficients for currencies $c \in \{\text{USD, Local Currency}\}$.²⁰ 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.

Table 1 reports the estimates for β_{USD} and $\beta_{\text{Local Currency}}$ from regression (1). The estimated coefficient in column 3 implies that insurers are 56 percentage points less likely to hold a local-currency bond than an otherwise similar euro-denominated bond. For banks (column 6), the point estimate is 52 percentage points. In contrast, open-end funds (column 9) do not differentially hold local-currency and euro-denominated bonds that are otherwise similar. To study sorting on the intensive margin, we replace the dummy outcome in (1) with the share of bond i held by an intermediary j in quarter t , and report these estimates in Appendix Table A.3. On the intensive margin, we estimate that insurers and banks typically own 5 and 4 percent less of a bond if it is denominated in local currency, relative to a similar euro-denominated bond (Columns 3 and 6 of Appendix Table A.3). For open-end funds, this point estimate is 1.6 percent less of a bond.²¹

We examine the role of governing law in Tables A.5 and A.6. Foreign-law bonds may give

¹⁹For 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 A. 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.

²⁰Our identification approach is similar to that in Maggiori et al. (2020).

²¹Negative point estimates for the intensive share across all intermediaries are consistent with the fact that local-currency bonds tend to be larger and more predominately held by domestic investors relative to similar hard-currency bonds. The significant differences between columns (1-6) and (7-9) are our paper's focus, as they speak to the differences in relative preferences between intermediary types.

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

	Dependent Variable: $\mathbb{1}\{h_{it}^j > 0\}$								
	Insurers			Euro-Based Intermediaries			Open-End Funds		
				Banks					
$\mathbb{1}\{\text{Local Currency}\}$	-0.478*** (0.00847)	-0.591*** (0.0375)	-0.558*** (0.0379)	-0.575*** (0.00821)	-0.538*** (0.0365)	-0.523*** (0.0363)	0.0156*** (0.00398)	0.0223 (0.0146)	0.0223 (0.0153)
$\mathbb{1}\{\text{USD}\}$	-0.209*** (0.00894)	-0.186*** (0.0312)	-0.176*** (0.0301)	-0.277*** (0.00866)	-0.0796*** (0.0277)	-0.0761*** (0.0273)	0.0249*** (0.00420)	0.0185 (0.0121)	0.0187 (0.0122)
Identifying N	27228	26436	26437	27228	26436	26437	27228	26436	26437
Currency RSq		0.133	0.121		0.159	0.151		0.00543	0.00537
Issuer FE		✓	✓		✓	✓		✓	✓
x Remaining Maturity Bucket		✓	✓		✓	✓		✓	✓
x Debt Type		✓	✓		✓	✓		✓	✓
x Size		✓	✓		✓	✓		✓	✓
x Coupon Type		✓	✓		✓	✓		✓	✓
x Bond Rating		✓	✓		✓	✓		✓	✓
Quarter FE			✓			✓			✓

Notes: OLS estimates of regression (1), which models the linear probability that an intermediary type holds any of a bond as a function of the bond's currency denomination and other characteristics. The leave-out group is euro-denominated bonds; coefficients should be read as the p.p. difference in the linear probability of holding the bond relative to a similar euro-denominated bond. Columns (1)–(3) report estimates for $j = \text{Insurers}$, columns (4)–(6) for Banks, and columns (7)–(9) for Open-End Funds. Within each group, the first column has no fixed effects, the second absorbs the interacted bond-characteristics fixed effects ticked at the foot of the table, and the third adds quarter fixed effects. Currency R^2 is the within- R^2 . Standard errors in parentheses are clustered at the bond and date level. In the appendix, Table A.3 reports estimates of investors' intensive-margin currency preference; Table A.4 reports a horse race between currency and maturity in explaining the cross-section of holdings; Tables A.5 and A.6 examine whether governing law can explain sorting away from local-currency bonds; and Figure A.4 examines heterogeneity in the sorting estimates across issuers' currencies.

creditors additional legal protection in default (Chamon et al., 2018). We exploit a subsample of issuers in our sample who placed hard-currency bonds under domestic law to test whether a preference for these foreign-law protections can explain sorting. Our European holdings data sample allows us to observe issuers, predominantly in Eastern Europe, place euro-denominated bonds under both foreign (English) law and domestic law. Exploiting this variation, we find that, even within bonds governed locally, insurers and banks disproportionately hold hard-currency bonds.²²

Not only do the differences in estimates between the two sectors suggest that investor types sort on currency, but we also find that currency has more explanatory power over investor holdings in some sectors than in others (Appendix Table A.3). Indicators for currency alone can

²²Governing law and currency are nearly collinear in the samples previous studies use: local-currency bonds are issued under domestic law, and hard-currency bonds under foreign law (Du & Schreger, 2016). The same holds for most issuers in our sample. We exploit two exceptions. First, some issuers issue hard-currency bonds under domestic law: euro-denominated bonds by Romania, Serbia, Hungary, and the Czech Republic, and dollar-denominated bonds by Argentina. Second, the Dominican Republic, the Philippines, and Chile issue a small number of local-currency bonds under foreign law.

explain up to 50 and 24 percent of the cross-section of ownership shares for insurers and banks, respectively, but only 9 percent of the cross-section of holdings for open-end funds. Additionally, within the hard currency category, these investors display a strong home-currency bias (Maggiori et al., 2020): they disproportionately hold dollar-denominated bonds relative to local-currency bonds, but appear to prefer euro-denominated bonds most of all. In what follows, we provide a theory that can help explain this differential treatment of local- and dollar-bonds, even though from the perspective of foreigners, both bonds carry exchange-rate risk. We test that theory directly in Section 5.²³

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.²⁴ Specifically, intermediaries who have greater ex-ante propensities to participate in local-currency markets on average also tend to be the most likely to sell bonds in response to global shocks.

In Figure 2, we examine four discrete episodes of capital outflows from emerging markets in the years of our sample. The figure reports net par-value flows into the bonds in our sample, relative to investors’ pre-episode holdings. In each episode, investors 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 and banks typically contribute very little to capital outflows. Figure 2 pools together flows in local- and hard-currency, but outflows from local-currency securities consistently exceed those from hard-currency securities (Appendix Figure A.5). In Table A.7, we report the first and second moments of capital outflows by intermediary sector across issuers and episodes.

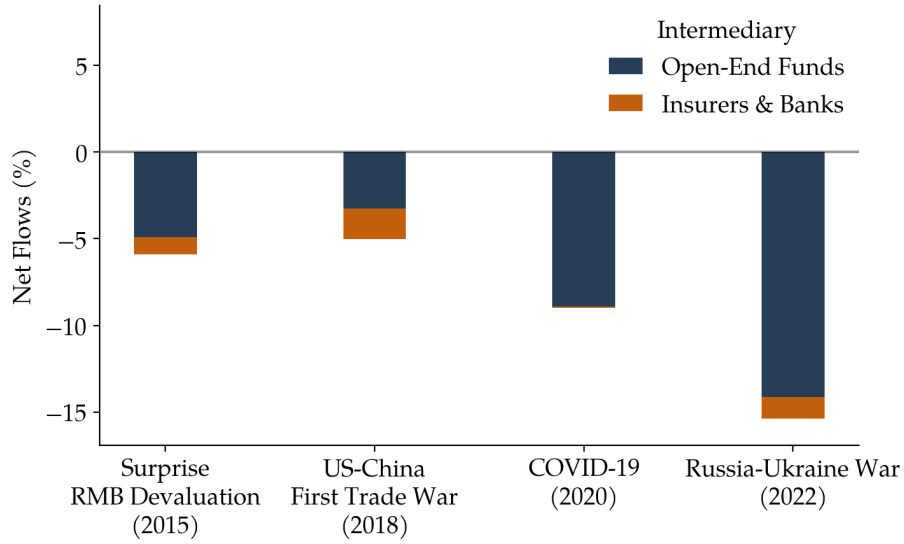
Fact 3: Fund-driven capital outflows correlate with price declines During these episodes of capital outflows, bonds held by open-end funds fall in value more than bonds held by other investors. Here, we produce reduced-form evidence of this relationship to motivate the study, but return to provide causal evidence of our price impact channel in Section 6. This fact suggests that the funding structures of foreign intermediaries matter for bond prices.

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

²³The 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, conditional on other bond observables.

²⁴Similar 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.

Figure 2: Investor Contributions to Capital Outflows
Contributions to Net Purchases by Euro-Area Investors, Local- and Hard-Currency Bonds Pooled



Source: ECB SHS. *Notes:* Net purchases in each episode are cumulative changes in par amount held relative to holdings at the start of the episode, in bond-currency units at the pre-episode exchange rate, so currency valuation does not enter. Local- and hard-currency holdings are pooled before the pre-episode base and the worst quarter are formed. Each bar is a sector's contribution to the total net selloff of euro-area investors in the worst quarter of the episode, using pre-episode investor shares as weights. The orange segment is insurers and banks; pension funds and the residual sectors are not drawn. In the appendix, Figure A.5 shows the same decomposition for Local- and Hard-Currency bonds separately, and Table A.7 computes it per issuer country and reports the cross-country mean, its standard error and the median for insurers, pension funds, banks and open-end funds separately.

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 markdown on the bond as the maximum loss on the bond's market value during the capital outflow period (Coppola, 2024). In Table A.8, we estimate regressions that test whether the ex-ante ownership composition of a bond in the quarter prior to an episode explains differential losses on the bond during an episode, relative to similar bonds from the same issuer. The coefficients report the additional expected losses on a bond associated with a bond being held in full by an intermediary type, relative to a residual, unnamed investor.

The estimates in Table A.8 imply that, 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 Column (3) imply that, all else equal, a local-currency bond held in full by a fund loses about 1.5 percent more of its value than a bond held in full by outside investors, while a bond held in full by a bank retains about 13.3 percent additional value relative to a bond held by outside investors. The point estimates for the effect of insurer-ownership on bond markdowns are positive, but highly insignificant.

Converse et al. (2023), Zhou (2023), and Coppola et al. (2025) have documented related facts

about the effects of intermediary composition on bond prices in other, related settings. We view this motivating fact as corroborating these findings in our setting of local-currency sovereign bonds. However, our main contribution is not to corroborate these findings, but rather to study intermediary composition as an endogenous outcome of these price effects and other sovereign-risk factors, and to estimate jointly how intermediary composition and fire-sale prices are determined in equilibrium. By studying these two forces jointly, we arrive at novel policy conclusions for sovereign issuers in particular.

We leave further investigation of whether the evidence in Table A.8 reflects causal effects associated with our theoretical mechanism to the analyses in Section 6.

4 A theory of intermediary sorting and fire sales

Section 3 documents three patterns: open-end funds disproportionately hold local-currency bonds, they account for most foreign sales during outflow episodes, and these sales coincide with price declines in local-currency bonds. In this section we develop a model of foreign intermediation of sovereign bonds that rationalizes these patterns and relates them to frictions in intermediation of bonds with exchange-rate risk. The model generates testable predictions about the cross-section of bond holdings and returns, from which we derive the empirical analyses in Sections 5 and 6.

We present first a version of the model in which the supply of bonds in each currency is fixed, to isolate intermediary-sorting and capital-outflow mechanisms. The key force at work in the model is competition among foreign intermediaries to produce safe and liquid claims denominated in hard currencies. Section 7 lets the sovereign strategically choose the currency composition of debt and characterizes its trade-offs.

4.1 Environment

The economy consists of (i) an emerging-market sovereign that issues long-term bonds backed by future primary-budget surpluses; (ii) foreign households who consume in units of hard-currency; (iii) financiers who intermediate bond markets; and (iv) domestic investors.

There are three periods, $t \in \{0, 1, 2\}$. In $t = 0$, the sovereign issues bonds in local- (L) and hard-currencies (H) and consumes the revenue.²⁵ Intermediaries buy bonds and issue claims denominated in H to foreign households. In $t = 1$, agents learn more information about the

²⁵In this section the supply of bonds in local- and hard currency debt is fixed and exogenous. We endogenize the relative supply of bonds in local-currency in Section 7. The model focuses on the currency denomination of external debt and abstracts from endogenous changes in the quantity of initial borrowing. This is one motivation for conditioning our empirical cross-country evidence on the overall level of external borrowing, which we do in Sections 3 and 6.

ability of the sovereign to repay bonds. With probability g , they learn that the future surplus will follow a responsible regime and bond repayments will be made with certainty. With probability $b \equiv 1 - g$, the fiscal regime will be risky and future budget surpluses uncertain. We interpret this event as a revelation of bad news about future fundamentals, as might arise from, e.g., an election or a commodities shock. In $t = 2$, budget surpluses and terminal exchange rates are realized and all uncertainty resolves. We solve backwards from this date.

Throughout, we refer to the currency of the sovereign borrower as the local currency, and the currency of foreign investors as the hard currency. The exchange rate is $\mathcal{E}$, stated in units of local currency consumption per unit of foreign consumption. An increase in $\mathcal{E}$ reflects a depreciation of the local currency. We denote prices and quantities of local-currency bonds with a superscript L and those of hard-currency bonds with an H .

Bond supply and default. In $t = 0$, the local sovereign issues one unit of long-term bonds, of which a share θ is denominated in local currency.²⁶ The face value of the sovereign's debt obligations in the final period, stated in local currency, is

$$B = \theta + (1 - \theta)\mathcal{E} \quad (2)$$

In $t = 1$, agents learn information about the future fiscal surplus, which is endowed in units of local currency and written as Z . With probability g , they learn that the surplus will follow a "responsible" fiscal rule and bond repayments will be made in the future with certainty. With probability b , the future budget surplus instead is drawn at random. The focus of our empirical analyses is the effect of long-horizon 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.

In $t = 2$, the government realizes its terminal fiscal surplus Z and the exchange rate $\mathcal{E}$. If the bad-news state has realized and these values are drawn at random, the sovereign may default. The sovereign may not strategically default; it repays its debt at face value if and only if the realized surplus exceeds its obligations B . We can thus define the default function $D \equiv \mathbb{1}\{Z < B\}$. Together, (2) and the default function D demonstrate how the local-currency share θ affects the credit risk of the sovereign: In the event of bad news, D becomes a random variable whose distribution depends jointly on realizations of Z , $\mathcal{E}$, and θ . At lower values of θ , the face value of the debt is more exposed to exchange-rate risk and the support of Z over which the sovereign repays in full shrinks.

²⁶We take θ as an exogenous parameter here, but endogenize it in Section 7.

Bond payoffs. In $t = 2$, the sovereign allocates the available local-currency resources Z to creditors in proportion to the face value of their obligations.²⁷

We express bond ex-post payoffs in units of hard-currency, as these payoffs are used to price claims on intermediaries. Let the payoffs be $X^H = X$ and $X^L = X\mathcal{E}^{-1}$, where $X = \min \{1, \frac{Z}{B}\}$ — the ratio of total repayments to obligations in the final period, stated in local-currency units. From the perspective of foreign creditors, hard-currency bonds are exposed to exchange-rate risk only indirectly through its effects on credit risk (X). Local-currency bonds are exposed to currency risk both indirectly through credit risk (X) and directly through the hard-currency valuation of the bond ($\mathcal{E}^{-1}$).

We express expected bond payoffs from time $t = 0$ using the operator $\mathbb{E}$, and expected bond-payoffs conditional on realizing the bad-news state using the operator $\mathbb{E}_b$. Likewise, we use X_b^c , X_g^c and P_b^c , P_g^c to denote payoffs and prices of bond c conditional on realizing the bad and good-news states, respectively.²⁸

4.2 Bond demand: Foreign households and intermediaries

Foreign households. In $t = 0$, foreign households allocate an endowment of hard-currency to consumption and claims on financial intermediaries. They are risk neutral over $t = 2$ consumption, but pay a premium for claims that deliver guaranteed $t = 2$ consumption. Their preferences are given by the utility function

$$U = C_0 + \beta \mathbb{E}[C_2] + \gamma M \quad (3)$$

where M is the quantity of guaranteed claims purchased in $t = 0$. Under these preferences, the economy features a fixed spread between the ex-ante value of risky claims and that of guaranteed claims, parameterized by $\gamma > 0$.

Throughout, we refer to any claim which delivers a guaranteed payoff in time 2 as a *money-like* claim. The model is agnostic as to whether this value derives strictly from the safety of the claim or from its liquidity; both interpretations can coexist.²⁹ Our use of money in the utility

²⁷The shares of Z obligated to local- and hard-currency creditors under this scheme are $\frac{\theta}{B}$ and $\frac{(1-\theta)\mathcal{E}}{B}$, respectively. In this sense, we assume a strict case of pari-passu bond repayments in the case of default. As a result, the share of resources available to hard-currency creditors adjusts mechanically with the exchange rate. 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. This has the implication that hard-currency debt becomes effectively senior to local-currency debt when the exchange rate depreciates.

²⁸That is, $X_g^H = 1$, $X_g^L = \mathcal{E}^{-1}$.

²⁹Refer to the discussion of money-likeness and convertibility in Appendix B.2.1. For the subsequent results to go through, money-likeness need not derive solely from the safety of a claim. The definition can be broader: a claim is money-like if it can be turned into a guaranteed unit of $t = 2$ consumption at some point within the life of the

function follows a large literature since Sidrauski (1967), while using it to generate a role for intermediation follows Stein (2012), Hanson et al. (2015), and W. Diamond (2020).³⁰

Intermediaries. Atomistic intermediaries purchase sovereign bonds and issue fully-contractible claims to foreign households. Intermediaries fund themselves with a combination of money-like claims valued at $\beta + \gamma$ and equity claims valued at β . Let j index a funding scheme and M_j^c denote the quantity of money-like claims issued per unit of bond c under a scheme j . An intermediary holding a bond c under a funding scheme j solves

$$\max_{M_j^c} \Pi_j^c = \underbrace{(\gamma + \beta)M_j^c}_{\text{money-like claims}} + \underbrace{\beta \mathbb{E}_j \left[\left(X_j^c - M_j^c \right)^+ \right]}_{\text{equity claims}} - \underbrace{P_0^c}_{\text{cost}} \quad \text{s.t. } M_j^c \leq K_j^c \quad (4)$$

where $\mathbb{E}_j[X_j^c]$ computes a scheme-specific expectation of payoffs and K_j^c is the maximum possible money issued under scheme j . We derive these objects below. (4) states that expected profits equal the enterprise value of holding bond c under scheme j less the cost of purchasing the bond. Since money-like claims are the cheaper form of funding, profit-maximizing intermediaries use these claims as much as possible, and the constraint in (4) always binds.

Intermediaries are ex-ante identical, but competition leads them to adopt a mix of funding strategies within each bond market. There exist two distinct strategies to construct money-like claims out of the sovereign bonds.³¹ We label these two strategies the “stable-funding” ($j = S$) strategy and the “unstable-funding” ($j = U$) strategy.

Stable strategy. First, an intermediary may issue a money-like claim backed by the worst-case *fundamental value* of the bond portfolio in $t = 2$. Such claims are not sensitive to new information about future bond payoffs, and need not be redeemed to preserve their money-ness. Let $\underline{X}^c$ be the value-at-risk, or a measure of the worst-case payoff, on bond c in $t = 2$. Stable-funded intermediaries are subject to the value-at-risk constraint $M_S^c \leq K_S^c = \underline{X}^c$, but may hold their bonds to maturity ($t = 2$). Substituting in K_S^c into (4) yields the expected profits from holding a unit of

economy, either through being contractually safe or redeemable.

³⁰We 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). Linearity is not necessary to deliver the model results. It focuses the model on the question of *how* intermediaries will produce safe assets M and not what the aggregate quantity of safe assets will be in the economy. It means households are never satiated in M and fixes the funding spread at γ .

³¹Appendix B.2.1 formalizes this claim.

bond c under this stable strategy:

$$\Pi_S^c = \gamma \underline{X}^c + \beta \mathbb{E}[X^c] - P_0^c \quad (5)$$

The gross payoff from holding bond c equals the risk-neutral, held-to-maturity value of the bond plus the money-creation value of the held-to-maturity bond, $\gamma \underline{X}^c$.

The value-at-risk constraint is the key feature of stable-funding intermediaries. We model it as the result of a limited guarantee scheme, but modeling the constraint as literal worst-case outcomes would deliver nearly identical results. Intermediaries have access to a guarantee scheme which provides indemnities against losses on their portfolio. The guarantee scheme is operated by a tax authority willing to bear losses with probability at most π ; it therefore requires the intermediary to fund with loss-absorbing equity any bond payoffs that fall short with probability π or greater (Shin, 2019).³² The quantity of money-like claims that one unit of bond c can back is then the π -quantile of its payoff,

$$\underline{X}^c(\pi) = F_c^{-1}(\pi; \theta) \equiv \inf \{x : F_c(x; \theta) \geq \pi\}, \quad (6)$$

where $F_c(\cdot; \theta)$ is the distribution of X^c conditional on bad news. Given the regime's tolerance π and the currency mix θ , $\underline{X}^c(\pi)$ is a constant, known to all agents at $t = 0$.

Unstable strategy. Second, an intermediary may issue a money-like claim backed by the *liquidation value* of the bond portfolio in $t = 1$. Such a claim must be redeemed in the bad-news state in order to realize its money-ness. Formally, households realize this money-ness by forcing the sale of the intermediaries' bond portfolio at the market price P_b^c and putting the proceeds in free storage. Unstable intermediaries may issue money-like claims up to the constraint $M_U^c \leq K_U^c = P_b^c$, but risk early liquidation. Therefore, from time $t = 0$, the expected profits from holding a unit of bond c under the unstable strategy are

$$\Pi_U^c = \gamma P_b^c + \beta \left(b P_b^c + g \mathbb{E}_g[X^c] \right) - P_0^c \quad (7)$$

The gross payoff from holding bond c under the unstable strategy equals the expected discounted *market value* of the bond portfolio plus the money-creation value of the bond, γP_b^c . Bad news forces unstable intermediaries to forego the *continuing* equity value of the bond.

The most literal interpretation of the money-like claim issued by the unstable intermediary

³²We take this modeling approach in order to allow for the bonds to potentially back zero money creation in the absence of a guarantee scheme. But one need not interpret $\underline{X}^c$ only as a product of a risk-based capital regime. One may also read it as a literal worst-case payoff on the bond, a disaster state for the bond, or the value-at-risk threshold at which households are willing to pay a premium for safety.

is a short-term debt collateralized by a sovereign bond (i.e., repo). However, it is not essential that the claim be debt-like. In Appendix B.2.1 we show that under certain conditions, an unstable intermediary that issues redeemable equity earns an identical profit function to (7). Every equilibrium object that follows from here is unchanged under the interpretation of the money-like claim as equity. The equivalence requires that households incentive-compatibly redeem in the bad-news state, which holds whenever the premium γ exceeds a threshold.

Let μ^c be the share of a bond c intermediated through the unstable scheme. Since the sovereign issues $B^L = \theta$ units of local-currency and $B^H = 1 - \theta$ units of hard-currency debt, the aggregate stock of money-like claims issued by intermediaries is

$$M = \sum_{c \in \{L, H\}} B^c [\mu^c M_U^c + (1 - \mu^c) M_S^c]$$

where M_U^c, M_S^c come from the constraints above.

Domestic investors. Beyond these intermediaries are inelastic investors who trade bonds on the secondary market. Without loss of generality, we call them domestic investors. Let demand of domestic investors for a bond c be Q^c . Domestic investors have demand for bonds denominated in currency $c \in \{L, H\}$ of

$$Q^c(P_b^c) = \eta^c (1 - \zeta^c), \quad \text{where} \quad \zeta^c \equiv \frac{P_b^c}{\mathbb{E}_b[X^c]} \quad (8)$$

and $\eta^c > 0$ is a market-specific demand elasticity. Outside the bad-news state, there is no trading between foreign intermediaries and domestic investors. In the bad-news state, demand is given by (8). ζ^c is an endogenous discount factor on bond c . We micro-found this demand curve in Section 7 but take it as given here.³³

4.3 Equilibrium bond prices and investor composition

We now specify the conditions for competitive 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 together with total bond supply B_0^L, B_0^H encode secondary-market bond supply in the bad-news state, and state-by-state bond

³³We 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. In addition, we assume $\eta^c = \eta B_0^c$, with $\eta > 0$: Demand in each market scales with the quantity of bonds outstanding, B_0^c , so that η parameterizes demand depth per unit of bond supply. This keeps the comparative statics with respect to θ from operating mechanically through relative market size; we return to it when we microfound the demand curve in Section 7.

prices (P_0^c, P_b^c) . The states of the world in which these objects are endogenous to the competitive forces in intermediation are the initial period ($t = 0$) and the bad-news state ($t = 1$). Outside of these states, bond prices are given by their frictionless, fundamental values.

Definition (Competitive equilibrium in bond markets). *Given initial bond supplies B_0^L, B_0^H and expected future bond payoffs, competitive equilibrium is a pair of intermediation strategies (μ^L, μ^H) and state-by-state bond prices (P_0^L, P_0^H) and (P_b^L, P_b^H) such that:*

- (i) **Zero profits.** *In each bond market $c \in \{L, H\}$, intermediaries have free entry and are indifferent between purchasing bonds with the stable and unstable funding: $\Pi_S^c = \Pi_U^c = 0$ for $c \in \{L, H\}$.*
- (ii) **No long-run arbitrage.** *Intermediaries are indifferent between participating in bond market L and market H: $\Pi_j^L = \Pi_j^H$ for $j \in \{U, S\}$.*
- (iii) **Market clearing.** *Both primary and secondary markets for bonds clear. In $t = 0$, primary market clearing for bonds is implied by free entry in (i) and linear preferences in (3). In $t = 1$, there is secondary market trading only if the bad-news state realizes, in which case $\mu^c B_0^c = Q^c(P_b^c)$ for $c \in \{L, H\}$.*

The equilibrium solution can be characterized compactly with two pieces of notation. Define the ratios

$$\omega \equiv \frac{\gamma}{\gamma + b\beta}, \quad \lambda^c \equiv \underline{X}^c(\pi) / \mathbb{E}_b[X^c] \quad (9)$$

ω is the money premium's share of the total value of a unit of funding; λ^c is the *safety ratio* of bond c , or a measure of its *collateral advantage*: how many stable, money-like claims a bond can produce conditional on its expected bad-news payoff. Imposing the free-entry condition (i), the equilibrium fire-sale discount on bond c is a scaling of the bond's safety ratio: $1 - \zeta^c = \omega (1 - \lambda^c)$. Market clearing (iii) then determines the composition of investors in each market. At an interior solution, the unstable intermediation share of bond c is $\mu^c = \eta (1 - \zeta^c) = \eta \omega (1 - \lambda^c)$.

The parameter ω indexes the model's distance from the Modigliani–Miller benchmark. As $\gamma \rightarrow 0$, $\omega \rightarrow 0$ and fire-sale prices converge to expected bad-news values. The funding composition is irrelevant to prices and quantities. As the money premium grows large relative to $b\beta$, $\omega \rightarrow 1$ and bonds are priced by the guarantees they can back. Figure 3 displays the equilibrium in the bad-news state.

Fiscal and exchange-rate innovations. In the case of bad news, $(Z, \mathcal{E})$ is drawn from a continuous joint distribution. To flesh out the mechanics of the model, we make the following assumptions about this distribution.

A1: The guarantee scheme requires capital against default risk: $\pi < \Pr(Z < B)$.³⁴

A2: (*Twin Ds*) Bad times for fiscal surpluses correlate with depreciated exchange rates: $\text{Cov}(Z, \mathcal{E}) \leq 0$. Conditional on default, the local currency is depreciated, and at least as depreciated as the bad-news average: $\Pr(\mathcal{E} > 1 \text{ and } \mathcal{E} \geq \mathbb{E}_b[\mathcal{E}] \mid Z < B) = 1$.

Assumption A1 states that intermediaries cannot fund the purchase of a risky bond using *only* money-like claims. A2 rules out a sovereign defaulting alongside a strong local currency. The additional assumption in A2 claims that depreciations in default are above-average depreciations.³⁵ This assumption is stronger than needed to deliver the main model results, but it simplifies the arguments significantly.³⁶ Under these assumptions, the two bonds' values-at-risk are ordered.

Lemma 1 (Ordering of values-at-risk). *Under A1–A2, for every $\theta \in [0, 1]$ and every $\pi < \Pr(Z < B)$:*

- (i) $\underline{X}^L(\pi) < \underline{X}^H(\pi)$: *the local-currency bond has lower tail payoffs;*
- (ii) $\lambda^L < \lambda^H$, *where λ^c is the safety ratio of bond c ((9)).*

Proof. See Appendix B.1.2.

The safety ratio measures the bond's guaranteed floor per unit of its expected bad-news payoff, and the lemma says local-currency bonds carry strictly more tail risk per unit of expected payoff. This ratio determines the equilibrium sorting of intermediaries in Proposition 1, and it is the object we test directly in Section 5.1.

The key insight of the model is given in Proposition 1 and illustrated in Figure 3. 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 that for hard-currency bonds. Moreover, the model delivers two intuitive comparative statics, which we test in the data in Section 5. The share done through the unstable funding strategy decreases in the local-currency safety ratio λ^L : greater downside exchange-rate risk lowers λ^L — it makes holding the local-currency bond costlier for stable intermediaries — and thereby raises the degree of sorting. In addition, when residual domestic investors are more price-elastic, the liquidation value of these bonds increases and more intermediaries need to sell during a fire-sale to eliminate profits from unstable funding.

³⁴Were instead $\pi \geq \Pr(Z < B)$, the scheme would allow purchases of risky bonds funded by money-like claims up to their full face value.

³⁵This assumption is motivated by a regularity in the sovereign-debt data, which has been referred to as the “twin” crises of Kaminsky and Reinhart (1999) and the “Twin Ds” of Na et al. (2018).

³⁶In Appendix B.3.2 we show that the ordering in part (i) of Lemma 1 requires depreciation only in the states where losses exceed the capital threshold, and that in a lognormal parameterization it survives assumptions weaker still, allowing appreciation in default with positive probability.

Proposition 1 (Equilibrium investor sorting). *Under the assumptions of Lemma 1, $\mu^L > \mu^H$ 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) decreasing in the local-currency safety ratio λ^L , and (ii) increasing in the elasticity of residual investors η .*

Proof. See appendix B.1.3.

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

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

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 the 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 trade at deeper fire-sale discounts and issue at larger discounts relative to expected payoffs than hard-currency bonds:*

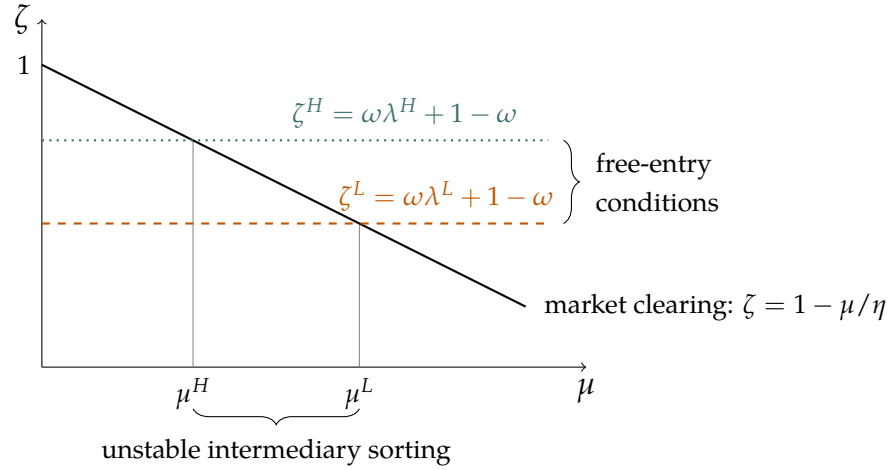
- (i) $\zeta^L < \zeta^H$: local-currency bonds trade at a deeper fire-sale discount.
- (ii) $P_0^L / \mathbb{E}[X^L] < P_0^H / \mathbb{E}[X^H]$: local-currency bonds issue at a greater discount to expected payoffs.

Proof. See appendix B.1.4.

The intuition behind Corollary 1 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 relative to their fair values in bad states of the world, despite their money-creation 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

Figure 3: Partial-Equilibrium Intermediation and Bond Prices



Note: Figure characterizes the competitive equilibrium in intermediation and bond prices, holding the supply of bonds in each currency fixed. The solid line is the market-clearing condition implied by outside-investor demand (8), stated per unit of bond supply. The dotted and dashed lines are the free-entry conditions of Lemma B.1, which pin down the fire-sale discounts on hard- and local-currency bonds at $\zeta^c = \omega\lambda^c + 1 - \omega$. Because tail risk lowers the safety ratio of local-currency bonds ($\lambda^L < \lambda^H$), the local-currency free-entry condition lies below the hard-currency one. The horizontal distance between the two intersections is the degree of sorting in Proposition 1. A larger η flattens the market-clearing line and widens the gap (comparative static (ii)); greater downside exchange-rate risk lowers λ^L , shifts the local-currency free-entry condition down, and raises μ^L (comparative static (i)).

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 bonds 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 commercial banks.³⁷ The business models of these intermediaries are to maintain stable funding even when the market values of their portfolios decline. Sustaining this capital structure requires that the portfolio backing the claims have relatively little fundamental risk in the long run.

In this way, our model nests the role of regulation in determining which assets intermediaries hold, and in particular, the constraints on banks and insurers in holding currency mismatch.³⁸

³⁷One 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 difference 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.

³⁸In both the euro area and the United States, insurers and banks participate in explicit guarantee schemes, like

That is, the model endogenizes the bias of regulation against currency mismatch (Faia et al., 2022; Du & Huber, 2023; Gutierrez et al., 2023). In our setting, intermediaries' exposure to regulation is a result of their liability structure. More stringent regulation in the form of a less generous risk-based capital regime not only raises costs of bearing exchange-rate risk for stable intermediaries, it also raises the share of intermediation of exchange-rate risk done through an unstable-funding strategy.

Intermediaries who take the unstable strategy purchase riskier bonds but subject themselves to the possibility of losing funding in the future. We draw an analogy between this strategy and the capital structures of intermediaries classified in our data as investment funds. The investment fund classification pools together hedge funds and mutual funds, but the latter dominate the sample. The analogy deserves discussion.

The most literal interpretation of the money-like claim issued by the unstable intermediary is short-term debt collateralized by a sovereign bond. Under this reading, the unstable intermediary resembles a repo-financed hedge fund, issuing both money and equity claims to households. A natural objection to our analogy is thus that such hedge funds are not the primary vehicles in corresponding data. Mutual funds do not issue debt-like claims, and do not promise safety to their investors. The model need not be read this stringently: in Appendix B.2.1 we show that the unstable fund can equivalently be structured as an unlevered open-end fund issuing redeemable equity, which generates an identical profit function to that of the repo-financed fund. The redemption option makes an equity claim money-like, in the sense of the model, up to the fund's liquidation value P_b^c ; γ is then read as the liquidity value of same-day net-asset-value redemption (Ma et al., 2022a) rather than the safety of senior debt.

Our modeling choice is motivated by the observation that bond 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 serves to generate these flows in a simple way, without taking a strong stance on the underlying manager incentives or behavioral biases which generate them. Like performance-driven flows, claims on the unstable intermediary are endogenously high-beta: relative to claims produced by stable intermediaries, they have higher returns conditional on good news and lower returns conditional on bad news.

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.

5 Why do investors sort on currency? Testing the model

This section proceeds in two parts. First, we validate the assumptions underlying Lemma 1, using the cross-section of bond returns. Second, we derive reduced form tests of Proposition 1 and its comparative statics, which we then apply to the cross-section of the holdings data. Then, we turn in Section 6 to the question of causal price impacts and a test of Corollary 1 in Section 6.

5.1 Validating Lemma 1: Tail payoffs in local-and hard-currency

Lemma 1, which follows directly from assumptions A1-A2, claims that local-currency bonds have relatively greater value-at-risk for hard-currency intermediaries. We validate the lemma using the cross-section of ex-post holding period returns. We estimate conditional quantiles of holding period returns, in absolute terms and scaled by mean returns,

$$Q_{it} \equiv Q_{\pi}[HPR_{it} \mid \text{Currency}_i, X_{it}] \quad \lambda_{it} \equiv \frac{Q_{\pi}[HPR_{it} \mid \text{Currency}_i, X_{it}]}{\mathbb{E}[HPR_{it} \mid \text{Currency}_i, X_{it}]} \quad (10)$$

as functions of bond observables and an indicator for whether the bond is denominated in local-currency. Formally, we estimate the conditional quantiles as functions of Currency_i using quantile regressions and the fixed-effects method of Machado and Santos Silva (2019). We estimate these objects separately for the quantiles $\pi = 25$ and $\pi = 10$ and separately for holding period returns HPR_{it} over the 1-, 3-, or 5-year horizon h . All holding-period returns are computed in euros and annualized.³⁹ These regressions provide tests of whether two similar bonds from the same issuer but in local- and hard-currencies have different values-at-risk or safety-ratios for euro-based intermediaries.

Local-currency bonds carry significantly larger left-tail risks from the perspective of a euro-based investor, both in absolute terms and relative to their mean returns. Table A.9 reports the difference, in percentage points, in the 25th percentile of annualized returns between local- and hard-currency bonds. The unconditional differences are large at every horizon, and they widen within issuer. Column (6) reports that the 25th-percentile return over a five-year horizon is 3.3 percentage points lower for a local-currency bond than for a hard-currency bond of the same remaining maturity from the same issuer. The differences also hold for tail returns relative to mean trailing returns, our proxy for the safety ratio λ . Table A.10 reports OLS coefficients from regressions of the 25th-percentile λ_{it} on a local-currency indicator. Consistent with the model

³⁹Holding-period returns in euros over horizon h are computed as $HPR_{it}(h) = \frac{P_{i,t} + \sum_{s=t-h}^t C_{is} \mathcal{E}_{t-h,i}}{P_{i,t-h}} \frac{\mathcal{E}_{t-h,i}}{\mathcal{E}_{t,i}}$ where $\mathcal{E}_{t,i}$ is the applicable bilateral exchange rate between the currency $c(i)$ of bond i and the euro in month t , stated in units of the local currency. Of course, for euro-denominated bonds we have $\mathcal{E}_{t,c(i)} = 1$.

in Section 4, these differences widen with the holding horizon: at one year, the 25th-percentile safety ratio of a local-currency bond is 0.05 lower than that of a hard-currency bond; at five years, the gap is 0.12.

5.2 Testing the comparative statics of Proposition 1

Next, we test Proposition 1 in the cross-section of the bond-holdings data. In Appendix A.6, we show that the model implies a log-linear relation between the open-end fund share of a bond, the bond’s safety ratio, and the market depth for the bond, which we assume is constant across bonds in the same currency. This implies two tests of the Proposition. The first is a bond-level regression of the log share of each bond held by open-end funds on $\log(1 - \lambda_{it})$ and on domestic market depth interacted with a local-currency indicator, with issuer $\times$ year fixed effects. The second, more demanding test differences the holdings shares across currencies within pairs of bonds from the same issuer and of similar remaining maturity:

$$\log \mu_{n,t}^L - \log \mu_{n,t}^H = \alpha_t + \alpha_{k(n)} + \beta_\lambda \left[\log(1 - \hat{\lambda}_{n,t}^L) - \log(1 - \hat{\lambda}_{n,t}^H) \right] + \beta_\eta \log \hat{\eta}_{k(n),t}^L + \varepsilon_{n,t}. \quad (11)$$

Here n indexes an issuer $\times$ remaining-maturity cell, and $k(n)$ the issuer of cell n . Because both sides of the gap come from the same cell and year, the regression differences out any determinant of fund holdings common to local- and hard-currency bonds of the same issuer, maturity and year. The regression states that the degree to which open-end funds disproportionately hold local-currency bonds in cell n depends on the relative safety ratios of local- and hard-currency bonds in that cell, the relative depth of the secondary market for local-currency bonds, time effects common to all issuers, and time-invariant issuer effects. The linear model of Section 4 predicts $\beta_\lambda = \beta_\eta = 1$. Because the main intuitions of the model do not depend on its linearity, we also estimate (11) in levels.

We compute the open-end fund shares $\mu_{n,t}^c$ for each bond, and for each cell and currency, directly from the SHS. We estimate safety ratios as the ratio of the π -th percentile to the mean of holding-period returns over a trailing 60-month window; for (11), we average them across the bonds in each cell and currency, weighted by amount outstanding. We proxy for the depth parameter $\hat{\eta}_{k(n),t}^L$ using the ratio of domestic financial assets to GDP, with financial assets from the IMF’s Monetary and Financial Statistics and GDP from the World Economic Outlook. In the bond-level regressions, we include issuer $\times$ year fixed effects so that β_λ is identified by variation across an issuer’s bonds within a year. In (11), with year and issuer fixed effects, β_λ is identified by within-issuer variation across cells and time in the safety-ratio gap between local- and hard-currency bonds, and β_η by within-issuer variation over time in domestic market depth.

Columns (3) and (4) of Table 2 report the estimates of (11). Consistent with the model’s pre-

Table 2: Tests of Proposition 1 Using the Cross-Section of Holdings

	Bond-level regressions		Bond-pair-level regressions	
	$\log \mu_{U,t}^i$		$\log \mu^L - \log \mu^H$	$\mu^L - \mu^H$
			Gap in logs	Gap in levels
$\log(1 - \lambda_{it})$	0.387** (0.142)	0.361*** (0.124)		
Safety-ratio gap, $1 - \lambda^L$ vs. $1 - \lambda^H$			0.374** (0.176)	0.238** (0.0985)
$\log \eta_{n,t}^L$	0.661* (0.339)	0.209 (0.262)	0.000784 (0.829)	-0.000658 (0.0381)
N	10248	9314	533	551
Within R^2	0.0317	0.00977	0.0327	0.0292
Issuer $\times$ Year FE	✓	✓		
Bond controls		✓		
Year FE			✓	✓
Issuer FE			✓	✓

Notes: Estimates of equations (38) (columns 1–2) and (11) (columns 3–4) at $\pi = 25$ and the 1-year horizon. Columns (1) and (2) are bond-level regressions on the bond-year panel of Local- and Hard-Currency bonds: the dependent variable is the log share of par outstanding held by euro-area open-end funds; λ_{it} is the safety ratio, the 25th percentile of annualized euro holding-period returns divided by their mean in a trailing 60-month window; and domestic depth enters interacted with the local-currency indicator. Both columns absorb issuer $\times$ year fixed effects; column (2) adds remaining maturity, size decile, coupon type and jurisdiction fixed effects (“Bond controls”). Columns (3) and (4) are bond-pair-level regressions: bonds are grouped into cells of issuer $\times$ remaining maturity, an observation is a cell-year with both a local- and a hard-currency side, and the dependent variable is the gap in open-end fund shares between the cell’s local- and hard-currency bonds, in logs in column (3) and in levels in column (4). The safety-ratio gap enters in the same form as the dependent variable: $\log(1 - \lambda_{n,t}^L) - \log(1 - \lambda_{n,t}^H)$ in column (3) and $(1 - \lambda_{n,t}^L) - (1 - \lambda_{n,t}^H)$ in column (4). Domestic depth $\eta_{k(n),t}^L$ is domestic financial assets to GDP, in logs. Columns (3) and (4) absorb year and issuer fixed effects. Regressions are unweighted. In columns (1) and (2), standard errors in parentheses are clustered at the issuer level. In columns (3) and (4), they are from an issuer-block bootstrap with 400 replications. In Appendix Table A.13, we run tests to gauge the magnitude of bias in β_λ due to measurement error. These tests suggest the estimate reported here is attenuated, but do not result in a significant estimate. In the appendix, Table A.10 reports summary statistics for the safety ratio estimates. Table A.12 reports the bond-pair-level regressions with exchange-rate moments in place of the safety-ratio gap; and Table A.14 reports the bond-level regressions at the 1-, 3- and 5-year horizons.

dictions, open-end funds hold a significantly larger share of local-currency bonds in cells where the local-currency safety ratio is low relative to the same issuer’s hard-currency safety ratio. The coefficient on the safety-ratio gap, β_λ , is 0.37 in logs and 0.24 in levels, both significant at the 5 percent level.⁴⁰ We find no positive relation between fund sorting and domestic market depth in these columns. The model-implied regressor is the *gap* in depth between the two markets, for which we do not have a good proxy. The bond-level regressions in columns (1) and (2) corroborate the safety-ratio result and show a positive relation with depth: open-end funds hold more of

⁴⁰The safety ratio is a generated regressor. We examine the magnitude of measurement error which may attenuate estimates of β_λ ; our tests suggest it may be highly attenuated, but are insignificant.

a bond when its safety ratio is lower and when domestic market depth is greater. The coefficient on the safety ratio is 0.39 (s.e. 0.14), and the coefficient on domestic market depth is 0.66 (s.e. 0.34).

6 Price impact of mutual-fund capital flows

Does foreign intermediary funding matter for bond prices, as Corollary 1 suggests? If so, what are the implications for sovereigns? The rest of the paper addresses these questions.

This section first tests the underlying assumptions that outflows from open-end funds have price impact when liquidating assets to meet capital withdrawals. We then test the more unique prediction of our framework from Corollary 1: that outflows have differential price impact on local- and hard-currency bonds. Then, 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 Corollary 1, 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 (8): Redemptions of claims on open-end funds reduce sovereign bond prices below fundamental values. The intuition of our framework rests on the claim that such outflows drive wedges between fundamental bond values and market prices. We thus 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 in exposure to open-end fund redemptions in the cross-section of bonds.

The invasion of Ukraine in February of 2022 drove large and heterogeneous outflows from European bond 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 bond 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.

Event study design. We identify the effect of open-end-fund outflows on local- and hard-currency bond prices by comparing yields of bonds who are held at funds with outflows to similar bonds

held at funds with fewer outflows, in a standard event-study design. The first step is to construct a bond-level, static, continuous treatment Treat_i which measures the exposure of bond i to event-driven bond-fund outflows. We describe the construction of these treatments below. We then estimate

$$y_{it} = \alpha_i + \sum_{h=-12, h \neq -1}^{12} \beta_h (\text{Treat}_i \times \mathbb{1}\{t = h\}) + \mathbb{1}' V_{g(i,t),t} + u_{it} \quad (12)$$

α_i is a bond fixed effect. $V_{g(i,t),t}$ is a vector of group $\times$ date effects, where bond i 's group $g(i, t)$ is a cell defined by issuer, currency, duration, and size, and varies over time. These effects absorb any shock common to bonds in the same cell at date t , including changes in currency-risk premia and in the prices of substitute bonds, so that β_h is identified by differences in yields between bonds in the same cell at the same date (Chaudhary et al., 2023). Because the cells are defined within currency, the effects also absorb changes in spot and forward exchange rates, and β_h measures price impact on the credit-spread component of the yield.⁴¹ Equation (12) is the empirical counterpart of (48), with the group structure allowed to vary over time.

The parallel trends assumption is that, in the absence of high co-holdings at funds that experience larger outflows, bonds in the same cell would experience the same evolution in yields over the sample period. This assumption need only hold for the yields of the bonds we study, and not for the funds that experience disproportionate outflows after the event. In practice, the assumption appears to hold even without conditioning on time-varying cell effects. Pre-February 2022 yields evolve similarly between treated and untreated bonds overall (see Figure A.6), and estimating the event study with static cell fixed effects does not significantly alter the estimates (see Appendix A.5). We report both pooled and monthly, dynamic versions of (12).

Constructing the treatments. We construct bond-level treatments Treat_i based on exposure to portfolio co-holdings to exposed issuers on the eve of the February 2022 invasion. The procedure to construct the treatment proceeds in four steps. (1) First, we observe the set of bonds in the investment universe of the mutual funds in our sample⁴² 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.⁴³ (2) Second, for each mutual-fund portfolio p , we calculate the portfolio

⁴¹This design is consistent with our abstraction from price impact in spot exchange rates in the main model.

⁴²The construction of the mutual fund sample is provided in Section 2

⁴³Formally, we tag any fixed-income security from issuers in these domiciles. These include fixed-income securities from non-sovereign entities. The sample of mutual funds we consider is dominated by portfolios with a fixed-income focus and have relatively little equity exposure. 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 to the results.

weight in these securities in December 2021, 3 months before the shock, and denote it ω_p^R .⁴⁴ (3) Third, we sort mutual-fund portfolios on ω_p^R . We split our sample of mutual fund portfolios along the median of ω_p^R . We define high- ω^R portfolios as those with holdings above the median in December 2021, and call this set of portfolios $\mathcal{P}^R$.⁴⁵ (4) Fourth, we construct the bond-level treatment as the share of bond i held by highly-exposed fund-portfolios $p \in \mathcal{P}^R$:

$$\mu_i^R = \frac{\sum_{p \in \mathcal{P}^R} h_{ip,2021m12}}{\text{Amt Out}_{i,2021m12}}. \quad (13)$$

h_{ip} is the holdings of bond i in portfolio p , stated in bond currency. μ_i^R is the share of bond i 's amount outstanding held by $\mathcal{P}^R$ portfolios.⁴⁶

In estimating (12), we make three adjustments to the sample of bonds to limit concerns about confounding variation driven by bond fundamentals. First, we exclude bonds used in the construction of ω_p^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 $\mathcal{P}^R$. 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).

Relation between the event study and the model. In Appendix A.6.2, we derive the event-study regression in (12) with treatments μ_i^R directly from the bond market clearing condition in the definition of competitive equilibrium in Definition 4.3. To do this, we relax one assumption of the model: We allow for open-end funds to face heterogeneous redemptions on the fund in the bad-news state, and to liquidate their bonds pro-rata in response. Intuitively, the treatment μ_i^R is a shifter of supply S_i in the bad-news state which (up to a constant) identifies the inverse outside demand elasticity $1/\eta$. Using this same simple framework, we extend the event study to a two-stage design next, in Section 6.2.

⁴⁴Letting ω_{ipt} denote the portfolio weight for security i in portfolio p in month t , and $\mathcal{I}^R$ the set of securities which we tag as fundamentally exposed according to the above criteria, we compute $\omega_p^R = \sum_{i \in \mathcal{I}^R} \omega_{ip,2021m12}$.

⁴⁵The results are robust to splitting funds along terciles or quintiles of this measure, which we report in Appendix A.5.

⁴⁶We consider alternative scalings of the treatment, based on fund portfolio weights, but focus on μ_i^R as the treatment in the main text because of its relevance to the two-step estimation that follows. The procedure described above inevitably involves degrees of freedom which could, in principle, introduce bias or confounding variation into the treatments. Our approach to this concern is to ensure that no single choice made in the procedure drives the results. Discussion of these alternative approaches and robustness tests can be found in Appendix A.5.

Validating the fund portfolios sort. Our procedure identifies a subset of funds $\mathcal{P}^R$ which were differentially affected by the events of the War in February 2022. We demonstrate this by estimating a simple differences-in-differences regression of fund flows on the sorting measure. Appendix Table A.15 summarizes the cumulative effects of the invasion on fund flows. Flows into high-exposure portfolios ($\mathcal{P}^R$) declined by 2 percent in the three months after the invasion relative to funds with lower exposure, and remained persistently lower up to 8 months later. We find pre-invasion trends in flows that differ across 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. Figure 4a reports estimates of regression (12) with $\text{Treat}_i = \mu_i^R$. The dependent 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 figure reports estimates after absorbing currency $\times$ remaining-maturity $\times$ issuer $\times$ month so that the effect may be read as the additional p.p. in credit spread relative to a nearby substitute of the bond, where that substitute is defined on these dimensions. In the second panel of the figure, we split the estimation into local- and hard-currency subsamples. Across bonds of all currencies, an additional standard-deviation of exposure to fund redemptions is associated with a peak impact on credit spreads of 8 basis points, a small but detectable effect. Moving to the right panel, where we split the estimation into local- and hard-currency subsamples, we find that the average effects vary significantly between the two bonds. Almost all of the detectable price impact is concentrated within local-currency bonds. There, the peak price impact (which occurs 3 months after the invasion) is 40 basis points per standard deviation of exposure. We discuss interpreting these magnitudes in more detail next. Consistent with the price dynamics one might expect in a fire sale, the cumulative effects on yields reported in Figure 4a are indistinguishable from zero after seven months.

In Appendix A.5, we conduct a number of robustness tests to support our construction of the treatments, choice of conditioning information in $V_{g(i),t}$ and the robustness of differential price impact across currencies. In Figure A.6, we examine the parallel trends assumption visually, both conditionally and unconditionally on bond fixed effects. Placebo tests for the event study using both incorrect event dates, and placebo treatments computed off of non-invasion related fund holdings, produce no detectable effect on bond prices. We examine the linearity of treatment effects in Table A.16. We examine the results from a differences-in-differences design that pools together the pre- and post-invasion months, using alternative scalings of the treatments,

alternative weights for the regression, and various controls for both bond substitute prices and exchange-rate valuations in Table A.18.

6.2 Decomposition of price impact estimates using a two-stage approach

How should we interpret the magnitude of price impact estimated in Figure 4b, and in particular, the large differences in price impacts between local and hard currencies? Proposition 1 and its corollary suggest that two forces are at work: supply, which is driven by the ex-ante intermediation by open-end funds, and residual demand elasticities, which the model takes as given.

In this section, we exploit our granular information on both bond holdings and prices to estimate a decomposition of these price impacts into these margins and their subcomponents. We derive estimating equations that use the same identifying variation as in the event study, but exploit the fact that we not only observe bond prices but also quantities and ex-ante intermediary composition. The decomposition allows us to shed light on the relative importance of each margin for explaining the divergence in price impacts between local- and hard-currency bonds estimated in Figure 4b. We derive the full approach in Appendix A.6, but provide the outline of it here.

We start by relaxing two assumptions of the model, in order to capture two margins of supply that might be relevant in the data but are simplified in the model. We allow (i) that outside demand may differ structurally across currencies, and (ii) that open-end funds face heterogeneous redemptions in response to bad news. First, we write a version of the residual demand curve (8) with currency-specific inverse demand elasticity $\eta^{c(i)}$ to bond spreads $y_{it} - y_{it}^*$, where y_{it}^* is the yield at which bond i is priced at its fundamental value.⁴⁷ With this demand equation and market clearing, the excess yields estimated in Figure 4a could come from (i) excess quantity of supply or (ii) inelastic outside demand.

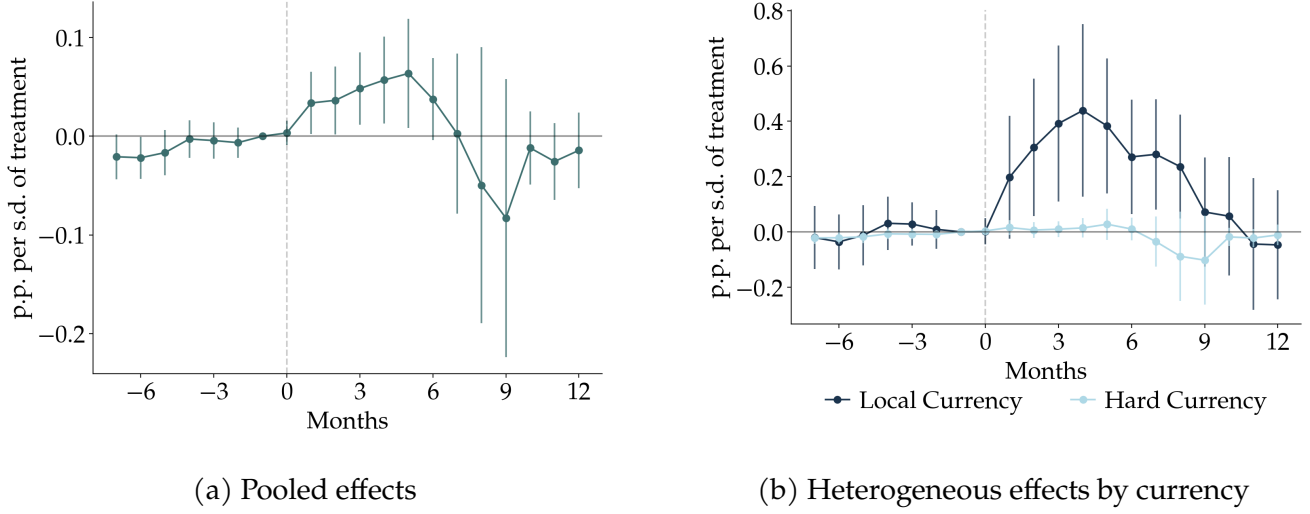
Second, we decompose the supply component S_0^i/B_0 of market-clearing into two pieces: that associated with ex-ante exposure to open-end funds, and that associated with quasi-random redemption at exposed funds. To do this, we partition funds into the set $\mathcal{P}^R$ (high pre-invasion exposure), and allow an individual fund p 's realized post-invasion redemption rate to be a function of its pre-invasion exposure:

$$\rho_p = \rho_0 + \Delta\rho \cdot \mathbb{1}\{p \in \mathcal{P}^R\} + e_p. \quad (14)$$

Here $\rho_p - \rho_0$ is the change in fund p 's redemptions after the invasion relative to its normal flows,

⁴⁷Equation (8) is linear in the price discount. Appendix (44) states it in yields, using a local duration approximation, (46).

Figure 4: Dynamic Price Impact of Redemptions from Open-End Funds



Notes: The figure reports estimated coefficients γ_h from the regression $y_{it} = \alpha_i + \sum_{h \neq -1} \gamma_h (\tilde{\mu}_i^R \times \mathbb{1}\{t = h\}) + \mathbb{1}' V_{g(i),t} + \varepsilon_{it}$, where $\tilde{\mu}_i^R$ is the treatment μ_i^R of (13), the share of bond i 's amount outstanding held by high-exposure open-end funds in December 2021, divided by its in-sample standard deviation, and y_{it} is the annualized yield to maturity. h is the month relative to February 2022; the leave-out month is $h = -1$ (January 2022), drawn at zero. α_i is a bond fixed effect, and $V_{g(i),t}$ comprises month fixed effects, issuer $\times$ remaining-maturity bucket $\times$ size decile $\times$ coupon type $\times$ currency fixed effects, and month $\times$ currency $\times$ remaining-maturity bucket $\times$ issuer fixed effects. The regression is estimated on a wide window, the full panel of bond-months: months before $h = -12$ are pooled into the $h = -12$ indicator and months after $h = 12$ into the $h = 12$ indicator, so the coefficient drawn at $h = 12$ is the effect at or beyond twelve months. The figure shows $h = -7, \dots, 12$; $h = -7$ is an interior event month. Observations are weighted by the bond's par outstanding relative to its issuer's. Error bars are 95 percent confidence intervals, using standard errors clustered at the bond level. The vertical axis is in percentage points of yield per one standard deviation of μ_i^R . Panel (a) pools all bonds; panel (b) estimates the regression separately on Local- and Hard-Currency bonds. In the appendix, Figure A.6 examines the parallel-trends assumption; Figure A.7 reports cumulative changes in holdings by exposure to open-end fund redemptions; Table A.15 reports open-end fund flows and redemptions by exposure to the invasion; Table A.18 reports pooled differences-in-differences estimates on local- and hard-currency bonds, triple-differences estimates on the pooled sample, and estimates under alternative treatments and weighting schemes; Table A.16 reports estimates by quartile of treatment; and Table A.17 reports placebo tests.

and e_p is the part of that change not explained by pre-invasion exposure.⁴⁸ Assuming funds liquidate their bond holdings pro-rata to redemptions, market clearing is

$$y_{it} - y_{it}^* = \underbrace{\frac{\rho_0^c \mu_U^i}{\eta^c}}_{\text{common "post" variation}} + \underbrace{\frac{\Delta \rho^c \mu_i^R}{\eta^c}}_{\text{"Post} \times \text{Treat" variation}} + \underbrace{\frac{\mu_U^i \bar{e}^i}{\eta^c}}_{\text{idiosyncratic variation}}, \quad (15)$$

where μ_i^R is the treatment constructed in (13). Under the identifying assumptions of the event study, and our assumptions about e_p , the treatment effect on a treated bond i relative to a similar,

⁴⁸We assume that these fund-specific changes are unrelated to which bonds a fund holds except through $\mathcal{P}^R$, so that conditional on information about ex-ante bond holdings and characteristics, the exposure of a bond i to e_p is iid and mean zero.

untreated bond is given by the second term, $\frac{\Delta\rho^c}{\eta^c} \mu_i^R$. The common “post”-term is shared by all bonds (conditional on observables including μ_U^i), and the idiosyncratic term is uncorrelated with the treatment. The average of the second term across currency- c bonds is the average treatment effect on the treated: $ATT^c \equiv \frac{\Delta\rho^c}{\eta^c} \mathbb{E}^c[\mu_i^R]$. The dosage of the treatment, $\mathbb{E}^c[\mu_i^R]$, can be decomposed further as $\mathbb{E}^c[\mu_i^R] = \mathbb{E}^c[\mu_U^i] \delta_c^R$, where δ_c^R is the share of fund holdings of currency- c bonds held by high-exposure funds. Substituting into ATT^c , the differences in estimated ATTs can be decomposed into four measurable margins:

$$\log \frac{ATT^L}{ATT^H} = \underbrace{\log \frac{\mathbb{E}^L[\mu_U^i]}{\mathbb{E}^H[\mu_U^i]}}_{\text{ex-ante sorting}} + \underbrace{\log \frac{\delta_L^R}{\delta_H^R}}_{\text{quasi-random exposure}} + \underbrace{\log \frac{\Delta\rho^L}{\Delta\rho^H}}_{\text{redemption}} + \underbrace{\log \frac{\eta^H}{\eta^L}}_{\text{demand depth}}. \quad (16)$$

This equation decomposes the ratio of average treatment effects on the treated into four terms. The first, sorting, is how much larger a share of the outstanding stock open-end funds hold in local- than in hard-currency bonds before the shock. The second, quasi-random exposure, is how much larger a share of those fund holdings sits at high-exposure funds in local- than in hard-currency bonds. The third, redemption, is how much more high-exposure funds were redeemed, relative to other funds, among the funds holding local-currency bonds than among those holding hard-currency bonds. The fourth, demand depth, is how much less outside investors absorb in local- than in hard-currency bonds per unit of yield concession.

We show in Appendix A.6 that we can estimate this decomposition directly using the following two-stage design, estimated separately for each currency c :

$$\frac{S_i}{B_0^i} \text{Post}_t = \alpha_i + \mathbb{1}' V_{g(i,t),t} + \beta_{FS}^c (\mu_i^R \times \text{Post}_t) + \pi^c (\mu_U^i \times \text{Post}_t) + u_{it}, \quad (17)$$

$$y_{it} = \alpha_i + \mathbb{1}' V_{g(i,t),t} + \beta_{RF}^c (\mu_i^R \times \text{Post}_t) + \pi_y^c (\mu_U^i \times \text{Post}_t) + \varepsilon_{it}, \quad (18)$$

along with the coefficient $\beta_{IV}^c = \beta_{RF}^c / \beta_{FS}^c$. Under our identifying assumptions, $\beta_{FS}^c = \Delta\rho^c$, $\beta_{RF}^c = \Delta\rho^c / \eta^c$, and $\beta_{IV}^c = 1 / \eta^c$ (56). Because we observe both μ_U^i and treatment dosage $\mathbb{E}^c[\mu_i^R]$ from December 2021 holdings, these estimates identify each term of (59). This approach imposes additional restrictions on our interpretation of the average treatment effects estimated previously: it forces the open-end fund exposure treatment to act on yields only through bond sales S_i , the endogenous variable in the first stage. The exclusion restriction is (57).

Implementation of the decomposition. We estimate the two-stage regression using quarterly data on bond-level holdings from the SHS, treatments constructed from Lipper, and the same bond-level price and characteristic information employed in the event study. In the baseline

estimates, we measure $(S_i/B_0^i)_t$ at the bond level as the cumulative change in par holdings of euro-area open-end funds of bond i since December 2021, divided by amount outstanding. As robustness, we also estimate a version in which we compute holdings directly from the Lipper flows data, and find similar results. We include in both steps of the estimation $V_{g(i),t}$, which includes the set of fixed effects in column (5) of Table A.18. When measuring the ex-ante holdings shares μ_U^i , we compute these as holdings of bond i by open-end funds divided by euro-area holdings of bond i , consistent with the model's specification of the same variable. The window over which we estimate is September 2021 - August 2022. We estimate versions of the two-stage regression with yields-to-maturity, duration-weighted yields, and bond prices as outcome variables, to examine the sensitivity of our estimates to the demand-curve specification. We estimate the two-stage coefficients in bootstraps, sampling in blocks of issuers.

Supply response: Substitution away from local-currency Consistent with larger fire sales in local- than in hard-currency bonds of the same issuer, issuers respond to mutual fund outflows by partially reallocating bond supply to hard currency. We use the same quasi-random variation in exposure to open-end fund redemptions as in the previous section. As in regression (64), we pair bonds into cells n matched on issuer and remaining maturity, and estimate

$$\tilde{\theta}_{n,t} = \alpha_t + \alpha_{k(n)} + \gamma_L \left(\text{Treat}_n^L \times \mathbb{1}\{t \geq 2022m2\} \right) + \gamma_H \left(\text{Treat}_n^H \times \mathbb{1}\{t \geq 2022m2\} \right) + \Gamma' X_{n,t} + \epsilon_{n,t} \quad (19)$$

where $\tilde{\theta}_{n,t}$ is net local-currency issuance in cell n in month t , and $\text{Treat}_n^c = \sum_{i \in n} \mu_i^R$ is the exposure of the cell's c -currency bonds to event-driven fund redemptions. Because the identifying variation is across matched pairs on characteristics other than currency, parallel trends must hold conditional on those characteristics. We compute net local-currency issuance as the change in log amount outstanding of local-currency bonds in cell n less the change in log amount outstanding of hard-currency bonds. The measure captures every margin of relative supply: new issuance, redemptions at maturity, tender offers, and re-openings.

Appendix Table A.19 reports the estimates. Issuers reduce net local-currency issuance by between 3.7 and 8.7 log points per standard deviation of exposure to fund redemptions.⁴⁹

⁴⁹The same standard deviation of exposure raises yields by 16 to 20 basis points (Table A.18). At a duration of five years, this implies a supply elasticity of roughly 3 to 9.

Table 3: Decomposition of the Price-Impact Gap

	(1) Yield	(2) Price, $-D y$
<i>Panel A: Decomposition according to equation (16).</i>		
$\log(\text{ATT}^L / \text{ATT}^H)$	1.76 (1.09)	0.31 (0.94)
Ex-ante sorting: $\log(\mathbb{E}^L[\mu_U^i] / \mathbb{E}^H[\mu_U^i])$	0.64 (0.17)	0.64 (0.17)
Quasi-random exposure: $\log(\bar{\delta}^L / \bar{\delta}^H)$	-0.01 (0.05)	-0.01 (0.05)
Redemption: $\log(\Delta\rho^L / \Delta\rho^H)$	0.09 (0.30)	0.09 (0.30)
Demand depth: $\log(\eta^H / \eta^L)$	1.03 (1.07)	-0.41 (0.90)
<i>Panel B: Currency-specific components of equation (16).</i>		
β_{RF}^L	0.511 (0.297)	-2.11 (1.59)
β_{RF}^H	0.166 (0.196)	-2.90 (2.44)
$\beta_{IV}^L = \beta_{RF}^L / \beta_{FS}^L$	-13.7 (7.96)	56.6 (42.9)
$\beta_{IV}^H = \beta_{RF}^H / \beta_{FS}^H$	-4.88 (6.14)	85.3 (72.5)
Draws with $\log(\text{ATT}^L / \text{ATT}^H)$ defined	455	455
First-stage F (KP), L	17.10	17.10
First-stage F (KP), H	30.02	30.02
Bonds, L	358	358
Bonds, H	363	363
Bond-months, L	6993	6993
Bond-months, H	7116	7116

Notes: The table reports estimates of the decomposition in equation (16). Panel A reports the log ratio of local- to hard-currency average treatment effects on the treated and its decomposition into four margins. The redemption and demand-depth margins are estimated as $\log(\beta_{FS}^L / \beta_{FS}^H)$ and $\log(\beta_{IV}^L / \beta_{IV}^H)$, which equal $\log(\Delta\rho^L / \Delta\rho^H)$ and $\log(\eta^H / \eta^L)$ under the identifying assumptions of Section 6.2. Panel B reports the reduced-form and IV coefficients from equations (17)–(18), estimated separately for local- and hard-currency bonds. Holdings are from Lipper. μ_U^i and μ_i^R are the holdings of all funds and of high-exposure funds as a share of the bond’s externally held debt. Sales S_i / B_0^i are fund holdings rolled forward on each fund’s own flows under pro-rata liquidation using fixed December 2021 weights. All specifications include bond fixed effects and month $\times$ issuer $\times$ currency $\times$ remaining-maturity fixed effects, as in column (5) of Table A.18, and run from December 2020 to August 2022, with Post equal to one from February 2022. Column (1) uses the yield to maturity in percentage points; column (2) the price-unit outcome $-D_i y_{it}$. Standard errors in parentheses are standard deviations across 499 bootstrap draws that resample issuers with replacement and re-estimate every term jointly. Standard errors are computed over draws with well-defined log ratios. In the appendix, Figure A.7 and Table A.15 examine the first-stage results on quantities in isolation. Tables A.18, A.16 and A.17 examine the reduced-form in isolation.

7 Implications for Sovereign 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? In this section, we extend the model proposed in Section 4 to consider the problem of a sovereign with a fixed borrowing need 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.

The local-currency share affects aggregate consumption in our model through two familiar channels and one novel mechanism. First, default imposes deadweight losses on aggregate output Aguiar and Amador (2013). A greater local-currency share reduces the probability of default and therefore raises expected output. Second, our model features a wedge between local- and hard-currency bond prices, even after accounting for expected exchange-rate movements. The sovereign may therefore relax the government budget constraint by issuing relatively more debt in the high-price currency, which in our setting is hard currency (Krishnamurthy & Vissing-Jorgensen, 2012; Jiang et al., 2021; Engel & Park, 2022).

Finally, the local-currency share affects domestic consumption in a novel way by determining the composition of bond intermediaries and the size of capital outflows in bad-news states. A higher local-currency share results in more unstable intermediation of the debt overall. When unstable intermediaries sell bonds, domestic investors absorb some of this capital outflow and forego investing in domestic projects. We assume that domestic projects have positive externalities on output.⁵⁰ Thus, capital outflows crowd out domestic investment. However, domestic investors recoup and consume arbitrage profits from absorbing these outflows. The consumption cost of bad news therefore depends on the net of these two effects.

Bond-pricing assumptions. The numeraire for the sovereign is one sure unit of local currency in $t = 2$. We denote the risk-neutral local-currency measure using $\mathbb{L}$, and that of the hard-currency measure $\mathbb{H}$. Let β^H denote the constant discount factor of hard-currency households and β^L denote the constant discount factor of the local-currency sovereign. We assume $\beta^H \mathbb{E}^H[\mathcal{E}_2^{-1}] = \beta^L$ (A3). From time $t = 0$, there is no expected exchange rate depreciation. Under the hard-currency numeraire, we have $\mathbb{E}^H[\mathcal{E}_2^{-1}] = 1$ (A4). Assumption A3 allows us to price the revenue raised by issuing to foreigners and the repayments made to foreigners under a consistent numeraire.⁵¹ We

⁵⁰One 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.

⁵¹The implicit assumption in A3 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.

discuss these assumptions and weaker assumptions in more detail in Appendix B.4.

Government budget. The government budget constraints for $t \in \{0, 1, 2\}$ are

$$T_0 \leq Z_0 + \theta P_0^L + (1 - \theta) P_0^H, \quad T_1 \leq Z_1, \quad T_2 \leq Z_2 - XB, \quad (20)$$

where T_t is the government's net transfer to domestic households and P_t^c is the bond price now in local-currency units. Net transfers comprise exogenous primary surpluses Z_t , plus revenue raised from issuance in $t = 0$, less bond repayments in $t = 2$, given by XB . Here and in Appendix B.4, $Z \equiv Z_2$ denotes the terminal surplus, so that B , X , and $\mathcal{E}$ are the objects of Section 4.⁵²

The debt manager faces competitive bond markets and cannot strategically default. They cannot choose θ to raise revenue at the expense of bond-holders, but they can take advantage of foreign household demand for money. We show in Appendix B.4.2 that under A3 and A4, the net local-currency revenue raised by bond issuance is precisely equal to the sum of money premia generated by sovereign bonds, $\sum_{c \in \{L, H\}} B_0^c (\gamma \underline{X}^c)$. The marginal effect of the local-currency share on net revenue is therefore $\gamma(\underline{X}^L - \underline{X}^H)$, which is negative.

This result highlights how households' utility from hard-currency-denominated money in (3) breaks the irrelevance result of Modigliani and Miller (1958) for the issuer. Without the money premium ($\gamma = 0$), net revenue is zero at every θ , and the currency composition of debt affects consumption only through default and domestic investment.

Costly default. In the event of default the domestic economy suffers a dead-weight cost in the form of lost output. Domestic output comprises a fixed endowment plus spillovers from domestic investment, introduced below. The endowment is Y in all $t < 2$ and in the case of no default, but $Y - \ell$ if the sovereign defaults in $t = 2$. The dead-weight loss ℓ scales with the severity of the default:

$$\ell \equiv \phi (B - Z) \mathbb{1}\{Z < B\}, \quad 0 < \phi < 1 \quad (21)$$

In what follows, we denote expected default losses under the local-currency numeraire using $\mathcal{L} = b \mathbb{E}_b^{\mathbb{L}}[\ell]$. Without loss of generality, and to simplify the notation, we set $Y = 1$.

⁵²As in previous sections, we abstract from the total leverage of the domestic economy. 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 outright 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 from foreigners to begin with.

Domestic investment. A measure η^c of identical, risk-neutral domestic investors invest a unit of local-currency endowment in domestic projects which yield in currency $c = \{H, L\}$. 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.

Domestic investors choose their investments period-by-period and state-by-state. Outside of the bad-news state, investors allocate their endowment to domestic projects and returns are trivially given by $\eta^c R(1)$. If the bad-news state occurs, another investment opportunity arises: to buy sovereign bonds at a discount from foreigners. This investment yields an expected return of $\frac{1}{\zeta^c}$. In the bad-news 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

$$\max_{q^L} \quad \pi_b^L = R(\iota^L) + q^L \mathbb{E}_b^L[X^L] \quad \text{subject to} \quad \iota^L + P_b^L q^L = 1 \quad (22)$$

Hard-currency investors have a symmetric profit function, which we detail in appendix B.4.⁵³

In what follows, we assume $R(\iota) = \iota^{1-\rho} / (1-\rho)$ for concreteness. The solutions to the profit-maximization problem imply investment in domestic projects given by $\iota_b^c = (\zeta^c)^{\frac{1}{\rho}}$ and aggregate project investment is given by $I_b^c = \eta^c (\zeta^c)^{1/\rho}$.⁵⁴

Bond-market clearing and aggregate investment. To clear bond markets given bad news, each domestic investor in c -currency projects must absorb a quantity $\frac{\mu^c B_0^c P_b^c}{\eta^c}$ of sovereign bonds. We assume the masses of domestic investors in each currency $c \in \{L, H\}$ are proportional to the initial supply of bonds in each currency: $\eta^L = \eta\theta$, $\eta^H = \eta(1-\theta)$. Aggregate domestic investment in c -currency projects in equilibrium is therefore

$$I_b^c = B_0^c (\eta - P_b^c \mu^c) \quad \text{for} \quad c \in \{L, H\}.$$

Intermediation by unstable intermediaries μ^c crowds out domestic investment in currency c . In partial equilibrium, crowding out is decreasing in the fire sale discount ζ^c , and increasing in the

⁵³Note 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. We think of investors absorbing bonds in a currency c on the secondary market as specialists in that currency, whereas large foreign 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, regardless of the size of outside investors.

⁵⁴By the budget constraint, aggregate demand for sovereign bonds in the bad-news state is $Q_b^c = \eta^c \left(1 - (\zeta^c)^{\frac{1}{\rho}}\right)$, which provides the microfoundation for the demand curves in Section 4.

share of intermediation performed by unstable funds. While the sovereign issuer's problem does not depend only on the *quantity* of investment in projects, we find it instructive to show how this quantity depends on the local-currency share of debt. Lemma 2 establishes this relationship.

Lemma 2 (Equilibrium Investment Crowding Out). *The marginal effect of raising the local-currency share on aggregate investment in domestic projects comprises two effects: (i) a direct effect of reallocating bond supply to a market where a greater fraction of supply is fire-sold in the bad state and (ii) an indirect effect of altering sovereign credit risk on equilibrium fire-sale prices. Both effects are negative. Local-currency debt crowds out domestic investment relative to hard-currency.*

Aggregate investment across all markets in the bad-state is $I_b = I_b^L + I_b^H$. The marginal effect of a change in θ on this quantity is

$$dI_b = \eta \left(\underbrace{\zeta_L^{1/\rho} - \zeta_H^{1/\rho}}_{\text{bond supply effect, } < 0} + \underbrace{\theta \frac{\partial \zeta_L}{\partial \theta} + (1 - \theta) \frac{\partial \zeta_H}{\partial \theta}}_{\text{indirect credit risk effect, } < 0} \right) d\theta$$

Proof. See appendix B.4.5.

Domestic investment enters consumption through the profits of private investors and through spillovers, which raise domestic output:

$$\Pi_t^D = \sum_{c \in \{L, H\}} \eta^c \underbrace{\pi_t^c}_{\text{private returns}}, \quad Y_t = 1 + \sum_{c \in \{L, H\}} \eta^c \underbrace{\alpha R(\iota_t^c)}_{\text{investment spillovers}} - \ell_t \quad (23)$$

In the fire sale, domestic investors make a profit at the expense of foreign bondholders, captured in the private returns term of (23). 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: α , which parameterizes the size of spillovers, and ρ , which governs the curvature of the domestic production function R . 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 a government with a utility function which places more weight on higher-marginal-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.

Sovereign issuer's problem. The sovereign issuer maximizes the expected stream of consumption, which is the sum of domestic output, the profits of domestic investors, and the government's net transfer.

$$\max_{\theta} \mathbb{E}_0^L \left[C_0 + \beta^L (C_1 + C_2) \right] \quad \text{s.t.} \quad C_t \leq Y_t + \Pi_t^D + T_t \quad \text{for } t \in \{0, 1, 2\} \quad (24)$$

where Y_t and Π_t^D are given by (23), with ℓ_t from (21), and T_t by (20). In solving (24), the sovereign issuer trades off the effects of θ on revenue and default against its effects on the risk of capital outflows and their spillovers. Proposition 2 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 sovereign issuer does not internalize the capital losses on foreign investors' balance sheets associated with fire sales. We show in appendix B.4 that the government's indifference condition for the choice of local-currency share θ simplifies to trading off the marginal benefit of a decline in expected default losses against two marginal costs: (i) that of foregoing the safety premium on hard currency, and (ii) that of the additional fire sales associated with local currency bond supply. The indifference condition for the social planner equates the marginal cost of the Original Sin – which is given by greater vulnerabilities to exchange rate depreciations and higher default costs – to the marginal costs of overcoming the Original sin, which arise from two 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 θ^* is the solution to the fixed point problem. We characterize the optimal local-currency share in Proposition 2.

Proposition 2 (Optimal Local-Currency Share). *Assuming the domestic production function R is sufficiently concave, the sovereign's problem in (24) admits interior solutions for θ , and the optimal local-*

currency share θ^* is: (i) **decreasing** in the safety premium γ , (ii) **decreasing** in the value-at-risk in exchange rates $\bar{\epsilon}$, (iii) **increasing** in the costliness of default ϕ , and (iv) the effect of the covariance of innovations to exchange rates and endowments σ_{ze} depends on two competing forces: the default channel (reducing the benefit of local currency) and the fire-sale channel (reducing the cost of local-currency fire sales). When fire-sale asymmetry dominates, θ^* is **increasing** in σ_{ze} .

Proof. See appendix B.4.7

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 2 have intuitive interpretation. All else equal:

- (i) When demand for hard-currency money is higher, parameterized by a greater γ , 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 : 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 $\bar{\epsilon}$, the premium on hard-currency external debt is greater, and fire sales in local-currency debt are worse.
- (iii) Costlier defaults make currency mismatch costlier.
- (iv) The effect of σ_{ze} on optimal local-currency issuance is governed by two competing forces. The *default channel*: a more negative covariance raises expected default losses, reducing the benefit of local-currency issuance ($\mathcal{L}_{\theta\sigma} > 0$). The *fire-sale channel*: a more negative covariance reduces the asymmetry in fire-sale discounts between local- and hard-currency bonds, lowering the cost of local-currency fire sales. When the fire-sale channel dominates, θ^* is increasing in σ_{ze} .

8 Conclusion

In this paper, we propose a novel channel through which the Original Sin may insulate emerging and developing sovereigns from capital outflows in periods of distress.

Intermediaries with stable and long-term funding systematically sort into holding hard-currency bonds, while those with open-ended funding systematically hold bonds denominated in local currency. This sorting cannot be explained away by selection of issuers into local-currency bond markets, the coincidence of local-currency issuance with intermediary capital across time, nor differences in bond maturity or governing law. Consistent with our theory of intermediation, it can be explained, in part, by the fundamental value-at-risk associated with exchange rates and the depth of domestic bond markets.

Sorting of local-currency bonds into the portfolios of open-end intermediaries disproportionately exposes it to capital outflows when these funds face redemptions. Capital outflows depress prices of sovereign bonds below fundamentals. However, conditional on the shock we study, capital outflows are larger and therefore depress prices by more for local-currency bonds, generating price wedges between local- and hard-currency. Issuers respond to these capital outflows by partially reallocating bond supply to hard currency.

The model we propose rationalizes these facts and enables us to consider policies aimed at ameliorating the tradeoffs faced by sovereigns in a setting where fire-sale prices affect domestic output. Within this model exercise, deepening of markets for local-currency bonds, while helpful for absorbing capital outflows in a partial equilibrium sense, also makes local-currency bonds an attractive asset for unstable intermediaries. Our results highlight the conditions under which this channel can undermine efforts to make sovereign debt more resilient by deepening domestic bond markets. Further research might investigate alternative policies aimed at ameliorating the tradeoffs faced by issuers with risky currencies, including, perhaps, the usefulness of capital controls conditioned on intermediaries' funding structures rather than residency, or, reserve management policies aimed at drawing in foreigners with stable funding ex-ante.

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A Empirical Appendix

A.1 Appendix to the Introduction

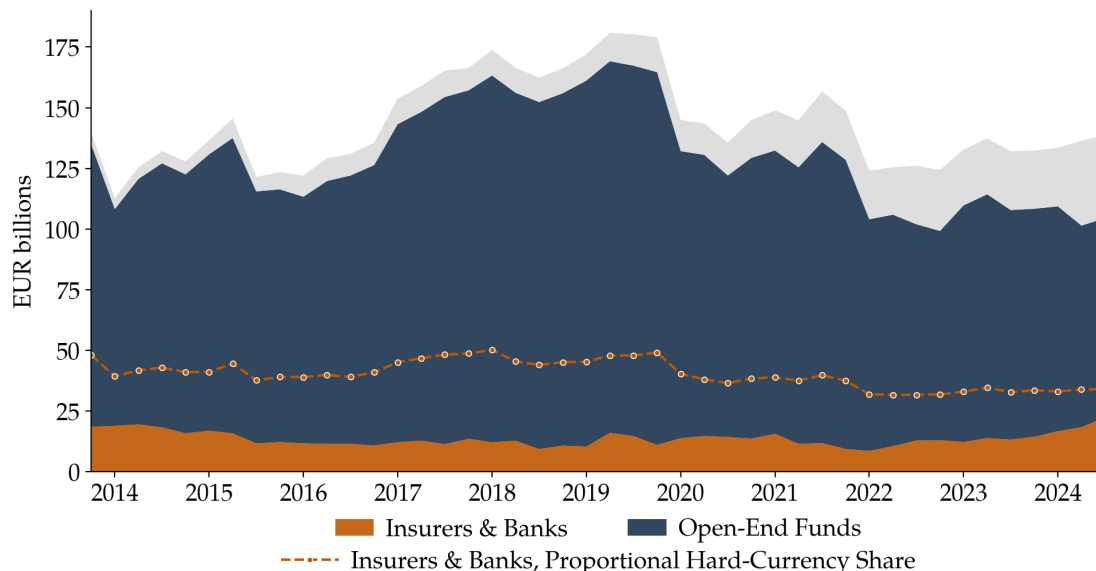
Figure 1 in the main text decomposes the growth of external debt outstanding over 2013–2018 by currency and investor type. This appendix reports that decomposition of levels, using in-sample currency growth figures, and the decomposition for the post-2018 period in which local-currency financing fell as a share of external debt for the countries in our sample.

Table A.1: Intermediary Holdings of Local- and Hard-Currency Bonds

	All Currencies	Hard Currency	Local Currency
<i>Panel A: Share of euro-area holdings, by sector (percent)</i>			
% Banks	18	20	14
% Insurance	11	16	2
% Funds	55	46	67
% Pensions (excl. NL)	2	3	0
% Pensions, NL	9	6	14
<i>Panel B: Contributions to growth in external debt, 2013–2018 (level-share imputation, IMF split)</i>			
Open-End Funds	63.4	24.4	40.8
Insurers & Banks	18.2	11.9	4.6
All sectors	81.7	36.3	45.4
<i>Panel C: 2019–2024, contributions to growth in external debt (flow-share imputation, IMF split)</i>			
Open-End Funds	−6.8	4.8	−11.6
Insurers & Banks	41.5	7.1	34.4
All sectors	37.5	13.7	23.8

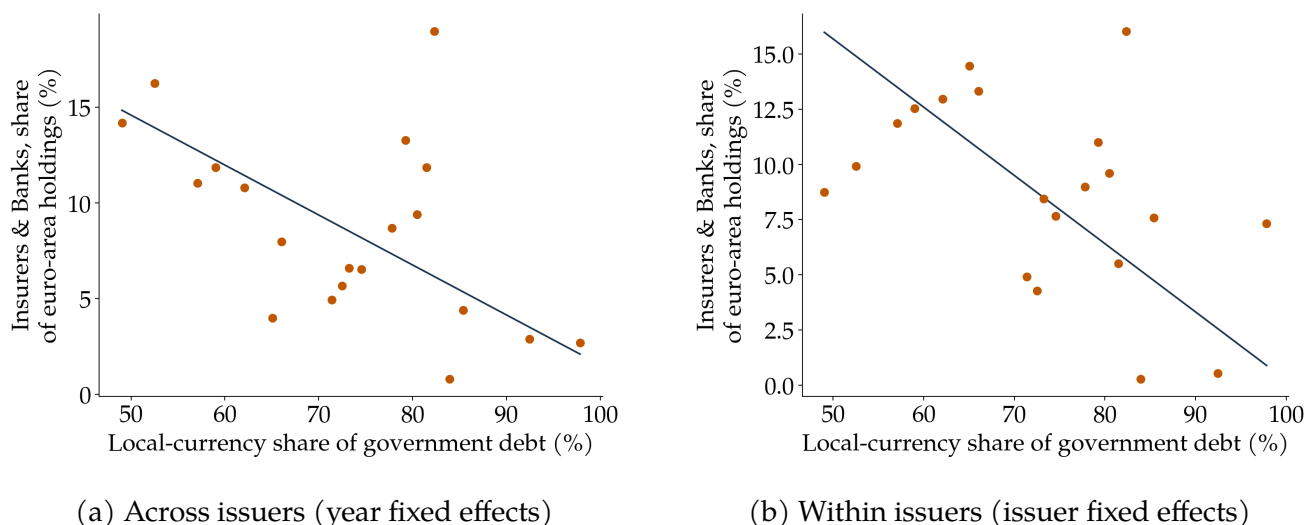
Sources: ECB SHS and Arslanalp and Tsuda (2014). *Notes:* Panel A reports the percent of euro-area holdings accounted for by each investor sector, the mean of quarterly observations over 2013–2024, with Luxembourg-domiciled holders excluded; the sample of bonds is described in Section 2. Panels B and C report the decomposition of growth in external debt outstanding of Figure 1, in percentage points of total growth over 2013–2018 (Panel B) and 2019–2024 (Panel C), with sectors down the rows and currencies across. In both panels the currency split is the local-currency share of each issuer’s government debt from Arslanalp and Tsuda (2014), counted once per issuer-year, and every holder area the SHS covers is used, Luxembourg included. Panel B uses the level-share imputation of Figure 1: within a currency, a sector’s contribution is the change in its euro-area holdings share times the stock. Its Insurers & Banks row also carries pension funds, households and other holders, so the two sector rows sum to the All sectors row in every column; in the sector rows the all-currencies entry is the sector’s contribution to the growth of all debt, computed directly, and need not equal the sum of its local- and hard-currency entries. Panel C uses the flow-share imputation: within a currency, a sector’s contribution is its share of euro-area net purchases over the window times that currency’s contribution to growth. Its Insurers & Banks row includes pension funds; households and other holders are not shown, so the two sector rows fall short of the All sectors row by their contribution, and the local- and hard-currency entries sum to the all-currencies entry in every row.

Figure A.1: Euro-Area Holdings of Local-Currency Sovereign Debt, by Holder Group



Sources: ECB-SHS. Notes: Areas are euro-area holdings of local-currency bonds in the sample of Section 2, in billions of euros, by quarter. The orange area represents holdings of insurers and banks, blue of open-end funds, and grey those of all other sectors. The dashed line is the local-currency holding insurers and banks would have if their share of local-currency holdings matched their share of hard-currency holdings in that quarter. The sample of bonds matches that of Table A.1.

Figure A.2: Issuers with Larger Insurer and Bank Investor Bases Borrow Less in Local Currency



Sources: ECB SHS, Arslanalp and Tsuda (2014), IMF. Notes: Binscatters of issuer-year observations (225 issuer-years, 20 bins). The vertical axis is the share of euro-area holdings of an issuer's sovereign bonds, in both currencies, held by insurers and banks. The horizontal axis is the local-currency share of the issuer's government debt from Arslanalp and Tsuda (2014). Panel (a) absorbs year fixed effects, so the variation is across issuers; panel (b) absorbs issuer fixed effects, so the variation is within an issuer over time. Both panels partial out the domestic non-bank share of government debt and the capital-control index, and use the same sample and axis scaling.

A.2 Appendix to Section 2

A.2.1 Representativeness of SHS Sample

Table A.2 compares the coverage of holdings in the SHS with those reported in the Coordinated Portfolio Investment Survey (CPIS). The first column reports holdings of each issuer's long-term debt securities by all investor economies that report to the CPIS. The second column reports the holdings of euro-area economies. The third reports euro-area holdings of the sovereign's bonds in our sample. Euro-area investors hold one-third of foreign holdings of long-term debt issued in these countries, 498 of 1,494 billion euros. Our sovereign sample holds 402 billion euros in an average quarter. It is of the same order of magnitude as total euro-area holdings and equals 27 percent of foreign holdings of all long-term debt from these issuers. The CPIS denominator includes non-sovereign issuers, so column (ii) understates the sample's coverage of foreign sovereign-bond holdings.

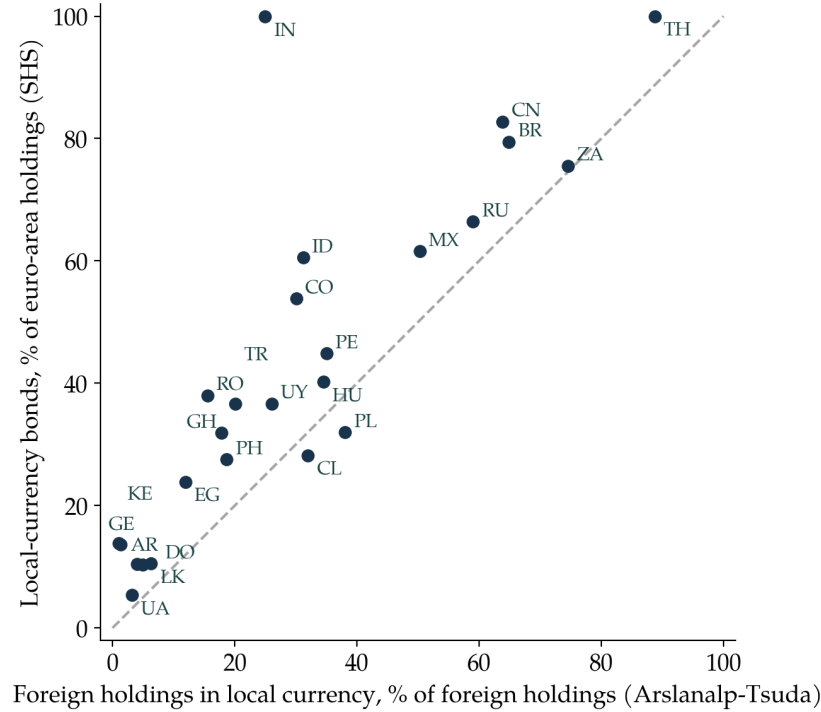
The currency composition of the sample is consistent with the currency composition of external debt of these countries estimated out of sample. Figure A.3 plots, for each issuer, the local-currency share of euro-area holdings of its sovereign bonds in our sample against the local-currency share of foreign holdings of its government debt estimated by Arslanalp and Tsuda (2014). The two shares line up along the 45-degree line. Issuers that borrow from foreigners mainly in local currency, such as South Africa, Brazil, and Mexico, appear in our sample with a high local-currency share. Issuers that borrow abroad mainly in hard currency, such as Argentina, Ukraine, and Georgia, appear with a low one. For most issuers the point lies above the line. Euro-area investors tilt toward local currency relative to the foreign investor base as a whole.

Table A.2: Coverage of the SHS Sample Relative to Foreign Holdings in the CPIS

Issuer	CPIS: long-term debt securities (EUR bn)		SHS sample (EUR bn)	Share of all foreign holdings (%)	
	All foreign holders	Euro area	Euro area	(i) CPIS euro area	(ii) SHS sample
AR	35.2	13.2	19.6	37.4	55.8
BR	143.3	37.8	27.2	26.4	19.0
CL	48.6	16.3	10.8	33.5	22.1
CN	236.5	26.2	16.2	11.1	6.8
CO	46.0	18.2	15.0	39.7	32.5
CZ	27.3	19.6	28.3	71.9	103.7
DO	11.5	5.7	6.1	49.6	53.2
EG	11.1	5.4	7.1	48.2	63.8
GE	2.0	1.1	0.2	56.2	10.8
GH	6.5	3.4	3.8	52.6	58.6
HU	32.1	16.0	14.3	49.9	44.5
ID	92.0	32.9	24.3	35.8	26.4
IN	58.1	13.4	5.1	23.1	8.7
IS	6.8	3.5	1.2	52.0	18.0
KE	3.4	1.8	1.8	52.8	52.6
KR	131.5	26.4	9.8	20.0	7.4
LK	6.9	3.4	3.8	49.5	55.1
MK	1.2	0.8	0.9	62.8	71.7
MX	200.9	66.2	39.6	32.9	19.7
NG	7.7	3.8	3.1	49.4	40.0
PE	29.4	12.7	9.1	43.2	30.8
PH	26.9	7.2	5.8	26.8	21.4
PL	80.0	49.4	38.8	61.8	48.6
RO	25.0	16.7	31.9	66.9	127.9
RS	6.1	3.0	3.3	49.4	54.2
RU	43.9	20.7	12.5	47.1	28.5
TH	25.1	9.6	7.8	38.3	31.2
TR	64.8	29.9	22.2	46.2	34.2
TW	9.0	1.0	0.2	11.3	2.2
UA	15.0	5.9	6.4	39.2	42.9
UY	11.4	5.0	4.6	44.1	40.6
ZA	49.1	21.7	20.8	44.2	42.4
Total	1494.4	498.1	401.6	33.3	26.9

Sources: IMF CPIS, ECB SHS, BIS. *Note:* Foreign holdings per CPIS sum, over all reporting investor economies, holdings of long-term debt securities issued by all residents of the country, sovereign and non-sovereign. Values are converted from US dollars at the end-December EUR/USD rate and averaged over 2013–2022. Euro-area holdings per CPIS sum the same series over the euro-area reporters. Croatia does not report. The SHS column is the average over quarters, 2013Q4–2024Q3, of euro-area par holdings of the country’s sovereign bonds in our sample. Column (i) divides euro-area CPIS holdings by all foreign holdings. Column (ii) divides the SHS column by all foreign holdings. The CPIS denominator covers every resident issuer while the SHS column covers the sovereign only, so both shares understate the sample’s coverage of foreign sovereign-bond holdings. Where the sovereign dominates external issuance they can exceed 100 percent.

Figure A.3: Local-Currency Share of Euro-Area Holdings Against the Foreign Aggregate



Sources: ECB SHS, Arslanalp and Tsuda (2014). Note: Each point is an issuer. The vertical axis is the local-currency share of euro-area holdings of the issuer's sovereign bonds in our sample. The horizontal axis is the local-currency share of foreign holdings of its government debt per Arslanalp and Tsuda (2014). Both are means over 2013–2022. The dashed line is the 45-degree line. The figure covers 25 issuers. CZ, IS, KR, and TW are not in the Arslanalp–Tsuda panel, and MK, NG, and RS have no estimate there.

A.3 Appendix to Section 3

A.3.1 Additional results and robustness supporting Fact 1.

This appendix reports additional results described in the main text supporting Fact 1. It also reports additional robustness exercises for the identification of intermediary sorting as a fact about bond currency. Table A.1 reports the decomposition of intermediary holdings across currencies in Levels.

Table A.3: Estimates of Investors' Intensive Margin Currency Preference

	Dependent Variable: $\ln$ of the intensive margin								
	Insurers			Banks			Open-End Funds		
$\mathbb{1}\{\text{Local Currency}\}$	-4.922*** (0.216)	-4.810*** (0.219)	-4.810*** (0.219)	-3.977*** (0.259)	-4.076*** (0.308)	-4.076*** (0.308)	-1.672*** (0.149)	-1.661*** (0.151)	-1.661*** (0.151)
$\mathbb{1}\{\text{USD}\}$	-3.870*** (0.209)	-3.853*** (0.209)	-3.853*** (0.209)	-2.660*** (0.194)	-2.677*** (0.193)	-2.677*** (0.193)	-0.758*** (0.164)	-0.760*** (0.164)	-0.760*** (0.164)
Log Amount Outstanding		-0.115 (0.0754)	0.885*** (0.0754)		0.114 (0.153)	1.114*** (0.153)		-0.0411 (0.0434)	0.959*** (0.0434)
Identifying N	13385	13384	13384	14386	14386	14386	25733	25732	25732
Currency RSq	0.511	0.513	0.479	0.236	0.237	0.231	0.0845	0.0849	0.250
Outcome	log share	log share	log holdings	log share	log share	log holdings	log share	log share	log holdings
Log Size Control		✓	✓		✓	✓		✓	✓

Note: OLS estimates of the intensive margin in logs. The share outcome $h_{it}^j / \text{Amount Out}_{it}$ has the bond's amount outstanding in its denominator, and local-currency bonds are larger than euro-denominated bonds from the same issuer, so a share is mechanically smaller for every sector on a local-currency bond. Within each intermediary type j , the first column regresses the log share held, $\ln(h_{it}^j / \text{Amount Out}_{it})$, on the currency indicators; the second adds $\ln \text{Amount Out}_{it}$ as a control; the third regresses log holdings, $\ln h_{it}^j$, on the currency indicators and $\ln \text{Amount Out}_{it}$. The second and third columns are the same regression written two ways, so their currency coefficients coincide and their size coefficients differ by exactly one; the third's size coefficient is the elasticity of the sector's holdings to bond size. All columns are estimated at a single level of the characteristics fixed effects, issuer $\times$ remaining maturity $\times$ debt type $\times$ size $\times$ coupon type $\times$ rating $\times$ jurisdiction, the most saturated specification of Table 1 without quarter effects, and are unweighted. The outcome is defined only where the sector holds a positive amount, so every column is conditional on owning, with the condition applied sector by sector. The leave-out currency is the euro. Standard errors in parentheses clustered at the bond and date level.

Table A.4: Horse-Race between Currency and Maturity in Cross-Section of Regressions

	Dependent Variable: $\mathbb{1}\{h_{it}^j > 0\}$								
	Insurers			Banks			Open-End Funds		
Remaining Maturity (years)	0.00355*** (0.000313)	0.00212 (0.00156)	-0.00157 (0.00139)	0.00364*** (0.000314)	0.00417*** (0.00140)	-0.000331 (0.000920)	0.00274*** (0.000131)	0.00216*** (0.000571)	0.00152*** (0.000426)
Identifying N	27147	27122	27103	27147	27122	27103	27147	27122	27103
Currency RSq		0.00186	0.00110		0.00882	0.0000709		0.0102	0.00496
Issuer FE		✓	✓		✓	✓		✓	✓
$\times$ Local Curr FE			✓			✓			✓

Note: OLS estimates of a sector's ownership indicator on the bond's remaining maturity in years. Column (1) of each group includes no fixed effects, column (2) adds issuer fixed effects, and column (3) adds the issuer $\times$ local-currency interaction, so the maturity coefficient in column (3) is identified within an issuer's bonds of a single currency. Standard errors in parentheses are clustered at the bond and date level.

Table A.5: Currency Preference Holding Governing Law Fixed

	Dependent Variable: h_{it}^j /Amount Out $_{it}$					
	Insurers		Banks		Open-End Funds	
<i>Panel A: Domestic-Law Bonds of AR, PH, CZ, RS, RO, CO, HU, PL</i>						
$\mathbb{1}\{\text{Local Currency}\}$	0.00297*** (0.000681)	0.00270*** (0.000751)	-0.0332*** (0.00420)	-0.0598*** (0.00429)	0.0208*** (0.00262)	0.0310*** (0.00287)
Bonds	1573	1573	1553	1553	1571	1571
Hard-currency bonds	249	249	249	249	249	249
R^2	0.00154	0.0563	0.00554	0.191	0.00516	0.0773
Issuer FE	✓		✓		✓	
<i>Panel B: Foreign-Law Bonds of DO, PH, CL</i>						
$\mathbb{1}\{\text{Local Currency}\}$	-0.0635*** (0.0101)	-0.0369*** (0.00870)	-0.0270*** (0.00392)	-0.0169*** (0.00337)	0.0498*** (0.0107)	0.0552*** (0.0108)
Bonds	110	110	107	107	110	110
Local-currency bonds	11	11	11	11	11	11
R^2	0.0202	0.286	0.0285	0.295	0.0111	0.0208
Issuer FE	✓		✓		✓	

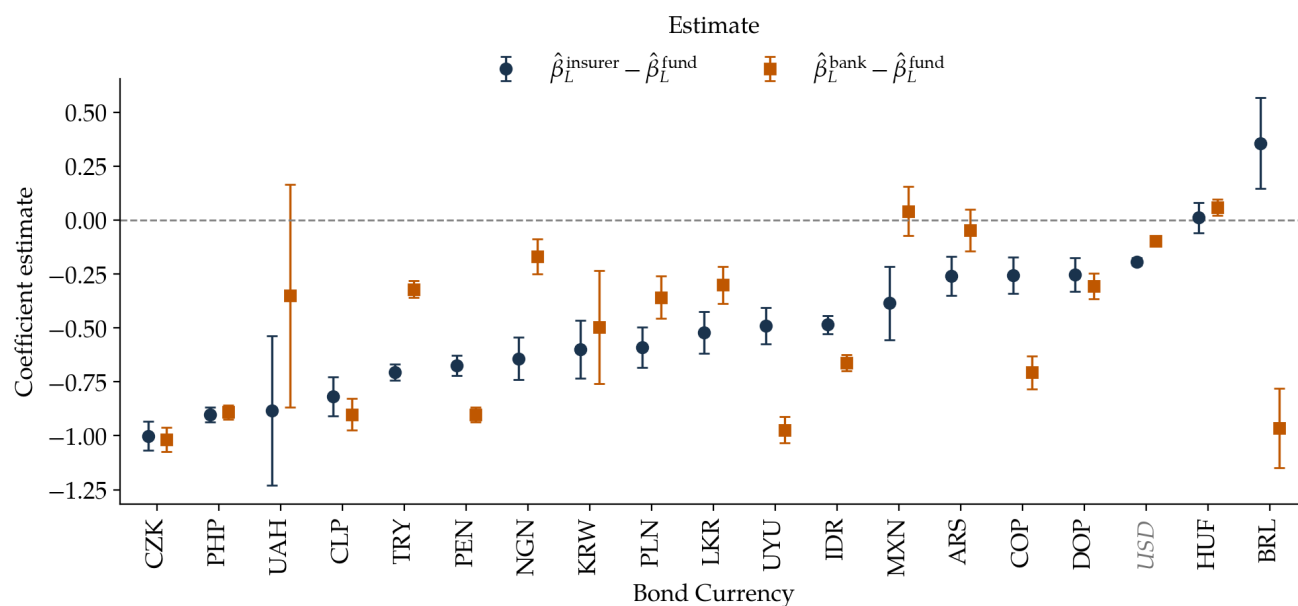
Notes: Bond-level regressions of the share of a bond held by a sector (amount held over amount outstanding, including zeros) on an indicator that the bond is in Local Currency, holding governing law fixed by sample. Panel A: Argentina, the Philippines, the Czech Republic, Serbia, Romania, Colombia, Hungary and Poland, the issuers with domestic-law hard-currency bonds; domestic-law bonds only, so domestically placed hard-currency bonds are compared with local-currency bonds. Panel B: the Dominican Republic, the Philippines and Chile, the issuers with foreign-law local-currency bonds; foreign-law bonds only, so local-currency global bonds are compared with the same issuers' foreign-law hard-currency bonds. Within each sector, the first column has no fixed effects and the second absorbs issuer fixed effects. "Bonds" counts unique bonds in the estimation sample; the row beneath counts those in the currency the sample is short of. China and India are excluded. Regressions are unweighted; standard errors in parentheses are not clustered.

Table A.6: Currency Preference Within Issuer and Governing Law

	Insurers			Banks			Open-End Funds		
<i>Panel A: Share conditional on owning, h_{it}^j / Amount Out$_{it}$</i>									
$\mathbb{1}\{\text{Local Currency}\}$	-0.186*** (0.0225)	-0.211*** (0.0359)	-0.240*** (0.0392)	-0.150*** (0.0160)	-0.0979*** (0.0135)	-0.109*** (0.0176)	-0.141*** (0.0168)	-0.0292 (0.0395)	-0.0336 (0.0389)
$\mathbb{1}\{\text{USD}\}$	-0.183*** (0.0210)	-0.178*** (0.0198)	-0.185*** (0.0194)	-0.106*** (0.0105)	-0.0893*** (0.0104)	-0.0852*** (0.0111)	-0.0773*** (0.0167)	-0.0761*** (0.0155)	-0.0879*** (0.0155)
Identifying N	9958	9944	9806	10582	10567	10435	20839	20822	20659
Within R^2	0.431	0.342	0.429	0.288	0.132	0.140	0.112	0.0313	0.0364
Issuer FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
x Governing Law		✓	✓		✓	✓		✓	✓
x Remaining Maturity Bucket			✓			✓			✓
<i>Panel B: $\ln(h_{it}^j / \text{Amount Out}_{it})$, size controlled</i>									
$\mathbb{1}\{\text{Local Currency}\}$	-4.705*** (0.226)	-4.585*** (0.470)	-4.975*** (0.348)	-4.816*** (0.328)	-5.221*** (1.156)	-5.706*** (1.010)	-1.571*** (0.211)	0.894 (0.860)	0.240 (0.543)
$\mathbb{1}\{\text{USD}\}$	-3.172*** (0.201)	-3.231*** (0.211)	-3.147*** (0.193)	-1.875*** (0.231)	-1.968*** (0.229)	-1.762*** (0.225)	-0.720*** (0.221)	-0.461** (0.213)	-0.453** (0.211)
Log Amount Outstanding	-0.347*** (0.0651)	-0.376*** (0.0791)	-0.398*** (0.0890)	-0.103 (0.136)	-0.0628 (0.121)	-0.0883 (0.122)	-0.00904 (0.0602)	0.0160 (0.0631)	0.0532 (0.0626)
Identifying N	9958	9944	9806	10582	10567	10435	20839	20822	20659
Within R^2	0.512	0.323	0.307	0.245	0.0712	0.0600	0.0517	0.0166	0.00827
Issuer FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
x Governing Law		✓	✓		✓	✓		✓	✓
x Remaining Maturity Bucket			✓			✓			✓
<i>Panel C: Ownership indicator, $\mathbb{1}\{h_{it}^j > 0\}$</i>									
$\mathbb{1}\{\text{Local Currency}\}$	-0.467*** (0.0415)	-0.0568 (0.100)	0.0289 (0.1000)	-0.450*** (0.0407)	-0.399*** (0.117)	-0.311*** (0.110)	-0.0474*** (0.0136)	-0.0495 (0.0410)	-0.0920* (0.0540)
$\mathbb{1}\{\text{USD}\}$	-0.0976** (0.0439)	-0.0827* (0.0467)	-0.0811* (0.0480)	0.0206 (0.0379)	-0.0251 (0.0362)	-0.0206 (0.0363)	-0.0169 (0.0115)	0.00270 (0.0103)	-0.00805 (0.0135)
Identifying N	21782	21766	21601	21782	21766	21601	21782	21766	21601
Within R^2	0.104	0.00352	0.00388	0.172	0.0259	0.0148	0.00489	0.00131	0.00301
Issuer FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
x Governing Law		✓	✓		✓	✓		✓	✓
x Remaining Maturity Bucket			✓			✓			✓

Notes: Bond-level regressions of a sector's holdings on the bond's currency (euro-denominated bonds left out) along a ladder of fixed effects: issuer; issuer $\times$ governing law; issuer $\times$ governing law $\times$ remaining-maturity bucket. Panel A: share of the bond held by the sector, among bonds it holds, weighted by the bond's share of its issuer's outstanding in that currency type and quarter. Panel B: log of that share with the log of the bond's amount outstanding as a control, unweighted. Panel C: indicator that the sector holds any of the bond, unweighted. Bonds with no governing law recorded, and bonds of China and India, are dropped. Standard errors in parentheses are clustered by bond and quarter.

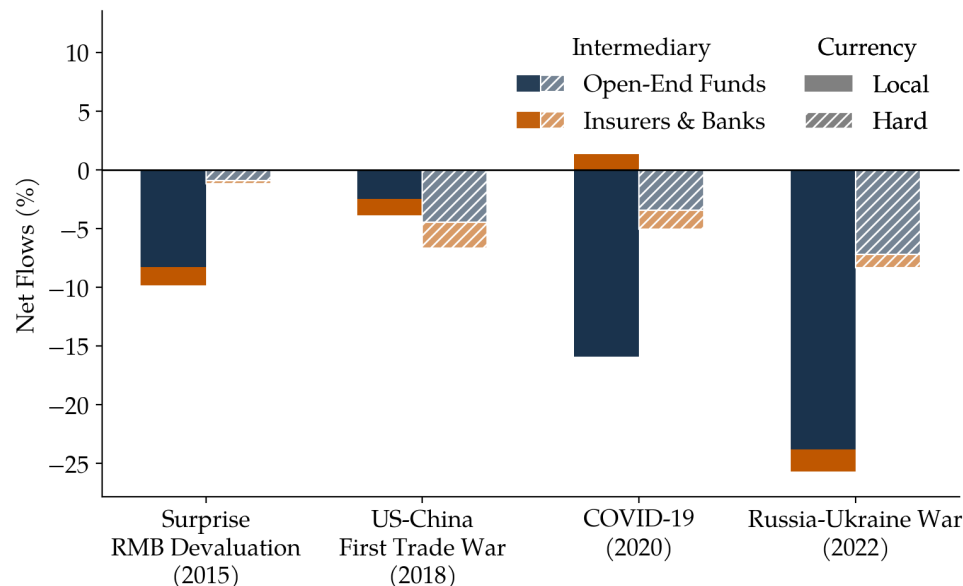
Figure A.4: Insurers' and Banks' Currency Preference Relative to Open-End Funds, by Bond Currency



Source: ECB SHS. Notes: For each bond currency, the difference between insurers' (circles) or banks' (squares) and open-end funds' coefficient on that currency in a linear probability model of whether the sector holds any of the bond, relative to an otherwise similar euro-denominated bond. Each sector's regression absorbs issuer $\times$ remaining maturity $\times$ debt type $\times$ size $\times$ coupon type fixed effects and quarter fixed effects. Bars are 95 percent intervals from a bootstrap of the three regressions jointly (500 replications). Currencies are ordered by the insurer difference. The Japanese yen and Swiss franc are not shown; the US dollar is the one hard currency shown, labeled in grey. Currencies without within-cell variation drop out of the estimation.

A.3.2 Additional results supporting Fact 2

Figure A.5: Investor Contributions to Capital Outflows, Local- and Hard-Currency Bonds



Source: ECB SHS. *Notes:* The decomposition of Figure 2 with Local- and Hard-Currency bonds side by side: solid bars are Local Currency and hatched bars Hard Currency, each computed over its own pre-episode holdings and its own worst quarter. Net purchases in each episode are cumulative changes in par amount held relative to holdings at the start of the episode, in bond-currency units at the pre-episode exchange rate, so currency valuation does not enter. Each bar is a sector's contribution to the total net selloff of euro-area investors in that currency, using pre-episode investor shares as weights. The orange segment is insurers and banks; pension funds and the residual sectors are not drawn.

Table A.7: Investor Contributions to Capital Outflows, by Issuer Country

	Local Currency			Hard Currency		
	Mean	SE	Median	Mean	SE	Median
<i>Panel A: Worst-case change in the sector's share of amount outstanding (percent)</i>						
Insurers	−0.05	0.04	−0.00	−0.24	0.18	−0.02
Pension Funds	−0.14	0.11	0.01	−0.06	0.02	−0.04
Banks	−0.74	0.48	−0.11	−0.78	0.39	−0.13
Open-End Funds	−2.05	0.57	−0.57	−1.18	0.13	−0.96
<i>Panel B: Contribution to the total net selloff, percent (net sales over pre-episode par holdings × pre-episode share)</i>						
Insurers	−0.32	0.21	−0.02	−0.31	0.22	−0.04
Pension Funds	−0.21	0.19	0.03	−0.17	0.06	−0.14
Banks	−2.86	1.53	−0.49	−1.50	0.55	−0.52
Open-End Funds	−13.61	2.50	−6.08	−5.31	0.70	−4.18

Source: ECB SHS. Notes: The decomposition of Figure 2 computed per issuer country, so each issuer has its own worst quarter, and summarized across issuers: the mean, its standard error, and the median, pooled over the four episodes. Insurers, pension funds and banks are separate sectors. Panel A is the sector's worst-case net sales in percent of the amount outstanding of the bonds it holds in that currency. Panel B is the sector's contribution to the total net selloff: its worst-case net sales in percent of its own pre-episode par holdings, times its pre-episode share of euro-area holdings, so contributions add up across sectors to the total net selloff, with the sectors not shown accounting for the remainder. Par amounts are in bond-currency units at the pre-episode exchange rate. Issuer × currency × sector cells with pre-episode holdings below one million euros are dropped before the statistics are taken.

A.3.3 Drawdown Construction

This appendix gives the detail behind the tests described in Fact 3 of Section 3 and reported in Table A.8. Let the drawdown on an individual bond i in a given episode $\mathcal{T}$ be $\zeta_{i,\mathcal{T}}$. The drawdown on bond i in capital-outflow episode $\mathcal{T}$ is the maximum loss on the bond over the episode,

$$\zeta_{i,\mathcal{T}} = \max_{t \in \mathcal{T}} \left\{ 1 - \frac{\prod_{s=\mathcal{T}_0}^{\mathcal{T}_{\max}} R_{i,s}}{\prod_{s=t_{i0}}^{\mathcal{T}_0} R_{i,s}} \right\}, \quad (25)$$

where $\mathcal{T}$ 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 the gross return in units of the bond currency.⁵⁵ Measuring the loss in bond-currency units means $\zeta_{i,\mathcal{T}}$ carries no exchange-rate valuation effect; the currency × episode fixed effects in the estimating equation absorb the common component of currency movements over the episode. We pool together individual bond

⁵⁵Note 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.

$i \times$ episode $\mathcal{T}$ observations and estimate

$$\zeta_{i\mathcal{T}} = \alpha_{\text{currency}(i) \times \mathcal{T}} + \sum_{j \in \{\text{Insurers, Banks, Funds}\}} \gamma_j \mu_{i,\mathcal{T}-4}^j + \Gamma'(\text{Bond FE}_{i,\mathcal{T}}) + \epsilon_{i,\mathcal{T}} \quad (26)$$

where the ex-ante share of bond i held by intermediary j is computed as

$$\mu_{i,\mathcal{T}_0-4}^j = \frac{h_{i,\mathcal{T}_0-4}^j}{\text{Amt Out}_{i,\mathcal{T}_0-4}},$$

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.⁵⁶ We include interacted fixed effects for the bond’s issuer, remaining maturity, size, and coupon type. We also include currency $\times$ episode effects, meaning we estimate each γ_j within bonds experiencing the same currency valuation effects.

⁵⁶The 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.

Table A.8: Intermediary Composition and Markdowns on Bonds During Capital Outflows

	Dependent Variable: Bond Drawdown $\zeta_{i\mathcal{T}}$ in Capital Outflow Period $\mathcal{T}$					
	Local Currency			Hard Currency		
Insurers ($\mu_{\mathcal{T}_0-4}^I$)	0.352 (0.306)	0.173 (0.212)	0.135 (0.171)	-0.0274** (0.0133)	0.0130 (0.0149)	-0.0153 (0.0160)
Banks ($\mu_{\mathcal{T}_0-4}^B$)	-0.0403*** (0.0138)	-0.167*** (0.0444)	-0.133* (0.0741)	-0.0740*** (0.0144)	-0.00505 (0.0167)	-0.00692 (0.0142)
Mutual Funds ($\mu_{\mathcal{T}_0-4}^F$)	0.00362 (0.0106)	0.0154* (0.00890)	0.0152* (0.00827)	0.0321 (0.0297)	0.0819*** (0.0235)	0.0236 (0.0179)
N	974	962	938	997	997	948
Bonds	479	471	455	409	409	391
Within R^2	0.00712	0.0337	0.0181	0.0416	0.0265	0.00304
Currency x Event FE		✓	✓		✓	✓
Issuer FE		✓	✓		✓	✓
x Remaining Maturity Bucket			✓			✓
x Debt Type			✓			✓
x Size			✓			✓
x Coupon Type			✓			✓
Other Holdings Controls	✓	✓	✓	✓	✓	✓

Notes: Table reports bond-level regressions of the form $\zeta_{i\mathcal{T}} = \alpha_{\text{currency}(i) \times \mathcal{T}} + \sum_{j \in \{\text{Insurers, Banks, Funds}\}} \gamma_j \mu_{i, \mathcal{T}_0-4}^j + \Gamma'(\text{Bond FE}_{i, \mathcal{T}}) + \epsilon_{i, \mathcal{T}}$, estimated separately on the local-currency subsample (columns 1–3) and the hard-currency subsample (columns 4–6), so every column is its own regression. Rows are the ex-ante holder sectors j ; the row labeled Mutual Funds is open-end funds. Within each subsample the three columns are three rungs of the fixed-effects ladder ticked at the foot of the table: none; currency $\times$ episode and issuer; and the most saturated characteristics interaction, issuer $\times$ remaining maturity $\times$ debt type $\times$ size $\times$ coupon type. Standard errors in parentheses are clustered at the bond level. The dependent variable is $\zeta_{i\mathcal{T}}$, the drawdown on the bond, defined in Appendix A.3.3. Sectoral ownership shares $\mu_{i, \mathcal{T}_0-4}^j$ are computed from the Securities Holdings Statistics, described in Section 2, four quarters before the episode opens. A coefficient is the maximum market-value loss on the bond (in percent / 100) associated with its being held in full by investor j , relative to a residual, unobserved investor, so a positive coefficient means a larger drawdown. There is one observation of $\mu_{i, \mathcal{T}_0-4}^j$ and one drawdown per bond i and episode $\mathcal{T}$. Every column carries the other sectors' holdings as controls.

A.4 Appendix to Section 5

This appendix collects the tables supporting Section 5. The first three tables validate Lemma 1. Table A.9 reports the relative value-at-risk of local-currency bonds at the 1-, 3- and 5-year horizons. Table A.10 reports the relative safety ratio. The subsequent three tables extend the tests of Proposition 1. Table A.12 estimates the bond-pair regression with exchange-rate moments in place of the safety-ratio gap. Table A.13 gauges the bias in β_λ from measurement error in the estimated safety ratio. Table A.14 reports the bond-level regressions at each horizon.

Table A.9: Estimated Relative Value-at-Risk in Local-Currency Bonds

	Q_{it}					
	1-year		3-year		5-year	
$1\{\text{Local Currency}\}, \pi = 10$	-5.507*** (1.358)	-6.826** (2.791)	-5.373*** (0.871)	-2.782 (2.681)	-5.713*** (0.795)	-3.895** (1.560)
$1\{\text{Local Currency}\}, \pi = 25$	-4.980*** (1.168)	-4.830* (2.536)	-4.742*** (0.762)	-2.339 (2.340)	-4.789*** (0.696)	-3.284** (1.314)
Identifying Bonds	2134	2134	1456	1456	862	862
Remaining Maturity FE	✓	✓	✓	✓	✓	✓
× Size	✓	✓	✓	✓	✓	✓
× Coupon Type	✓	✓	✓	✓	✓	✓
× Issuer		✓		✓		✓
Unconditional moments from sample						
Quantile, $\pi = 10$, Hard Currency	-6.41	-6.41	-0.90	-0.90	3.32	3.32
Quantile, $\pi = 25$, Hard Currency	1.60	1.60	4.31	4.31	6.20	6.20
Quantile, $\pi = 10$, Local Currency	-7.65	-7.65	-2.90	-2.90	-0.89	-0.89
Quantile, $\pi = 25$, Local Currency	-0.27	-0.27	0.87	0.87	1.81	1.81

Notes: Estimates of the conditional quantiles Q_{it} in (10), using quantile regressions of the form $Q_{\pi}[HPR_{it} | \text{Currency}_i, X_{it}] = \alpha(\pi) + \beta(\pi)1\{\text{Local Currency}_i\} + \Gamma'(\pi)X_{it}$. X_{it} are fixed effects for remaining maturity × size in the first column of each horizon, interacted with the issuer in the second. 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. The fixed-effects columns use the multi-step location-scale estimator of Machado and Santos Silva (2019).

Table A.10: Estimated Relative Safety Ratio of Local-Currency Bonds

	λ_{it}					
	1-year		3-year		5-year	
1 {Local Currency}, $\pi = 10$	-0.0395* (0.0206)	-0.0901*** (0.0185)	-0.0222 (0.0278)	-0.111*** (0.0277)	-0.0656* (0.0337)	-0.169*** (0.0315)
1 {Local Currency}, $\pi = 25$	-0.0212* (0.0119)	-0.0483*** (0.0136)	-0.0150 (0.0252)	-0.0789*** (0.0253)	-0.0350 (0.0316)	-0.117*** (0.0317)
Identifying Bonds	2293	2267	2118	2090	1809	1783
Remaining Maturity FE	✓	✓	✓	✓	✓	✓
× Size	✓	✓	✓	✓	✓	✓
× Issuer		✓		✓		✓
Year FE	✓	✓	✓	✓	✓	✓
Unconditional moments from sample						
$\bar{\lambda}_{\pi=10} \text{Hard Currency}$	0.806	0.806	0.719	0.719	0.695	0.695
$\bar{\lambda}_{\pi=25} \text{Hard Currency}$	0.893	0.893	0.842	0.842	0.816	0.816
$\bar{\lambda}_{\pi=10} \text{Local Currency}$	0.793	0.793	0.719	0.719	0.663	0.663
$\bar{\lambda}_{\pi=25} \text{Local Currency}$	0.888	0.888	0.840	0.840	0.806	0.806

Notes: OLS estimates of $\lambda_{it} = \alpha(\pi) + \beta_c(\pi) \mathbb{1}\{\text{Bond Currency}_i = c\} + \Gamma'(\pi)X_{it}$, the counterpart of equation (10) with the safety ratio of (9) as the outcome. λ_{it} is the π -th percentile of annualized euro holding-period returns over the column's horizon, divided by their mean, in a trailing 60-month window ending in December of year t ; at the bond level where the bond has at least 24 such returns and at the issuer $\times$ currency level otherwise. The two quantiles are estimated jointly, with every fixed effect interacted with π , so each coefficient equals its separate regression. The first column of each horizon absorbs remaining maturity $\times$ tenor $\times$ size $\times$ coupon type (within pair); the second adds the issuer (within issuer); both absorb year effects. λ_{it} is a generated regressor. We compute standard errors in parentheses from a calendar-time block bootstrap with 200 replications. Months are resampled in 12-month blocks jointly across bonds and λ_{it} is rebuilt from the resampled returns in each draw, and the regression is re-estimated. Stars use the normal approximation to the bootstrap standard error. The bottom panel reports unconditional sample means of λ_{it} by currency, for $\pi = 10, 25$.

Table A.11: Estimates of Value-at-Risk and Safety Ratio Using Bootstrapped Quantile Regressions

	Q_{it}		$Q_{it}/\mathbb{E}[\cdot c]$	
	1-year	3-year	1-year	3-year
$\mathbf{1}\{\text{Local Currency}\}, \pi = 10$	-6.826** (2.926)	-2.782 (2.229)	-0.0373 (0.0288)	-0.0218 (0.0647)
$\mathbf{1}\{\text{Local Currency}\}, \pi = 25$	-4.830* (2.479)	-2.339 (1.974)	-0.0177 (0.0248)	-0.00803 (0.0562)
Identifying Bonds	2134	1456	2134	1456
Remaining Maturity FE	✓	✓	✓	✓
× Size	✓	✓	✓	✓
× Coupon Type	✓	✓	✓	✓
× Issuer	✓	✓	✓	✓
	Unconditional moments from sample			
Unconditional, $\pi = 10$, Hard Currency	-6.41	-0.90	0.842	0.759
Unconditional, $\pi = 25$, Hard Currency	1.60	4.31	0.914	0.885
Unconditional, $\pi = 10$, Local Currency	-7.65	-2.90	0.855	0.754
Unconditional, $\pi = 25$, Local Currency	-0.27	0.87	0.923	0.845

Notes: This table takes an alternate approach to estimating the conditional quantile λ_{it} in equation (10), by estimating it in a quantile regression. All four columns are estimates from quantile regressions of the form in equation (10), with fixed effects absorbed by the multi-step location-scale procedure of Machado and Santos Silva (2019). Columns (1) and (2): the outcome is the annualized holding-period return over a 1- and a 3-year horizon, inclusive of coupon payments and exchange-rate valuation against the euro, in percentage points; these are the within-issuer columns of Table A.9. Columns (3) and (4): the outcome is the gross holding-period return over the column's horizon divided by its mean among bonds of the same currency type, so the local-currency coefficient is the difference in the ratio of the π -th percentile to the mean, Local minus Hard Currency: the quantile-regression counterpart of the safety ratio of (9). The means condition on currency type only, not on the fixed-effect cells. All columns absorb remaining maturity × size × coupon type × issuer fixed effects. Bootstrapped standard errors are reported in parentheses, with the bootstrap clustered at the bond level and, in columns (3) and (4), the currency means re-estimated in every draw. The unconditional rows are sample quantiles of returns by currency in columns (1) and (2) and sample ratios of the quantile to the mean of gross returns by currency in columns (3) and (4). Table A.10 reports OLS estimates with the safety ratio λ_{it} itself as the outcome.

Table A.12: Tests of Proposition 1 Using Issuer-Level Variation and Linearized Form

	Dependent Variable:			
	$\log \mu^L - \log \mu^H$	$\mu^L - \mu^H$	$\log \mu^L - \log \mu^H$	$\mu^L - \mu^H$
	Model-implied regressors		Exchange-rate regressors	
Safety-ratio gap $\log(1 - \hat{\lambda}^L) - \log(1 - \hat{\lambda}^H)$	0.374** (0.169)	0.238** (0.0807)		
Domestic financial depth, $\eta_{n,t}$	0.000784 (0.201)	-0.000658 (0.00731)	-2.107 (14.39)	-0.609** (0.226)
FX 75th percentile			0.116 (4.207)	0.0799 (0.0570)
CIP deviation, government bonds			-0.0105 (0.00798)	-0.000236** (0.0000949)
N	533	551	125	132
Within R^2	0.0327	0.0292	0.0114	0.0604
Year FE	✓	✓	✓	✓
Issuer FE	✓	✓	✓	✓

Notes: Estimates of equation (39) at $\pi = 25$ and the 1-year horizon. Bonds are grouped into cells of issuer $\times$ remaining maturity. An observation is a cell-year with both a local- and a hard-currency side. The dependent variable is the log gap in euro-area open-end fund shares between an issuer's local- and hard-currency bonds in columns (1) and (3), and the level gap in columns (2) and (4). Columns (1) and (2) use the safety-ratio gap, in logs, $\log(1 - \lambda_{n,t}^L) - \log(1 - \lambda_{n,t}^H)$, and in levels, $(1 - \lambda_{n,t}^L) - (1 - \lambda_{n,t}^H)$. Columns (3) and (4) replace it with exchange-rate moments: the 75th percentile of the exchange rate against the euro over a rolling 20-quarter window, and the CIP deviation on local-currency government bonds. Domestic depth is domestic assets to GDP. It enters in logs in columns (1) to (3) and in levels in column (4). All columns absorb year and issuer fixed effects. Standard errors in parentheses are clustered at the issuer level.

Table A.13: Measurement Error in the Safety-Ratio Gap

	Estimate	Bootstrap SE	$p, \beta_\lambda = 1$	N
OLS, 60-month window (Table 2, col. 3)	0.374	0.176	0.000	533
Split-sample IV: earlier half, instrumented by later half	1.641	13.519	0.962	328
Split-sample IV: later half, instrumented by earlier half	0.534	6.728	0.945	328
Split-sample IV: average of the two	1.087	10.108	0.993	328
Reliability of the 60-month gap (Spearman–Brown)	0.371	0.133		328
Implied β_λ : OLS / reliability	1.010			

Notes: Estimates of β_λ in equation (11), in logs, at $\pi = 25$ and the 1-year horizon. The first row is column (3) of Table 2, with $\hat{\lambda}$ computed over the trailing 60-month window. The split-sample rows recompute $\hat{\lambda}$ on two 24-month halves of that window, separated by 12 months so that no 1-year holding-period return falls in both, and instrument the safety-ratio gap computed on one half with the gap computed on the other, after partialling out $\log \eta^L$ and year and issuer fixed effects; the third split-sample row averages the two estimates. The reliability row is the Spearman–Brown reliability of the full-window gap, $2r / (1 + r)$, where r is the correlation between the two halves' residualized gaps. Under classical measurement error, OLS converges to the reliability times β_λ , so the last row divides the OLS estimate by the reliability. Standard errors are from an issuer-block bootstrap with 400 replications, issuers resampled with replacement; p -values test $\beta_\lambda = 1$, the model's prediction, using the normal approximation to the bootstrap standard error. The split-sample rows use the cell-years in which both halves are observed. Regressions are unweighted.

Table A.14: Sorting of Euro-Area Open-End Funds on the Safety Ratio and Market Depth

	$\log \mu_{U,t}^i$			
	1-year		3-year	
$\beta_\lambda: \log(1 - \lambda_{it})$	0.387** (0.142)	0.361*** (0.124)	0.148 (0.144)	0.213** (0.0900)
$\beta_\eta: \log \eta_{n(i),t}^L$	0.661* (0.339)	0.209 (0.262)	0.716** (0.327)	0.277 (0.243)
N	10248	9314	8836	8522
Bonds	2132	1974	1955	1844
Within R^2	0.0317	0.00977	0.0274	0.00530
Issuer $\times$ Year FE	✓	✓	✓	✓
Bond controls		✓		✓

Notes: The 1-year columns are columns (1) and (2) of main-text Table 2. Estimates of equation (38) on the bond-year panel of local- and hard-currency bonds. The dependent variable is the log share of par outstanding held by euro-area open-end funds. λ_{it} is the 25th percentile of annualized euro holding-period returns over the column's horizon, divided by their mean, in a trailing 60-month window. $\eta_{n(i),t}^L$ is domestic assets to GDP. All columns absorb issuer $\times$ year fixed effects. The second column at each horizon adds remaining maturity, size decile, coupon type and jurisdiction fixed effects. Regressions are unweighted. Standard errors in parentheses are clustered at the issuer level.

A.5 Price impact estimates and robustness tests

A.5.1 Alternative treatment measures

In this appendix, we consider alternative scalings of the treatment, based on fund portfolio weights. The main text focuses on μ_i^R because of its relevance to the two-step estimation in Section 6.2. The procedure described in Section 6 inevitably involves degrees of freedom which could, in principle, introduce bias or confounding variation into the treatments. Our approach to this concern is to ensure that no single choice made in the procedure drives the results.

The first alternative scales the same numerator by the fund holdings of the bond rather than by its amount outstanding:

$$\delta_i^R = \frac{\sum_{p \in \mathcal{P}^R} h_{ip,2021m12}}{\sum_p h_{ip,2021m12}}$$

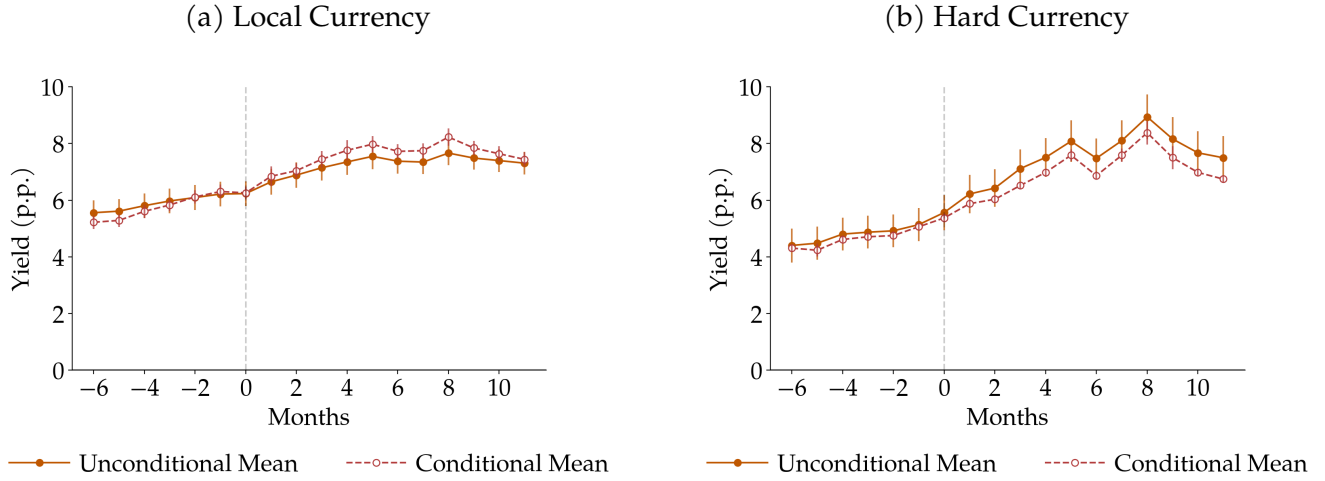
δ_i^R is the share of bond i 's fund holdings held by high- ω^R funds. It relates to the main-text treatment by $\mu_i^R = \mu_U^i \delta_i^R$, where μ_U^i is the share of the bond held by all funds (42).

A third treatment measure, which represents a different scaling of the same idea, computes the relative importance of bond i to high- ω^R funds. The *portfolio weight* of bond i in high- ω^R funds is

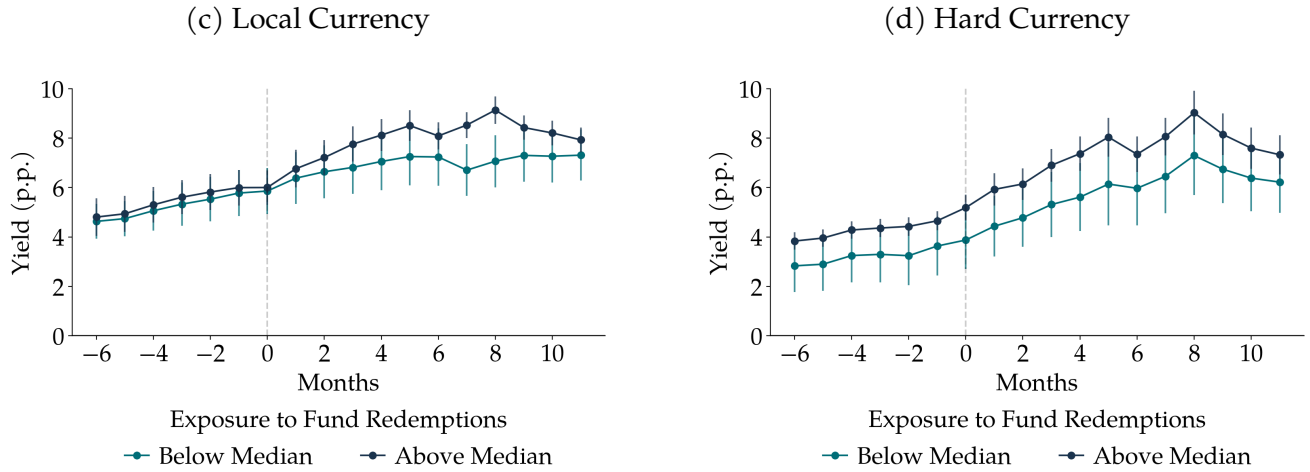
$$\omega_i^R = \frac{\sum_{p \in \mathcal{P}^R} h_{ip,2021m12}}{\sum_{p \in \mathcal{P}^R} \text{TNA}_{p,2021m12}}$$

where TNA refers to the total net assets of fund p . Both μ_i^R and ω_i^R 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 μ_i^R 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_i^R may be a more natural predictor of bond supply. We report results for both.

Figure A.6: Examination of Parallel Trends Assumption
Mean Bond Yields, Unconditional & Conditional on Bond Fixed Effects

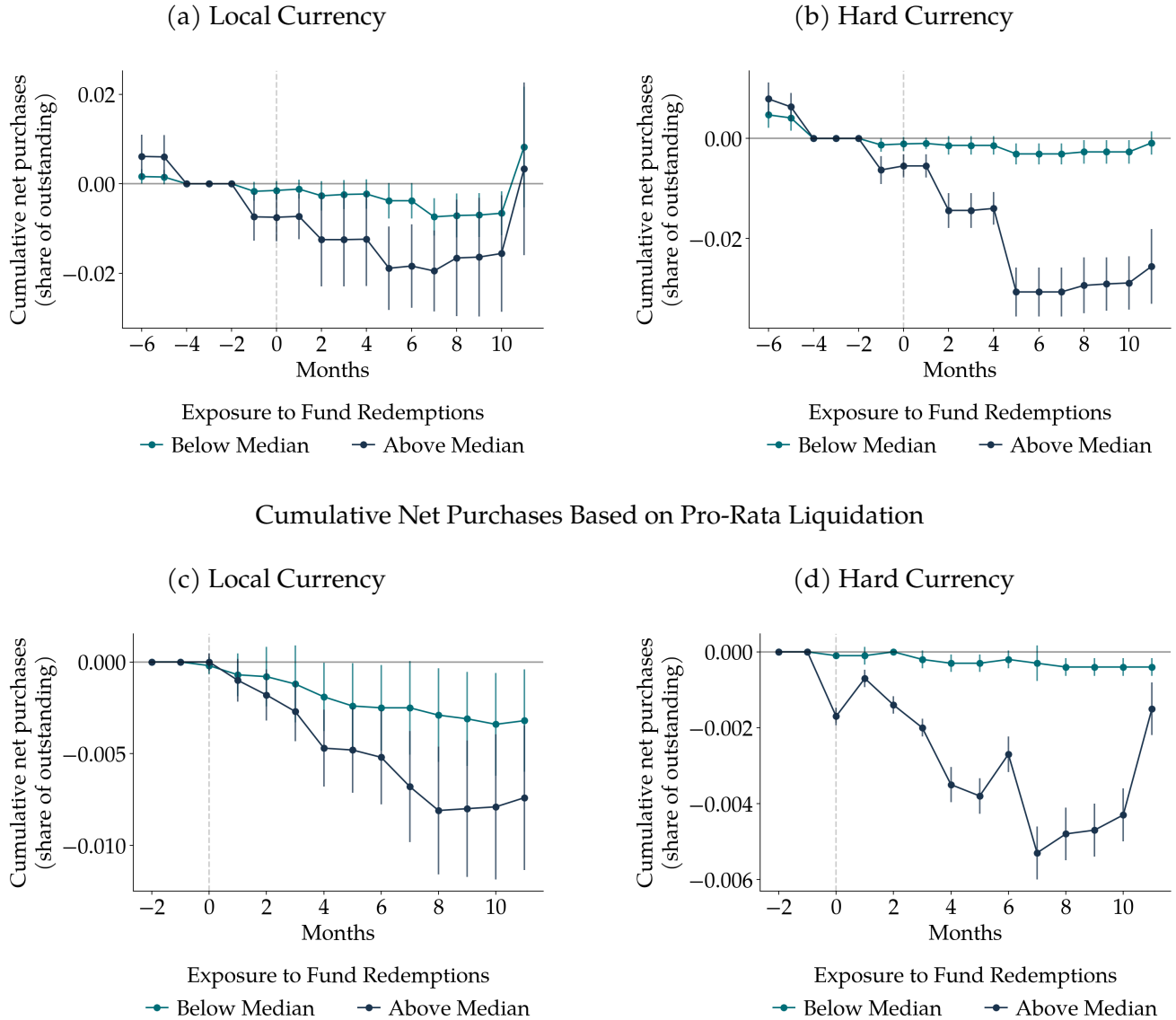


Bond Yields by Exposure to Mutual Fund Outflows



Notes: The figure plots mean annualized bond yields by month relative to February 2022, for local- and hard-currency bonds. Panels (a) and (b) compare the unconditional mean with the conditional mean. The conditional mean removes issuer $\times$ remaining maturity $\times$ size $\times$ coupon type $\times$ currency fixed effects from the yield and adds back the sample mean. Panels (c) and (d) split bonds into two treatment groups, below and above the median of μ_i^R , the share of the bond held by high-Russia-exposure funds in December 2021. The median is taken on the pooled sample. These means condition on treatment group only, not on bond observables. All means use the regression weights. The error bars are 90 percent confidence intervals assuming i.i.d. standard errors.

Figure A.7: Cumulative Changes in Holdings, by Exposure to Open-End Fund Redemptions
Cumulative Net Purchases by Euro-Area Open-End Funds



Sources: ECB SHS, Lipper. Notes: The figure plots unconditional means by month relative to February 2022, for bonds above and below the median of the treatment μ_i^R , with the bins cut on the pooled sample. The outcome is q_{it} , cumulative net purchases of the bond since the dose date (December 2021, the fourth quarter of 2021 in the SHS) as a share of the bond's par amount outstanding at that date, so negative values are net sales. Panels (a) and (b): euro-area open-end funds' holdings of the bond in the SHS, in par, quarterly, each month taking its quarter's value. Panels (c) and (d): Lipper funds' positions at the dose date, each moved only by its fund's cumulative net flows, so a fund meets redemptions by selling its portfolio pro rata; positions are valued in euros at dose-date prices. In each pair of panels the treatment and its median split are computed from that panel's holdings, so the two rows do not group the same bonds. Bands are 98 percent confidence intervals.

Table A.15: Open-End Fund Flows and Redemptions by Exposure to the Invasion

	Fund flow DiD		Peak monthly redemption ρ_p on $\mathcal{P}^R$	
	Post $\times \mathcal{P}^R$	Implied $\Delta\rho$	$\Delta\rho$	ρ_0
	% of TNA / month	% of TNA	% of TNA	% of TNA
$\mathcal{P}^R$: above-median exposure	-0.33 (0.16)	-4.33 (2.12)	-0.41 (1.11)	-9.88 (0.87)
Identifying portfolios	8,328	8,328	7,631	7,631
Portfolio-months	188,888	188,888		
$\mathcal{P}^R$ main effect	✓	✓		
Post main effect	✓	✓		

Notes: The unit of observation is a Lipper fund portfolio, which pools a fund's share classes. The monthly net flow of a portfolio is the median across its share classes of the share class's net flow in percent of its total net assets, after winsorizing share-class flows. $\mathcal{P}^R$ is defined on 31 December 2021. For each portfolio we compute the weight of securities issued by entities domiciled in Russia, Ukraine, former Soviet states, or states bordering Russia or Ukraine. Portfolios above the median of that weight are in $\mathcal{P}^R$. The indicator is fixed for the whole window. Column (1) reports γ from the regression $f_{pt} = \alpha + \beta \mathbb{1}\{t \geq 2022m2\} + \delta \mathbb{1}\{p \in \mathcal{P}^R\} + \gamma (\mathbb{1}\{p \in \mathcal{P}^R\} \times \mathbb{1}\{t \geq 2022m2\}) + \varepsilon_{pt}$ on portfolio-months from February 2021 through February 2023. The regression includes no fixed effects. Each portfolio is weighted by its peak total net assets over the window. Standard errors are clustered by portfolio. Column (2) multiplies γ by the 13 months from February 2022 through February 2023 and reports the result in percent of total net assets. It is the cumulative flow differential between $\mathcal{P}^R$ and other portfolios that the regression implies. Columns (3) and (4) use the redemption rate ρ_p of the model appendix. For each portfolio we compound its monthly flows from February 2022 onward, $c_{pt} = \prod_{s=2022m2}^t (1 + f_{ps}/100) - 1$, and set ρ_p to the minimum of c_{pt} over February 2022 through February 2023. ρ_p is therefore the peak cumulative net outflow in the window, as a share of total net assets, with a negative sign. A month with a missing flow contributes zero to the product. Portfolios with no observed flow in the window, or no total net assets in December 2021, are dropped. We then regress ρ_p on the $\mathcal{P}^R$ indicator with the same weights and robust standard errors. Column (3) is the coefficient, $\Delta\rho$, and column (4) the constant, ρ_0 . The identifying units are the 8,328 portfolios in the flow panel and the 7,631 portfolios with a redemption rate.

Table A.16: Examination of Constant Treatment Effects: DiD Estimates by Quartile of Treatment

Treatment:	Dependent Variable: Bond Yield y_{it}		
	μ_i^R	δ_i^R	ω_i^R
<i>Panel A: Local-currency subsample</i>			
Post $\times$ Quartile 2	0.651* (0.354)	1.121** (0.459)	0.798 (0.452)
Post $\times$ Quartile 3	0.739* (0.380)	1.156** (0.457)	0.759* (0.403)
Post $\times$ Quartile 4	0.769* (0.392)	1.087** (0.452)	0.905** (0.366)
N	7698	7721	7592
Identifying Bonds	397	398	390
<i>Panel B: Hard-currency subsample</i>			
Post $\times$ Quartile 2	0.699 (0.416)	-0.282 (0.384)	-0.623 (0.716)
Post $\times$ Quartile 3	-0.0817 (0.408)	0.225 (0.437)	-0.286 (0.695)
Post $\times$ Quartile 4	0.0480 (0.290)	0.546 (0.475)	-0.604 (0.653)
N	7471	7471	7450
Identifying Bonds	377	377	376
Month FE	✓	✓	✓
ISIN FE	✓	✓	✓
Issuer FE	✓	✓	✓
x Remaining Maturity Bucket	✓	✓	✓
x Size	✓	✓	✓
x Coupon Type	✓	✓	✓
x Currency	✓	✓	✓
Currency x Month FE	✓	✓	✓

Notes: The table reports estimates of $y_{it} = \alpha_i + \sum_{k=2}^4 \beta_k (\text{Post}_t \times \mathbb{1}\{\text{Treat}_i \in Q_k\}) + \mathbb{1}'V_{g(i),t} + \varepsilon_{it}$, where y_{it} is the annualized yield to maturity of bond i in month t , Post_t equals one from February 2022, and Q_k is the k -th quartile of the treatment named in the column header, cut within that treatment; the first quartile is the omitted group. The treatments are μ_i^R , δ_i^R and ω_i^R of equation (13). All columns include bond fixed effects and issuer $\times$ remaining-maturity bucket $\times$ size decile $\times$ coupon type $\times$ currency fixed effects and currency $\times$ month fixed effects. Panel A estimates the regression on local-currency bonds and Panel B on hard-currency bonds. The sample runs from December 2020 to August 2022. Observations are weighted by the bond's amount outstanding relative to its issuer's in that currency and month. Standard errors in parentheses are clustered by issuer and month.

A.5.2 Placebo and additional robustness tests for differences-in-differences analysis

Pooled DiD results.

Placebo tests and additional robustness. In Table A.17 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 A.18 we re-estimate the baseline price impact on local-currency bonds using two alternative weighting schemes for the cross-sectional bond variation. In table A.16 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. In Table A.18, we summarize the robustness of the treatment effects when estimated in a pooled differences-in-differences design. We report for each exercise the results from currency subsamples (Panels A and B) and for the full sample, estimated with a triple-difference term on local-currency. Throughout, standard errors are clustered at the issuer and month level, using a wild bootstrap procedure to account for the small number of issuer-clusters (24).

Table A.17: Placebo Tests for the Differences-in-Differences Design

	Dependent Variable: Bond Yield y_{it}			
	Placebo event date, treatment μ_i^R		Placebo treatment μ_i^{placebo}	
	– 6 months	+ 6 months	Bond FE + FX	Ccy $\times$ Month
Placebo estimate	0.0739 (0.0497)	-0.0423 (0.0794)	0.0147 (0.0517)	0.0333 (0.0659)
N	11820	11820	11891	12663
Identifying Bonds	368	368	370	398
Within RSq	0.000367	0.000177	0.0000159	0.0000794
F stat	2.216	0.284	0.0812	0.255
Mean Y	5.47	5.47	5.47	5.63
SE Y	3.73	3.73	3.72	3.71
Mean Treat	.0335	.0335	.0541	.0521
SE Treat	.0855	.0855	.171	.166
Month FE	✓	✓	✓	✓
ISIN FE	✓	✓	✓	✓
Issuer FE	✓	✓	✓	✓
x Remaining Maturity Bucket	✓	✓	✓	✓
x Size	✓	✓	✓	✓
x Coupon Type	✓	✓	✓	✓
x Currency	✓	✓	✓	✓
Currency x Month FE	✓	✓		✓

Notes: All columns estimate the pooled differences-in-differences specification of equation (12) on local-currency bonds, with the treatment scaled by its in-sample standard deviation. Columns (1) and (2) keep the treatment μ_i^R and move the event date: the post indicator switches on six months before the invasion, in August 2021, in column (1), and six months after, in August 2022, in column (2). Both absorb bond and month fixed effects, issuer fixed effects interacted with remaining-maturity bucket, size decile, coupon type and currency, and currency $\times$ month fixed effects, and include the change in the exchange rate as a control. Columns (3) and (4) keep the event date and replace the treatment with μ_i^{placebo} , the share of bond i 's amount outstanding held by all open-end funds in December 2021 rather than by the exposed funds. Column (3) absorbs the bond and issuer-interacted fixed effects and includes the exchange-rate control. Column (4) replaces the control with currency $\times$ month fixed effects. Standard errors in parentheses are clustered at the issuer and month level.

Table A.18: Robustness of the Price-Impact Estimates in a Pooled DiD Design

	Baseline: μ_i^R , post window to August 2022				Dependent Variable: Bond Yield y_{it} μ_i^R , Ccy $\times$ Month FE			Alternative treatment		ω_i^R , alternative weights	
	TWFE	Bond FE	Ccy $\times$ Month	+ Maturity	+ Issuer	Binned IV	Full window	δ_i^R	ω_i^R	WLS	OLS
										outst. wts.	unweighted
Panel A: Local-currency subsample											
Post $\times$ Treat	-0.114 (0.217)	0.00158 (0.194)	0.103 (0.0729)	0.118* (0.0640)	0.118* (0.0640)	0.0757 (0.0734)	0.0977 (0.0782)	0.250** (0.121)	0.192** (0.0756)	0.220** (0.0758)	0.210** (0.0880)
N Identifying Bonds	7937 397	7698 397	7698 397	7486 392	7486 392	7698 397	13026 401	7721 398	7592 390	6959 364	6977 364
Panel B: Hard-currency subsample											
Post $\times$ Treat	-0.117 (0.215)	-0.0507 (0.133)	-0.0507 (0.133)	-0.0287 (0.103)	0.0170 (0.0112)	-0.136 (0.132)	-0.165 (0.158)	0.352** (0.174)	-0.225 (0.148)	-0.152 (0.112)	-0.0599 (0.104)
N Identifying Bonds	7503 377	7471 377	7471 377	7471 377	7208 371	7471 377	13058 377	7471 377	7450 376	7447 376	7450 376
Panel C: Triple difference, local- and hard-currency bonds pooled											
Post $\times$ Treat	-0.142 (0.264)	-0.0629 (0.163)	-0.0621 (0.163)	-0.0352 (0.127)	0.0208 (0.0137)	-0.200 (0.177)	-0.203 (0.193)	0.504** (0.249)	-0.611 (0.403)		
Post $\times$ Local Currency $\times$ Treat	0.0356 (0.301)	0.0655 (0.207)	0.159 (0.176)	0.146 (0.150)	0.0896 (0.0594)	0.376* (0.184)	0.295 (0.205)	-0.293 (0.267)	0.753* (0.402)		
N Identifying Bonds	15440 774	15169 774	15169 774	14957 769	14694 763	15169 774	26084 778	15192 775	15042 766		
Month FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bond FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Issuer $\times$ Maturity $\times$ Size $\times$ Coupon $\times$ Ccy FE		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Currency $\times$ Month FE			✓	✓	✓	✓	✓	✓	✓	✓	✓
Currency $\times$ Month $\times$ Maturity FE				✓	✓					✓	✓
Currency $\times$ Month $\times$ Maturity $\times$ Issuer FE					✓						
Wild-bootstrap SE (issuer, month)	✓	✓	✓	✓	✓		✓	✓	✓		
FX control										✓	✓
Post window to Aug. 2022	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓

Notes: Estimates of equation (12) with y_{it} the annualized yield to maturity and $\text{Post}_t = 1$ from February 2022. Panel A: local-currency bonds; Panel B: hard-currency bonds; Panel C pools both currencies and estimates a triple-difference coefficient, $\text{Post} \times \text{Local Currency} \times \text{Treat}$. The estimation window is December 2020 to August 2022, except column (6), which extends it to December 2023. Columns (1)–(4) use μ_i^R of (13), standardized, and add successive fixed-effects which can be read from the bottom panel. Columns (5)–(8) have the fixed effects of column (3): (5) instruments μ_i^R with indicators for its quartiles; (6) uses the full window; (7) and (8) replace μ_i^R with δ_i^R and ω_i^R . Columns (9) and (10) test for stability of coefficients under various weighting schemes, e.g., by amount outstanding in (9) or not at all in (10). Other columns weight by the bond's amount outstanding relative to its issuer's in that currency type and month. Standard errors are clustered by issuer and month using a wild cluster bootstrap with 400 replications.

Table A.19: Net Local-Currency Issuance Response to the Open-End Fund Shock

	Dependent Variable: Net Local Currency Issuance $\tilde{\theta}_{n,t}$					
	Treatment: μ_i^R			Treatment: ω_i^R		
Post $\times$ Treat $_n^L$	-0.0555* (0.0297)	-0.0872** (0.0346)	-0.0697** (0.0311)	-0.0261 (0.0191)	-0.0463*** (0.0150)	-0.0365*** (0.0137)
Post $\times$ Treat $_n^H$			-0.00365 (0.0286)			-0.0305 (0.0332)
N	5658	5658	5658	5658	5658	5658
Identifying Cells	275	275	275	275	275	275
F stat	7.636	4.949	22.65	9.289	2.777	23.27
Mean Y	0.01	0.01	0.01	0.01	0.01	0.01
SE Y	0.45	0.45	0.45	0.45	0.45	0.45

Notes: Pooled differences-in-differences estimates of equation (19) at the level of cells n . Cells are size-weighted portfolios of bonds matched on issuer, remaining maturity, size, and coupon type, and contain both local- and hard-currency bonds. The dependent variable is net local-currency issuance within the cell, $\tilde{\theta}_{n,t} = \Delta \log(\text{Par out in Local Currency}_{n,t}) - \Delta \log(\text{Par out in Hard Currency}_{n,t})$, constructed from the CSDB and seasonally adjusted. Treat $_n^L$ and Treat $_n^H$ are the cell-level treatments of equation (19), built from the bond-level treatment μ_i^R in columns (1)–(3) and ω_i^R in columns (4)–(6), and scaled by their standard deviation. Within each treatment, the first column is the two-way fixed-effects estimator with cell and month fixed effects, the second adds the interacted bond fixed effects of the price-impact regressions excepting the currency $\times$ month fixed effects, and the third adds Post $\times$ Treat $_n^H$ as a control. Standard errors, in parentheses, are clustered at the issuer and date level using a wild bootstrap. *Sources:* Lipper, CSDB.

A.6 Derivation of the empirical tests in Section 6

In this appendix, we derive the empirical specifications of regressions (64) and the differences-in-differences regression in (12) from the model equations. To draw a link between the model equations and the regression specifications, we interpret atomistic unstable intermediaries as individual mutual funds and index them by p . We index bonds by i , with currency $c(i) \in \{L, H\}$, issuer $n(i)$, and par amount outstanding B_0^i .

The model of §4 assumes there is one margin of adjustment in supply in the bad-news state, which is the extensive margin of entry of unstable intermediaries. This note introduces two additional margins of supply that may be relevant in the data, derives how each enters the fire-sale discount $1 - \zeta$, and derives the regressions to test for the importance of these margins.

The appendix first derives the empirical regression of Proposition 1, then derives the event-study design from bond-market clearing equations, then derives the two-stage estimation procedure for the decomposition of average treatment effects used in Section 6.

A.6.1 Deriving the test of Proposition B.4

We start by decomposing bond-market clearing. Let $h_{ip} \geq 0$ be fund p 's pre-shock par holding of bond i . We extend the model of §4 to allow for the supply of bonds in the bad-news state to be affected by two additional variables, which we take here to be exogenous and given:

- Define the *redemption rate* $\rho_p \in [0, 1]$: the share of a fund p 's claims redeemed.
- The *liquidation intensity* $\phi_{ip} \equiv s_{ip}/(\rho_p h_{ip})$: sales relative to a pro-rata liquidation of the position, defined when $\rho_p h_{ip} > 0$. $s_{ip} \geq 0$ is the par amount of bond i sold by fund p .

Supply of bond i to outside investors is $S_i = \sum_p s_{ip}$. Multiplying and dividing by the fund-held stock and by the redemption-weighted stock to obtain the net supply:

$$\begin{aligned} \frac{S_i}{B_0^i} &= \frac{\sum_p s_{ip}}{B_0^i} \\ &= \frac{\sum_p h_{ip}}{B_0^i} \cdot \frac{\sum_p \rho_p h_{ip}}{\sum_p h_{ip}} \cdot \frac{\sum_p s_{ip}}{\sum_p \rho_p h_{ip}}. \end{aligned} \quad (27)$$

Define the three ratios

$$\mu_U^i \equiv \frac{\sum_p h_{ip}}{B_0^i}, \quad \bar{\rho}^i \equiv \frac{\sum_p \rho_p h_{ip}}{\sum_p h_{ip}}, \quad \bar{\phi}^i \equiv \frac{\sum_p s_{ip}}{\sum_p \rho_p h_{ip}} = \frac{\sum_p \rho_p h_{ip} \phi_{ip}}{\sum_p \rho_p h_{ip}}, \quad (28)$$

so that μ_U^i is the unstable share of the bond, $\bar{\rho}^i$ is the holdings-weighted redemption rate faced by the bond's fund holders, and $\bar{\phi}^i$ is the redemption-weighted average liquidation intensity. Then (27) is $\frac{S_i}{B_0^i} = \mu_U^i \bar{\rho}^i \bar{\phi}^i$. The model of §4 assumes $\rho_p = 1$ (full redemption) and, because each intermediary holds one bond, $\phi_{ip} = 1$. Then $S^c/B_0^c = \mu^c$.

Outside demand is given by the domestic investor demand curve in §4. Here, we assume that market depth per unit outstanding, η^c , is currency-specific, so that at the bond level

$$Q^i(P_b^i) = \eta^i (1 - \zeta^i), \quad \eta^i = \eta^{c(i)} B_0^i, \quad \zeta^i \equiv \frac{P_b^i}{\mathbb{E}_b[X^i]}. \quad (29)$$

Market clearing $S_i = Q^i$ gives $1 - \zeta^i = \frac{\mu_U^i \bar{\rho}^i \bar{\phi}^i}{\eta^{c(i)}}$, or, in logs,

$$\log(1 - \zeta^i) = \log \mu_U^i + \log \bar{\rho}^i + \log \bar{\phi}^i - \log \eta^{c(i)}. \quad (30)$$

The liquidation margin $\bar{\phi}$ has no counterpart in the model of §4, since there is no diversification motive and local- and hard-currency intermediaries of both types are completely separable.

We therefore simplify the analysis from here and assume $\bar{\phi} = 1$: I.e., we assume that funds liquidate bonds on a pro-rata basis in response to redemptions. It is easy enough to reintroduce $\bar{\phi}$ as a reduced-form parameter to the analysis below. Under this assumption,

$$\frac{S_i}{B_0^i} = \mu_U^i \bar{\rho}^i, \quad 1 - \zeta^i = \frac{\mu_U^i \bar{\rho}^i}{\eta^{c(i)}}. \quad (31)$$

Decomposition of equilibrium fire-sale discounts. The decomposition in (30) is a partial-equilibrium decomposition. In equilibrium, quantities do not determine the equilibrium fire sale discounts ζ^c because there is free entry into intermediation. We derive equilibrium discounts allowing for unstable intermediaries to anticipate a redemption rate of $\rho^c \leq 1$. The unstable intermediary liquidates a fraction ρ^c of its position at P_b^c and holds the remainder to maturity. Its profit per unit of bond c is

$$\Pi_U^c = \gamma P_b^c + \beta \left(b [\rho^c P_b^c + (1 - \rho^c) \mathbb{E}_b[X^c]] + g \mathbb{E}_g[X^c] \right) - P_0^c, \quad (32)$$

The stable-intermediary profit is unchanged from §4, but the zero-profits condition changes. Setting $\Pi_U^c = \Pi_S^c$ yields

$$1 - \zeta^c = \frac{\gamma (1 - \lambda^c)}{\gamma + \beta b \rho^c} \equiv \omega(\rho^c) (1 - \lambda^c), \quad \omega(\rho) \equiv \frac{\gamma}{\gamma + b \beta \rho}. \quad (33)$$

η^c does not appear in (33). Instead, market depth regulates how much supply (unstable intermediation) is needed to make prices competitive. This is Proposition 1(ii). At $\rho^c = 1$ we obtain the baseline discount of §4, $1 - \zeta^c = \omega(1 - \lambda^c)$. Market clearing (31) then gives the share of unstable intermediaries in market c :

$$\mu_U^c = \frac{\eta^c (1 - \zeta^c)}{\rho^c} = \frac{\eta^c \omega(\rho^c) (1 - \lambda^c)}{\rho^c}. \quad (34)$$

Empirical Counterpart to (34). Take logs and apply the free-entry condition bond-by-bond. For bond i with safety ratio $\lambda^i \equiv \underline{X}^i / \mathbb{E}_b[X^i]$, (34) reads

$$\log \mu_U^i = \log \eta_{n(i)}^{c(i)} + \log \frac{\omega(\rho^{c(i)})}{\rho^{c(i)}} + \log (1 - \lambda^i), \quad (35)$$

where depth is allowed to vary by issuer as well as currency. The three objects in this regression need empirical counterparts.

The safety ratio. λ^i is the ratio of the π -quantile of the bond's payoff to its mean, both in hard

currency. Its sample counterpart at horizon h is

$$\hat{\lambda}_{i,t}(\pi, h) \equiv \frac{Q_\pi [HPR_{i,t}(h)]}{\mathbb{E} [HPR_{i,t}(h)]}, \quad (36)$$

the π -quantile of the gross euro holding-period return of §5.1 divided by its mean, computed over a trailing window at the bond level or, where the bond-level window is short, at the issuer $\times$ currency level. This uses the same object as the quantile regressions in §5.1, which estimate $Q_\pi[HPR]$ by currency within issuer, and adds the normalization by the mean that the model requires.

Linearization. Under a lognormal approximation to the payoff, $\log X^i \sim N(m_i, s_i^2)$, the quantile is $\exp(m_i + s_i \Phi^{-1}(\pi))$ and the mean is $\exp(m_i + s_i^2/2)$, so

$$\begin{aligned} \log \lambda^i &= - \left| \Phi^{-1}(\pi) \right| s_i - \frac{s_i^2}{2}, \\ 1 - \lambda^i &\approx \left| \Phi^{-1}(\pi) \right| s_i \quad \text{to first order,} \quad \log(1 - \lambda^i) \approx \text{const} + \log s_i. \end{aligned} \quad (37)$$

The mean m_i drops out. Within issuer, the local-currency payoff variance exceeds the hard-currency variance by the exchange-rate variance and its covariance with the surplus, so the cross-currency gap in $\log s_i$ is driven by the exchange-rate moments that §5.2 uses as regressors. The direct measure (36) is preferable because it does not rely on the lognormal approximation, and because it uses the tail rather than the variance, which is what the model specifies.

Depth. We proxy η_n^L with the size of the domestic financial sector, measured as the domestic claims of financial corporations relative to nominal GDP. Domestic claims are the sum of claims on the private sector, the central government, and state and local governments, from the IMF Monetary and Financial Statistics. Nominal GDP is from the World Economic Outlook. We do not use the domestic share of sovereign debt from Arslanalp and Tsuda (2014) for this purpose. That share is one minus the share held by foreigners, so it is mechanically related to μ_U^i . There is no issuer-level proxy for η_n^H , so we treat it as common across issuers and absorb it in the currency effect.

Redemptions. $\omega(\rho^c)/\rho^c$ is currency-specific but time-invariant; therefore, a currency fixed-effect absorbs it.

Substituting into (35) and adding an issuer $\times$ year effect to absorb time-varying issuer fundamentals gives the regression

$$\begin{aligned} \log \mu_{U,t}^i &= \alpha_{n(i),t} + \alpha_{c(i)} + \beta_\lambda \log(1 - \hat{\lambda}_{i,t}) \\ &\quad + \beta_\eta \log \hat{\eta}_{n(i),t}^L \mathbb{1}\{c(i) = L\} + \Gamma' X_{it} + \varepsilon_{it}, \end{aligned} \quad (38)$$

The model predicts $\beta_\lambda = 1$ and $\beta_\eta = 1$. This regression uses variation across issuers in the difference of the safety ratio and domestic local-currency bond-market depth. The issuer $\times$ year effect absorbs the credit-spread and issuer-condition controls that §5.2 includes as proxies for $\mathbb{E}_b[X]$. The X_{it} are the bond controls of §3 and §5.2: remaining maturity, size, coupon type, jurisdiction. Aggregating to the issuer $\times$ year level, and differencing across currencies, gives the analogue of the §5.2 specification:

$$\log \mu_{n,t}^L - \log \mu_{n,t}^H = \alpha_t + \beta_\lambda \left[\log \left(1 - \hat{\lambda}_{n,t}^L \right) - \log \left(1 - \hat{\lambda}_{n,t}^H \right) \right] + \beta_\eta \log \hat{\eta}_{n,t}^L + \varepsilon_{n,t}. \quad (39)$$

The current §5.2 differs from (39) in three ways. It uses the level difference $\mu^L - \mu^H$ rather than the log ratio. It uses exchange-rate moments (volatility, right-tail quantile) in place of the safety-ratio gap, which is the linearized version (37). And it includes credit-spread and volatility controls that the model says belong inside $\hat{\lambda}$ or in the issuer $\times$ year effect. Because $\hat{\lambda}_{i,t}$ is a generated regressor, conventional standard errors on β_λ ignore its sampling error. We compute standard errors by a block bootstrap over issuers. Each draw re-estimates $\hat{\lambda}_{i,t}$ from the holding-period returns before re-estimating (38).

A.6.2 Identifying the residual demand elasticity η

The next task is to quantify the demand elasticity η , which determines equilibrium sorting of intermediaries and informs us in interpreting the price-impact measures estimated in the main body of the paper. We do this using the same treatments we construct in the main body of the paper, but reframe the treatments as shifters of bond-level redemption coefficients $\bar{\rho}^i$, in keeping with the model laid out above. In this section, we derive the estimation approach and assumptions under which these treatments can be used to identify η^c , a currency-specific elasticity.

Constructing redemption shifters $\bar{\rho}^i$. Partition funds into $\mathcal{P}^R$ (high pre-invasion exposure) and the rest, and write fund p 's realized post-invasion redemption rate as a function of their pre-invasion exposure.

$$\rho_p = \rho_0 + \Delta\rho \cdot \mathbb{1}\{p \in \mathcal{P}^R\} + e_p, \quad (40)$$

where $\Delta\rho$ is the redemption differential between high-exposure and other funds and e_p is fund-specific. $\Delta\rho$ is the reduced-form coefficient in the differences-in-differences regression of fund flows on the exposure indicator $\mathbb{1}\{p \in \mathcal{P}^R\}$, which Table A.15 reports. That regression puts the

differential at about 2 percent of TNA in the three months after the invasion. Substituting into $\bar{\rho}^i$:

$$\bar{\rho}^i = \frac{\sum_p \rho_p h_{ip}}{\sum_p h_{ip}} = \rho_0 + \Delta\rho \cdot \frac{\sum_{p \in \mathcal{P}^R} h_{ip}}{\sum_p h_{ip}} + \frac{\sum_p e_p h_{ip}}{\sum_p h_{ip}} = \rho_0 + \Delta\rho \delta_i^R + \bar{e}^i. \quad (41)$$

where δ_i^R is the treatment constructed in (13). Now substitute (41) into (31):

$$\frac{S_i}{B_0^i} = \rho_0 \mu_U^i + \Delta\rho \mu_i^R + \mu_U^i \bar{e}^i, \quad \mu_i^R \equiv \mu_U^i \delta_i^R = \frac{\sum_{p \in \mathcal{P}^R} h_{ip}}{B_0^i}. \quad (42)$$

μ_i^R is the share of the bond's outstanding held at high-exposure funds: the model's own quantity, the share of the bond held by intermediaries who will sell. The composition margin enters (42) through the *dose* μ_i^R , not through the coefficient on it.

DiD specification. Let y_{it}^* denote the yield at which bond i is priced at its fundamental value $\mathbb{E}_b[X^i]$ at t conditional on bad news. Let

$$y_{it}^* = \alpha_i + \mathbb{1}' V_{g(i),t} + v_{it}, \quad (43)$$

where α_i is a bond effect, $V_{g(i),t}$ a vector of bond-characteristic $\times$ date effects (e.g., issuer-level fundamental news, including war exposure, or currency $\times$ month valuations), and v_{it} idiosyncratic. Outside demand for bond i is linear in the spread between the market yield y_{it} and its fundamental yield y_{it}^* :

$$Q^i = \eta^{c(i)} B_0^i (y_{it} - y_{it}^*). \quad (44)$$

In (44), η^c is the par amount absorbed by outside investors, per unit outstanding and unit of yield wedge. Note the demand curve in the main text (29) is linear in the price discount $1 - \zeta^i$. The two demand curves are related by the local approximation for a bond with modified duration D_i (fixed at its pre-event value). Evaluating

$$y_{it} = a_i - \frac{1}{D_i} \log P_{it}, \quad (45)$$

where a_i is a bond-specific constant that depends on coupon and maturity with price P_{it} and fundamental value $\mathbb{E}_b[X^i]$,

$$\begin{aligned} y_{it} - y_{it}^* &= -\frac{1}{D_i} \left(\log P_{it} - \log \mathbb{E}_b[X^i] \right) = -\frac{1}{D_i} \log \zeta_{it}, \\ 1 - \zeta_{it} &\approx -\log \zeta_{it} = D_i (y_{it} - y_{it}^*). \end{aligned} \quad (46)$$

We estimate versions of the following Differences-in-Differences specification both in terms of the yield to maturity and in terms of the bond price-duration product to ensure that our estimates are not biased by the approximation above. We report the price-unit estimates in Appendix A.5.2. Market clearing after the bad-news shock, combined with (44) yields

$$\begin{aligned} \eta^c B_0^i (y_{it} - y_{it}^*) &= \mu_U^i \bar{\rho}^i B_0^i \\ y_{it} - y_{it}^* &= \frac{\mu_U^i \bar{\rho}^i}{\eta^{c(i)}}. \end{aligned} \quad (47)$$

The yield spread is zero before the shock and equal to (47) after, so $y_{it} = y_{it}^* + (\mu_U^i \bar{\rho}^i / \eta^{c(i)}) \text{Post}_t$. Substituting (43):

$$y_{it} = \alpha_i + \mathbb{1}' V_{g(i),t} + \frac{1}{\eta^{c(i)}} \mu_U^i \bar{\rho}^i \text{Post}_t + v_{it}. \quad (48)$$

The group $\times$ date effects enter (48) additively and are not scaled by duration, so, conveniently, additive fixed effects absorb them in cells of any duration composition. The error is v_{it} , which also, conveniently, features no duration scaling. The treatment coefficient is $1/\eta^c$. Unweighted OLS in yield units is therefore the specification implied by (43) and (44). For robustness, we also consider the price-unit outcome $-D_i y_{it}$ and the WLS with weights equal to the square of bond duration D_i^2 .

Interpreting the counterfactual yield. Throughout, we condition on a bond fixed effect α_i and the vector of fixed effects $V_{g(i),t}$. This means that, formally, the counterfactual for the post-event yield is not y_{it}^* , but rather the within-cell average of y_{it} after the shock. We implicitly assume that this within-cell average is centered on y_{it}^* . Let $\tilde{x}_{it}$ denote any variable residualized on $\{\alpha_i, V_{g(i),t}\}$. By Frisch–Waugh–Lovell,

$$\tilde{y}_{it} = \frac{\mu_U^i \bar{\rho}^i}{\eta^c} \widetilde{\text{Post}_t} + \tilde{\varepsilon}_{it}, \quad \tilde{\varepsilon}_{it} \equiv \tilde{v}_{it}. \quad (49)$$

$\mu_U^i \bar{\rho}^i / \eta^c$ in (49) is the bond's yield spread relative to a zero-dose bond in the same cell. The fixed

effects absorb any spread common to all bonds in the cell. Substituting (42):

$$\tilde{y}_{it} = \frac{\Delta\rho}{\eta^c} \widetilde{\mu_i^R \text{Post}_t} + \frac{\rho_0}{\eta^c} \widetilde{\mu_U^i \text{Post}_t} + \underbrace{\frac{\mu_U^i \bar{e}^i}{\eta^c} \widetilde{\text{Post}_t}}_{\tilde{u}_{it}} + \tilde{\varepsilon}_{it}. \quad (50)$$

With η^c and $\Delta\rho^c$ common to bonds within currency, (50) is the two-way fixed-effects regression

$$y_{it} = \alpha_i + \mathbb{1}' V_{g(i),t} + \beta^c (\mu_i^R \times \text{Post}_t) + \pi^c (\mu_U^i \times \text{Post}_t) + u_{it}, \quad (51)$$

$$\beta^c = \frac{\Delta\rho^c}{\eta^c}, \quad \pi^c = \frac{\rho_0}{\eta^c},$$

with u_{it} equal to $\tilde{u}_{it}$ in (50). The coefficients in (51) are identified if

$$\mathbb{E} \left[\left(\mu_i^R \times \text{Post}_t \right) u_{it} \mid \alpha_i, V_{g(i),t}, \mu_U^i \times \text{Post}_t \right] = 0, \quad (52)$$

which, reading off (50), requires two things. First, the treatment should be uncorrelated with $\mu_U^i \bar{e}^i$, meaning that idiosyncratic redemptions at the bond's other fund-holders should be uncorrelated with $\mathcal{P}^R$ exposure; second, it should be uncorrelated with post-shock idiosyncratic fundamental news v_{it} .

A.6.3 Estimating the decomposition (59)

The design estimates the slope β_{RF}^c in currency c . This exercise decomposes that estimand into the composition, redemption, and demand-depth margins of (31). Consider the two-stage system, estimated for each currency c ,

$$\text{FS: } \frac{S_i}{B_0^i} \text{Post}_t = \alpha_i + \mathbb{1}' V_{g(i),t} + \beta_{FS}^c (\mu_i^R \times \text{Post}_t) + \pi^c (\mu_U^i \times \text{Post}_t) + u_{it}, \quad (53)$$

$$\text{RF: } y_{it} = \alpha_i + \mathbb{1}' V_{g(i),t} + \beta_{RF}^c (\mu_i^R \times \text{Post}_t) + \pi_y^c (\mu_U^i \times \text{Post}_t) + \varepsilon_{it}, \quad (54)$$

$$\text{IV: } \beta_{IV}^c = \frac{\beta_{RF}^c}{\beta_{FS}^c}. \quad (55)$$

Formally, under (42), (50), and (57), we can estimate

$$\beta_{FS}^c = \Delta\rho^c, \quad \beta_{RF}^c = \frac{\Delta\rho^c}{\eta^c}, \quad \beta_{IV}^c = \frac{1}{\eta^c}. \quad (56)$$

The first-stage coefficient equals the redemption differential. The IV coefficient equals inverse demand depth. The identifying assumption for reading off the coefficients is the exclusion re-

striction

$$\mathbb{E} \left[\left(\mu_i^R \times \text{Post}_t \right) \tilde{\varepsilon}_{it} \mid \alpha_i, V_{g(i),t}, \mu_U^i \times \text{Post}_t \right] = 0, \quad (57)$$

$$\tilde{\varepsilon}_{it} = \tilde{v}_{it},$$

Relevance requires $\Delta\rho^c \neq 0$. $\Delta\rho^c$ is the redemption differential of $\mathcal{P}^R$ funds relative to others, weighted by their holdings of currency- c bonds. The reduced-form slope gives the average treatment effect on currency- c bonds relative to a zero-dose bond of the same cell,

$$\overline{\Delta y}^c \equiv \beta_{RF}^c \mathbb{E}^c[\mu_i^R] = \beta_{FS}^c \beta_{IV}^c \mathbb{E}^c[\mu_i^R]. \quad (58)$$

This is the average treatment effect on the treated of unstable intermediaries on the bond yield in currency c . Taking the ratio of treatment effects across currencies and logs allows us to decompose the differential yield impacts on local currency into four margins:

$$\log \frac{\overline{\Delta y}^L}{\overline{\Delta y}^H} = \underbrace{\log \frac{\mathbb{E}^L[\mu_U]}{\mathbb{E}^H[\mu_U]}}_{\text{sorting}} + \underbrace{\log \frac{\delta_L^R}{\delta_H^R}}_{\text{quasi-random exposure}} + \underbrace{\log \frac{\beta_{FS}^L}{\beta_{FS}^H}}_{\text{redemption } \Delta\rho^L / \Delta\rho^H} + \underbrace{\log \frac{\beta_{IV}^L}{\beta_{IV}^H}}_{\text{demand depth } \eta^H / \eta^L} \quad (59)$$

where $\bar{\delta}^c \equiv \mathbb{E}^c[\mu_U^i \delta_i^R] / \mathbb{E}^c[\mu_U^i]$ is the μ_U -weighted average exposure in currency c , so that $\mathbb{E}^c[\mu^R] = \mathbb{E}^c[\mu_U] \bar{\delta}^c$ by (42). The four margins are the ex-ante sorting of unstable intermediaries into the currency, the quasi-random exposure of those intermediaries to the shock, the ex-post redemption intensity, and the outside investor demand depth.

We estimate every piece: the dose from December 2021 holdings, β_{FS}^c and β_{IV}^c from (53)–(55). The sum is exact by construction. The share of margin k equals its term divided by the left-hand side. The redemption differential is also measurable directly from fund flows, as $\Delta\rho^c$ weighted by currency- c holdings. Under pro-rata liquidation $\beta_{FS}^c = \Delta\rho^c$, so the ratio $\beta_{FS}^c / \Delta\rho^c$ tests the pro-rata assumption and, if it differs from one, measures $\bar{\phi}^c$.

Table A.20: Summary of issuers included in bond sample

Country	<i>Averages Across Quarters</i>	
	Euro Area Holdings (EUR bn)	No. ISINs
AR	19.61	196.45
BR	27.23	63.41
CL	10.75	40.86
CN	16.20	232.61
CO	14.96	48.43
CZ	28.32	49.16
DO	6.13	51.41
EG	7.09	79.98
GE	0.22	8.70
GH	3.83	43.98
HU	14.31	57.09
ID	24.27	115.98
IN	5.07	101.64
IS	1.22	13.34
KE	1.81	19.84
KR	9.77	79.93
LK	3.79	42.32
MK	0.89	7.36
MX	39.59	91.00
NG	3.07	28.50
PE	9.05	42.66
PH	5.77	80.95
PL	38.83	69.89
RO	31.93	92.00
RS	3.30	46.05
RU	12.52	62.89
TH	7.81	40.91
TR	22.16	82.48
TW	0.20	10.30
UA	6.44	43.05
UY	4.64	28.25
ZA	20.83	40.32
Total (sum of rows)	401.61	2012

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 A.21: Summary of bond holdings sample by currency

Currency	<i>Averages Across Quarters</i>	
	Euro Area Holdings (EUR bn)	No. ISINs
<i>Hard Currencies</i>	193.90	785
ATS	0.00	1.00
BEF	0.00	1.00
CHF	0.59	6.32
DEM	0.14	12.02
EUR	85.92	208.23
GBP	0.46	12.20
HKD	0.00	1.00
ITL	0.08	6.34
JPY	1.07	20.02
USD	105.64	516.61
<i>Local Currencies</i>	208.12	1241
ARS	2.03	24.11
BRL	21.64	43.30
CLF	0.89	9.36
CLP	2.14	15.52
CNY	13.41	209.75
COP	7.93	23.77
COU	0.12	6.02
CZK	23.77	43.86
DOP	0.64	26.45
EGP	1.69	49.14
GEL	0.03	9.24
GHS	1.22	26.89
HUF	5.76	35.20
IDR	14.69	54.75
INR	5.07	101.64
ISK	0.20	8.75
KES	0.25	11.80
KRW	8.41	69.05
LKR	0.40	23.25
MKD	0.01	3.17
MXN	23.69	42.93
MXV	0.69	7.63
NGN	0.35	13.45
PEN	4.06	30.00
PHP	1.59	54.86
PLN	12.41	32.64
RON	12.13	45.23
RSD	0.66	20.07
RUB	8.32	38.05
THB	7.81	40.91
TRY	8.12	43.59
TWD	0.20	10.30
UAH	0.35	19.03
UYI	0.46	6.21
UYU	1.24	14.20
ZAR	15.74	26.39
All currencies	402.02	2025

A.6.4 Summary and Balance Tables for the SHS Sample

Table A.22: Balance Tables for Bond-Level Holdings Regressions

	Hard Currency	Local Currency
<i>Observations</i>		
Unique ISINs	647	466
N	9128	6132
<i>Bond Size</i>		
Amount Outstanding (mil. EUR)	1275	1524
<i>Coupon Type</i>		
Fixed	98.8	99.2
Variable	0.4	0.7
Zero	0.8	0.1
<i>Bond Rating</i>		
aa	3.7	1.2
a	15.2	7.7
bbb	49.6	61.9
bb	9.3	2.6
b	5.8	16.0
ccc	16.0	9.5
cc	0.5	1.1
<i>Remaining Maturity (Bucket)</i>		
30y+	15.3	7.8
20y	18.5	22.0
10y	36.0	27.0
5y	22.5	25.4
2y	6.7	16.4
3m	1.0	1.4
<i>Original Maturity (Bucket)</i>		
30y+	24.8	20.9
20y	28.8	28.6
10y	37.3	36.6
5y	8.3	12.0
2y	0.9	1.9
3m	0.0	0.0

Note: Sample for the bond-level holdings regressions of Table 1, split by currency type. Shares in percent. Amounts outstanding in millions of euros.

Table A.23: Balance Tables Split on Fund Holdings

<i>Bond-Level Treatment: Insurers' + Banks' Share</i>		
	Below Median	Above Median
<i>Observations</i>		
Unique ISINs	512	487
N	828	861
<i>Bond Size</i>		
Amount Outstanding (mil. EUR)	1879	1749
<i>Currency Type</i>		
Local Currency	68.2	29.4
Hard Currency	31.8	70.6
<i>Coupon Type</i>		
Fixed	97.0	97.0
Variable	1.4	2.3
Zero	1.6	0.7
<i>Bond Rating</i>		
aa	0.6	3.7
a	2.8	16.6
bbb	37.0	20.6
bb	5.7	1.9
b	5.7	11.3
ccc	9.9	1.6
cc	1.4	0.3
<i>Remaining Maturity (Bucket)</i>		
30y+	7.9	5.5
20y	15.8	8.8
10y	29.6	30.7
5y	26.2	28.1
2y	18.7	22.9
3m	1.8	4.1
<i>Original Maturity (Bucket)</i>		
30y+	21.4	10.5
20y	28.7	34.7
10y	30.6	42.2
5y	16.8	11.6
2y	2.5	1.0

Note: Sample for the markdown regressions of Table A.8, split at the median of the pre-episode ownership share of insurers and banks. Shares in percent. Amounts outstanding in millions of euros.

B Model appendix

This appendix has four parts. Appendix B.1 proves the results of Section 4: Lemma 1, Proposition 1, and Corollary 1, and characterizes corner equilibria. Appendix B.2 develops a model with bond mutual funds: contractual arrangements for the unstable intermediary, and a more general model in which repo funds and bond mutual funds coexist. Appendix B.3 collects further details on the model of Section 4 and its extensions: debt repayments, the risk-based capital regime, fire-sale arbitrageurs, and hedging. Appendix B.4 collects the derivations behind Section 7 and proves Lemma 2 and Proposition 2.

B.1 Proofs for Section 4

B.1.1 Equilibrium fire-sale discount and issue prices

Lemma B.1 (Equilibrium fire-sale discount and issue prices). *In competitive equilibrium, the fire-sale price, the fire-sale discount factor $\zeta^c \equiv P_b^c / \mathbb{E}_b[X^c]$, and the initial bond price P_0^c satisfy*

$$P_b^c = \omega \underline{X}^c + (1 - \omega) \mathbb{E}_b[X^c], \quad \zeta^c = \omega \lambda^c + 1 - \omega, \quad (60)$$

$$P_0^c = \gamma \underline{X}^c + \beta \mathbb{E}[X^c], \quad (61)$$

where $\omega = \gamma / (\gamma + b\beta)$ and $\lambda^c = \underline{X}^c / \mathbb{E}_b[X^c]$ are defined in (9).

Proof. From (5) and (7), the profits from intermediating bond c under the stable and unstable strategies are $\Pi_S^c = \gamma \underline{X}^c + \beta \mathbb{E}[X^c] - P_0^c$ and $\Pi_U^c = (\gamma + \beta)P_b^c + \beta g \mathbb{E}_g[X^c] - P_0^c$. Since $\mathbb{E}[X^c] = g \mathbb{E}_g[X^c] + b \mathbb{E}_b[X^c]$, we can write $\beta g \mathbb{E}_g[X^c] = \beta \mathbb{E}[X^c] - b\beta \mathbb{E}_b[X^c]$, so the unstable profit is $\Pi_U^c = (\gamma + b\beta)P_b^c + \beta \mathbb{E}[X^c] - b\beta \mathbb{E}_b[X^c] - P_0^c$. Imposing the free-entry condition $\Pi_S^c = \Pi_U^c$, the terms $\beta \mathbb{E}[X^c]$ and P_0^c cancel, leaving $(\gamma + b\beta)P_b^c = \gamma \underline{X}^c + b\beta \mathbb{E}_b[X^c]$. Dividing by $\gamma + b\beta$ gives the first expression in (60); dividing further by $\mathbb{E}_b[X^c]$ gives the second. Zero profits for the stable strategy, $\Pi_S^c = 0$, give (61).

Remark. The fire-sale discount is strictly positive, $1 - \zeta^c = \omega(1 - \lambda^c) > 0$, if and only if $\lambda^c < 1$: the capital floor lies below the expected bad-news payoff. We maintain $\lambda^c < 1$ for both bonds throughout. Since $\underline{X}^c(\pi)$ is nondecreasing in π and converges to the infimum of X^c as $\pi \rightarrow 0$, the condition holds for every sufficiently small π .

B.1.2 Proof of Lemma 1

Recall A1, $\pi < \Pr(Z < B)$, and A2, $\text{Cov}(Z, \mathcal{E}) \leq 0$ together with $\Pr(\mathcal{E} > 1 \text{ and } \mathcal{E} \geq \mathbb{E}_b[\mathcal{E}] \mid Z < B) = 1$. Let F_L and F_H denote the distributions of X^L and X^H conditional on bad news. Both are con-

tinuous, because $(Z, \mathcal{E})$ has a continuous joint distribution.

Part (i). Consider the probability that the local-currency bond pays no more than the hard-currency bond's capital floor, $F_L(\underline{X}^H(\pi))$. The hard-currency bond pays $\underline{X}^H(\pi)$ or less only in default states, since $\underline{X}^H(\pi) < 1$ under A1. In those states the local currency is worth less than one unit of hard currency (A2), so the local-currency bond pays even less:

$$X^L = X^H \mathcal{E}^{-1} < X^H \leq \underline{X}^H(\pi).$$

Every state in which the hard-currency bond breaches the threshold is therefore also a state in which the local-currency bond breaches it, and $F_L(\underline{X}^H) \geq F_H(\underline{X}^H) = \pi$. This alone implies only the weak ordering $\underline{X}^L(\pi) \leq \underline{X}^H(\pi)$.

The ordering is strict. By definition, $F_L(\underline{X}^H) = \Pr(X^L \leq \underline{X}^H)$. Splitting this event at the hard-currency bond's own breach — the event $\{X^H \leq \underline{X}^H\}$ is contained in it, since $\mathcal{E}^{-1} < 1$ in default —

$$F_L(\underline{X}^H) = \underbrace{\Pr(X^H \leq \underline{X}^H)}_{=\pi} + \Pr(\underline{X}^H < X^H \text{ and } X^H \mathcal{E}^{-1} \leq \underline{X}^H).$$

The last term collects the states in which the hard-currency bond pays strictly more than the floor, yet the depreciation is deep enough that the local-currency bond still pays less than it. Such states occur with positive probability: with positive probability the hard-currency bond pays just above the floor; every such state is a default state; and in default the local currency is worth strictly less than one unit of hard currency. Hence $F_L(\underline{X}^H) > \pi$. Continuity of F_L then delivers a strict quantile ordering: there exists $x' < \underline{X}^H(\pi)$ with $F_L(x') \geq \pi$, so $\underline{X}^L(\pi) \leq x' < \underline{X}^H(\pi)$.

Part (ii). The magnitude clause of A2 and Jensen's inequality bound the hard-currency value of the local currency in every default state by its bad-news average:

$$\mathcal{E}^{-1} \leq \frac{1}{\mathbb{E}_b[\mathcal{E}]} \leq \mathbb{E}_b[\mathcal{E}^{-1}].$$

In every state where the hard-currency bond breaches its floor — all of them default states — the local-currency bond therefore pays

$$X^L = X^H \mathcal{E}^{-1} \leq \underline{X}^H(\pi) \mathbb{E}_b[\mathcal{E}^{-1}].$$

It follows that $F_L(\underline{X}^H \mathbb{E}_b[\mathcal{E}^{-1}]) \geq \pi$, and hence

$$\underline{X}^L(\pi) < \underline{X}^H(\pi) \mathbb{E}_b[\mathcal{E}^{-1}], \quad (62)$$

where strictness follows from the same drag-in argument as in part (i). Turning to expected payoffs, write $X^L = X^H \mathcal{E}^{-1}$ and expand:

$$\mathbb{E}_b[X^L] = \mathbb{E}_b[X^H] \mathbb{E}_b[\mathcal{E}^{-1}] + \text{Cov}_b(X^H, \mathcal{E}^{-1}) \geq \mathbb{E}_b[X^H] \mathbb{E}_b[\mathcal{E}^{-1}]. \quad (63)$$

The covariance is nonnegative under A2. For any constant a , $\text{Cov}_b(X^H, \mathcal{E}^{-1}) = \mathbb{E}_b[(X^H - a)(\mathcal{E}^{-1} - \mathbb{E}_b[\mathcal{E}^{-1}])]$. Take $a = 1$. Then $X^H - 1 = -(1 - X)D \leq 0$, and it is nonzero only in default. In default, the magnitude clause of A2 gives $\mathcal{E} \geq \mathbb{E}_b[\mathcal{E}]$, so $\mathcal{E}^{-1} \leq 1/\mathbb{E}_b[\mathcal{E}] \leq \mathbb{E}_b[\mathcal{E}^{-1}]$ by Jensen's inequality, and the second factor is also nonpositive. The product is nonnegative in every state, so the covariance is nonnegative. Dividing (62) by $\mathbb{E}_b[X^L]$ and applying (63),

$$\lambda^L = \frac{\underline{X}^L(\pi)}{\mathbb{E}_b[X^L]} < \frac{\underline{X}^H(\pi) \mathbb{E}_b[\mathcal{E}^{-1}]}{\mathbb{E}_b[X^L]} \leq \frac{\underline{X}^H(\pi) \mathbb{E}_b[\mathcal{E}^{-1}]}{\mathbb{E}_b[X^H] \mathbb{E}_b[\mathcal{E}^{-1}]} = \lambda^H.$$

The proof uses A2 only in the states where losses exceed the capital threshold: depreciation — of above-average size — conditional on those states suffices. Appendix B.3.2 shows that in a lognormal parameterization the ordering in part (i) survives assumptions weaker still, allowing appreciation in default with positive probability.

B.1.3 Proof of Proposition 1

The Proposition states that under the assumptions of Lemma 1, $\mu^L > \mu^H$ for any $\theta \in [0, 1)$, and that the degree of sorting $\mu^L - \mu^H$ is (i) decreasing in the local-currency safety ratio λ^L and (ii) increasing in the elasticity of residual investors η .

Step 1: Fire-sale discounts. By Lemma B.1, free entry pins the fire-sale discount on each bond at $1 - \zeta^c = \omega(1 - \lambda^c)$. All dependence on c runs through the safety ratio λ^c ; $\omega = \gamma/(\gamma + b\beta)$ is common to both bonds and strictly positive because $\gamma > 0$.

Step 2: Market clearing. In the bad-news state, unstable intermediaries liquidate $\mu^c B_0^c$ units of bond c , and domestic investors absorb $Q^c(P_b^c) = \eta^c(1 - \zeta^c)$ by (8), with $\eta^c = \eta B_0^c$. Market clearing, condition (iii) of the equilibrium definition, gives $\mu^c B_0^c = \eta B_0^c(1 - \zeta^c)$, so that at an interior solution

$$\mu^c = \eta(1 - \zeta^c) = \eta\omega(1 - \lambda^c).$$

Step 3: *Sorting*. Subtracting,

$$\mu^L - \mu^H = \eta \omega (\lambda^H - \lambda^L). \quad (64)$$

By Lemma 1(ii), $\lambda^L < \lambda^H$, and therefore $\mu^L - \mu^H > 0$.

Step 4: *Comparative statics*. Both follow from (64).

- (i) $\partial(\mu^L - \mu^H)/\partial\lambda^L = -\eta\omega < 0$. The degree of sorting is decreasing in the local-currency safety ratio. An increase in right-tail exchange-rate risk, holding expected depreciation fixed, lowers λ^L and therefore raises the degree of sorting; in the lognormal parameterization of Appendix B.3.2, a larger σ_e widens $\sigma_{w-e} - \sigma_w$ and pushes $\underline{x}^L$, hence λ^L , down.
- (ii) $\partial(\mu^L - \mu^H)/\partial\eta = \omega (\lambda^H - \lambda^L) > 0$. The degree of sorting is increasing in the elasticity of residual investors.

Step 5: *Corners*. The interior formula in Step 2 applies when $\eta\omega(1 - \lambda^c) < 1$. In general, $\mu^c = \min\{1, \eta\omega(1 - \lambda^c)\}$. The all-stable corner $\mu^c = 0$ cannot arise: a vanishing unstable entrant would sell at fundamental value, $\zeta^c = 1$, and earn $\gamma (\mathbb{E}_b[X^c] - \underline{X}^c) > 0$. The all-unstable corner $\mu^c = 1$ arises exactly when $\eta\omega(1 - \lambda^c) \geq 1$; Appendix B.1.5 gives the derivation. Since $1 - \lambda^L > 1 - \lambda^H$, the ordering $\mu^L \geq \mu^H$ holds for every parameterization, with equality only when $\eta\omega(1 - \lambda^H) \geq 1$, in which case both markets are fully intermediated by unstable funding and $\mu^L = \mu^H = 1$. Strict sorting therefore holds whenever the hard-currency market is interior, which is the case the Proposition describes. If only the local-currency market is at its corner, $\eta\omega(1 - \lambda^L) \geq 1 > \eta\omega(1 - \lambda^H)$, then $\mu^L - \mu^H = 1 - \eta\omega(1 - \lambda^H)$: the degree of sorting is invariant to λ^L and decreasing in η . Comparative statics (i) and (ii) are therefore statements about interior equilibria.

B.1.4 Proof of Corollary 1

The Corollary states that in competitive equilibrium: (i) local-currency bonds trade at a deeper fire-sale discount in the bad-news state, $\zeta^L < \zeta^H$; and (ii) local-currency bonds issue at a larger discount relative to their expected payoffs, $P_0^L/\mathbb{E}[X^L] < P_0^H/\mathbb{E}[X^H]$.

Part (i). From Lemma B.1, $\zeta^c = \omega \lambda^c + 1 - \omega$. The fire-sale discount factor is a strictly increasing affine function of the safety ratio, with slope $\omega > 0$ common to both bonds. Since $\lambda^L < \lambda^H$ by Lemma 1(ii), $\zeta^L < \zeta^H$.

Part (ii). From Lemma B.1, $P_0^c/\mathbb{E}[X^c] = \gamma \underline{X}^c/\mathbb{E}[X^c] + \beta$. This is an increasing affine function of the unconditional safety ratio $\underline{X}^c/\mathbb{E}[X^c]$, with slope γ and intercept β independent of c . It

remains to show $\underline{X}^L / \mathbb{E}[X^L] < \underline{X}^H / \mathbb{E}[X^H]$. We use one further property of the good-news state:

$$\mathbb{E}_g[\mathcal{E}^{-1}] \geq \mathbb{E}_b[\mathcal{E}^{-1}], \quad (65)$$

the local currency is, in expectation, at least as depreciated after bad news as after good news. Under the normalization in Section 4, (65) reads $\mathbb{E}_b[\mathcal{E}^{-1}] \leq 1$. From the proof of Lemma 1, $\underline{X}^L < \underline{X}^H \mathbb{E}_b[\mathcal{E}^{-1}]$ by (62), and $\mathbb{E}_b[X^L] \geq \mathbb{E}_b[X^H] \mathbb{E}_b[\mathcal{E}^{-1}]$ by (63). Decomposing unconditional expectations across the two news states, with $X_g^L = \mathcal{E}^{-1}$ and $X_g^H = 1$,

$$\mathbb{E}[X^L] = g \mathbb{E}_g[\mathcal{E}^{-1}] + b \mathbb{E}_b[X^L] \geq g \mathbb{E}_b[\mathcal{E}^{-1}] + b \mathbb{E}_b[X^H] \mathbb{E}_b[\mathcal{E}^{-1}] = \mathbb{E}_b[\mathcal{E}^{-1}] \mathbb{E}[X^H],$$

where the inequality uses (65) for the first term and (63) for the second. Hence

$$\frac{\underline{X}^L}{\mathbb{E}[X^L]} < \frac{\underline{X}^H \mathbb{E}_b[\mathcal{E}^{-1}]}{\mathbb{E}[X^L]} \leq \frac{\underline{X}^H \mathbb{E}_b[\mathcal{E}^{-1}]}{\mathbb{E}_b[\mathcal{E}^{-1}] \mathbb{E}[X^H]} = \frac{\underline{X}^H}{\mathbb{E}[X^H]},$$

which gives $P_0^L / \mathbb{E}[X^L] < P_0^H / \mathbb{E}[X^H]$.

B.1.5 Corner equilibria

The solution in Section 4 and the proof of Proposition 1 characterize interior equilibria, $\mu^c \in (0, 1)$. Here we give the conditions under which a single strategy intermediates all of market c .

From the profit functions, the advantage of the unstable strategy at a fire-sale discount factor ζ^c is

$$\begin{aligned} \Pi_U^c - \Pi_S^c &= (\gamma + b\beta)P_b^c - \gamma \underline{X}^c - b\beta \mathbb{E}_b[X^c] \\ &= (\gamma + b\beta) \mathbb{E}_b[X^c] (\zeta^c - \omega \lambda^c - (1 - \omega)), \end{aligned}$$

where λ^c and ω are as defined in (9). The sign of the advantage is the sign of $\zeta^c - \zeta^{c*}$, where $\zeta^{c*} \equiv \omega \lambda^c + 1 - \omega$ is the interior fire-sale discount factor of Lemma B.1. Market clearing, $\mu^c B_0^c = Q^c(P_b^c)$ with demand (8), gives $\zeta^c = 1 - \mu^c / \eta$.

All-unstable corner ($\mu^c = 1$). At $\mu^c = 1$, market clearing gives $\zeta^c = 1 - 1/\eta$. The unstable strategy must remain weakly profitable at this price:

$$1 - \frac{1}{\eta} \geq \omega \lambda^c + 1 - \omega \iff \eta \omega (1 - \lambda^c) \geq 1.$$

Hence $\mu^c = \min\{1, \eta\omega(1 - \lambda^c)\}$. The corner arises when outside demand is elastic enough that liquidating the whole market does not push the price below ζ^{c*} . Because $\lambda^L < \lambda^H$, the local-currency market reaches this corner first: if $\mu^H = 1$, then $\mu^L = 1$.

All-stable corner ($\mu^c = 0$). This corner does not arise. At $\mu^c = 0$, a measure-zero unstable entrant liquidates at $\zeta^c = 1 > \zeta^{c*}$ and earns $\Pi_U^c - \Pi_S^c = \gamma(\mathbb{E}_b[X^c] - \underline{X}^c) > 0$.

B.2 A model with bond mutual funds

B.2.1 Contractual arrangements for the unstable-funding intermediary

A natural objection to the model is that the unstable-funding intermediary can be read as issuing short-term safe debt collateralized by the liquidation value of its portfolio, while the most prevalent open-end vehicles in our data are un-levered mutual funds. This appendix shows that the claims issued by the unstable funds need not be interpreted as debt-like to generate the main results and predictions of the model.

We start by proving that the model in Section 4 admits an equivalent representation in which unstable intermediaries can issue short-term, collateralized debt claims and redeemable equity claims interchangeably. We call unstable intermediaries which issue debt claims “repo funds” and those which issue redeemable equity claims “mutual funds.” Under this alternative interpretation of the model, we show that both repo funds and mutual funds coexist when the premium γ is sufficiently high, and have equivalent profit functions to that of the unstable intermediary in the main text.

We then write a more general model which nests the one in Section 4. In the generalized model, we allow that mutual funds may not earn the full money premium, but may earn a smaller premium from households for being redeemable. We show that even in this generalized setting, mutual funds coexist alongside the repo funds of the main text, and have a comparative advantage over stable intermediaries in intermediating local-currency debt.

Together, these results illustrate that the core intuition of the model in the main text does not rely on the claim of unstable intermediaries being debt- or money-like in literal terms, but rather on it being redeemable in the event of bad news. The core result — that financing local-currency bonds with stable funding is relatively expensive — holds in a more general model, and does not depend on a precise interpretation of the unstable intermediary in the main text.

We classify an intermediation strategy by its *funding stability* — stable (the portfolio is held to maturity) or unstable (the portfolio is exposed to early liquidation) — and by its *claim structure* — debt-like or equity-like. The unstable strategy of Section 4 can be implemented either as collateralized short-term debt or as redeemable equity. The two deliver the same profit function,

so every equilibrium object is unchanged. What distinguishes them is only whether the run is forced contractually or exercised as an option by households. Intermediaries issue the equity-like claim when, ex-ante, they expect that households find redemption incentive-compatible. A closed-end equity fund, which is stable but produces no money-like claim, is strictly dominated by other strategies and operates at zero measure under all parameterizations. Together, these results formalize the claim in Section 4 that the funding schemes which produce money-like claims reduce to the stable and unstable strategies.

Unstable equity claims. Consider an unstable fund issuing a single class of *redeemable equity*. Each share can be redeemed on demand at net asset value, met by liquidating the portfolio, and there is no debt on the balance sheet. The money-likeness of the claim arises not from a repayment promise but from the redemption option: in any state, the household can convert the share into hard-currency consumption at the prevailing net asset value and place the proceeds in storage. In the good-news state the share is worth the going-concern value of the bond and households do not redeem. Conjecture that in the bad-news state they do, so the fund liquidates at P_b^c . The claim is then money-like up to $M_U^c = P_b^c$, the amount deliverable in *every* state. This means that the enterprise value of the vehicle is equal to the expected market value of the fund (i.e., NAV) plus an additional premium provided because the equity is redeemable.

$$\Pi_U^c = \underbrace{\gamma M_U^c}_{\text{liquidity premium}} + \underbrace{\beta (b M_U^c + g \mathbb{E}_g[X^c])}_{\text{expected net asset value}} - \underbrace{P_0^c}_{\text{cost of bond}} \quad (66)$$

which, at $M_U^c = P_b^c$, rearranges to

$$\Pi_U^c = \underbrace{(\gamma + \beta) P_b^c}_{\text{value of redeemable claims}} + \underbrace{\beta g (\mathbb{E}_g[X^c] - P_b^c)}_{\text{value of residual equity}} - P_0^c, \quad (67)$$

exactly the unstable-funding profit (7) of the main text with the collateral constraint binding. Under this reading, γ is the liquidity value of same-day net-asset-value redeemability rather than the safety of a debt contract.

The conjecture requires that redemption be optimal. A household arriving at the bad-news state weighs the safe value locked in by redeeming, $(\gamma + \beta)P_b^c$, against the risky expected payoff of staying in, $\beta \mathbb{E}_b[X^c]$:

$$(\gamma + \beta) P_b^c \geq \beta \mathbb{E}_b[X^c] \quad \Longleftrightarrow \quad \zeta^c \geq \frac{\beta}{\gamma + \beta}. \quad (68)$$

The redemption region in ζ -space is $[\beta/(\gamma + \beta), 1]$ and widens as γ rises. Substituting the equi-

librium fire-sale discount $\zeta^c = \omega\lambda^c + 1 - \omega$ from Lemma B.1 reduces (68) to a condition on primitives.

Lemma B.2 (Region of definite redemption). *In the interior equilibrium, foreign households redeem their claims on the open-end fund in the bad-news state if and only if*

$$(\gamma + \beta)\lambda^c \geq \beta g \iff \gamma \geq \underline{\gamma}^c \equiv \beta \frac{g - \lambda^c}{\lambda^c}, \quad (69)$$

where λ^c is the safety ratio of bond c defined in (9). The threshold $\underline{\gamma}^c$ is decreasing in λ^c and in the crisis probability b , and is independent of the outside-demand elasticity η . If $\lambda^c \geq g$, then $\underline{\gamma}^c \leq 0$ and households redeem for every $\gamma \geq 0$.

Proof. Substitute $\zeta^c = \omega\lambda^c + 1 - \omega$ into (68) and rearrange:

$$\omega\lambda^c + 1 - \omega \geq \frac{\beta}{\gamma + \beta} \iff \omega(1 - \lambda^c) \leq \frac{\gamma}{\gamma + \beta} \iff (\gamma + \beta)(1 - \lambda^c) \leq \gamma + b\beta,$$

using $\omega = \gamma/(\gamma + b\beta)$ and dividing by $\gamma > 0$ in the last step. Expanding and canceling γ , the last inequality reads $\beta - \lambda^c(\gamma + \beta) \leq b\beta$, i.e. $(\gamma + \beta)\lambda^c \geq (1 - b)\beta = g\beta$. Dividing by λ^c gives the threshold form; the comparative statics and the $\lambda^c \geq g$ corner follow by inspection of $\underline{\gamma}^c = \beta(g/\lambda^c - 1)$.

The condition gathers the mechanism into one inequality. A stronger money motive raises the value of converting the claim into a safe store relative to the forgone upside, so redemption is sustained at high γ . A higher safety ratio raises the equilibrium liquidation value and shrinks the forgone upside, so $\underline{\gamma}^c$ falls with λ^c . And the equity upside arrives only with probability g : as $b \rightarrow 1$, $\underline{\gamma}^c \rightarrow -\beta$ and redemption is automatic. Because $\lambda^L < \lambda^H$ (Lemma 1), the threshold is ordered $\underline{\gamma}^L > \underline{\gamma}^H$: sustaining voluntary redemption in the riskier local-currency market requires a strictly stronger liquidity motive.

Unstable debt claims. A vehicle which finances the bond with one-period collateralized debt (repo) plus equity has expected profits equal to (7) in the main text:

$$\Pi_{\text{repo}}^c = (\gamma + \beta)P_b^c + \beta g(\mathbb{E}_g[X^c] - P_b^c) - P_0^c, \quad (70)$$

also identical to (67). The repo-financed hedge fund and the open-end mutual fund are, at certain values of γ , the same intermediary; the only difference is that the repo form does not require the households' redemption option to be exercised.

Closed-end equity is dominated. If instead shares cannot be redeemed before $t = 2$ and the fund holds the bond to maturity behind a single class of non-redeemable equity, the claim carries no contractual floor and backs no money-like claims: $M_{CE}^c = 0$ and $\Pi_{CE}^c = \beta \mathbb{E}[X^c] - P_0^c$.

Lemma B.3 (Closed-end equity is dominated). *For any bond with $\underline{X}^c > 0$ and any $\gamma > 0$, $\Pi_S^c - \Pi_{CE}^c = \gamma \underline{X}^c > 0$: the closed-end fund is strictly dominated by the stable-funding strategy and operates at zero measure.*

Proof. Subtracting, $\Pi_S^c - \Pi_{CE}^c = \gamma \underline{X}^c > 0$. Equivalently, for a hold-to-maturity intermediary choosing a senior money-like claim $M \in [0, \underline{X}^c]$, the objective $(\gamma + \beta)M + \beta \mathbb{E}[(X^c - M)\mathbb{1}\{X^c \geq M\}] - P_0^c$ has derivative $(\gamma + \beta) - \beta = \gamma > 0$ on $[0, \underline{X}^c]$, where $\mathbb{1}\{X^c \geq M\} = 1$ in every state; the optimum is the corner $M = \underline{X}^c$, which is the stable strategy.

Declining to tranche off the guaranteed floor leaves γ per unit on the table; the closed-end fund is the $M = 0$ corner of the stable strategy and is never chosen.

We summarize these results together into the following statement.

Proposition B.1 (Contractual irrelevance). *In any equilibrium with $\gamma > 0$, for each bond c : (i) the closed-end equity strategy operates at zero measure; (ii) a share $1 - \mu^c$ of the bond is intermediated by the stable, debt-like strategy and a share μ^c by unstable strategies, with μ^c exactly as in Proposition 1, regardless of the contractual form of unstable financing; (iii) the unstable strategy can be implemented as redeemable equity if and only if $\gamma \geq \underline{\gamma}^c$. If this is the case, the debt-like and equity-like implementations deliver identical profits, so the split between them is indeterminate.*

Corollary B.1 (Composition of unstable intermediation). *Since $\lambda^L < \lambda^H$ implies $\underline{\gamma}^L > \underline{\gamma}^H$, and assuming $0 < \underline{\gamma}^H < \underline{\gamma}^L$: (a) if $\gamma < \underline{\gamma}^H$, all unstable financing in both markets is debt-like; (b) if $\underline{\gamma}^H \leq \gamma < \underline{\gamma}^L$, the equity-like (mutual-fund) form operates in the hard-currency market only; (c) if $\gamma \geq \underline{\gamma}^L$, both forms operate in both markets. In every region $\mu^L > \mu^H$. If $\lambda^H \geq g$, then $\underline{\gamma}^H \leq 0$ and region (a) is empty.*

The sorting result is thus robust to the contractual interpretation of the unstable intermediary. It does not require that mutual funds issue debt, only that their liabilities are made more valuable to households by the option to redeem them. The choice of label changes the interpretation of γ : it reflects not only the safety of senior debt but also the liquidity value of same-day redemption. The corollary also states that redeemable equity is easier to sustain with safer bonds, whose fire-sale haircut is smaller in equilibrium.

Money-likeness as convertibility. The equivalence result above states that a claim structured as redeemable equity earns some of the "money premium." This claim is easier to swallow if we

expand the definition of money-likeness to include convertibility. In our model, money-likeness need not derive solely from the safety of a claim. The definition can be broader: a claim is money-like if it can be turned into a guaranteed unit of $t = 2$ consumption at some point within the life of the economy, either by holding it to maturity, by reselling it at par, or by redeeming it and storing the proceeds. Two primitives make this interpretation concrete. First, *storage*: households have access to a technology that converts one unit of hard-currency consumption at $t = 1$ into one unit at $t = 2$; intermediaries do not. Second, *liquidity*: the household-to-household resale market for money-like claims is perfectly elastic, even while the $t = 1$ bond market has finite elasticity η .

Under these primitives, the premium γ may be interpreted as a premium on convertible claims. A claim on a stable intermediary is guaranteed at $t = 2$ by construction, and a household with an interim liquidity need can hypothetically resell it at $t = 1$ to another household at its face value of one. A claim on an unstable intermediary carries no $t = 2$ guarantee; the household makes it safe by redeeming at $t = 1$ and placing the proceeds in storage. Read this way, γ is a premium not on safety as such but on *convertibility*. With free storage and a deep resale market for money-like claims, the safety and liquidity interpretations of γ overlap.

Alternative microfoundations for the collateral advantage of hard currency. The advantage of hard-currency debt in collateralizing long-term claims in hard currencies 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 earn a premium by contracting to buy and manage an asset 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. In D. W. Diamond (1991), Myers and Rajan (1998), and D. W. Diamond and Rajan (2001), 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 verifica-

bility 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.2.2 A more general model with bond mutual funds

In this appendix, we extend the model to feature explicit bond mutual funds which issue redeemable equity claims to households. We make two modifications to the model in the main text. The first modification is to household preferences. Households retain an explicit preference for claims which are contractually money-like: senior, liquid, safe, and debt-like. Households may also be willing to delegate some of their savings to outside asset managers (like a bond mutual fund), but pay a premium if those savings are redeemable at market value at any time. The second premium is the value of the redemption option. We view this set of assumptions as capturing, in a simple way, the idea that redeemability makes delegating asset management more feasible or desirable.

The second modification is that we allow for a gradient of bad-news states to arrive in $t = 1$. This assumption expands the state space of the model, and generates a role for equity-like claims that is distinct from the role of the repo-like claim in the main text. With a bigger state space, the mutual-fund share has option value which exceeds the value of the repo in some states, and thus operates in positive measure from $t = 0$.

The core results from this model extension are summarized in Propositions [B.2](#) and [B.4](#). The first states that for a range of values for the redemption premium, both repo funds and bond mutual funds operate in positive measure, generate fire sales in potentially different states of the world, and participate in both local- and hard-currency bond markets. The second result states the parallel result to Proposition [1](#) in the main text: Mutual funds have a comparative advantage in financing local currency. Proposition [B.4](#) states that under regularity assumptions which extend assumptions A1-A2 to this expanded state space, local-currency bonds are disproportionately held by mutual funds and subject to fire sales.

The intuition parallels that of the simpler model. The stable and repo strategies are constrained in issuing claims that they can contractually repay in every state of the world, which

limits their ability to earn the money premium on bonds with fundamental downside risk.⁵⁷ Local-currency depreciations constrain money creation by both stable and repo funds, and create a comparative advantage for mutual funds. The mutual fund earns its premium on redemptions in mild states, where liquidation values stay close to fundamentals and future fundamental downside risk becomes irrelevant. The mutual fund therefore gives up less than the competing strategies when it finances local currency. The expansion of the state space allows us to model both repo fire sales and mutual-fund redemptions coexisting in equilibrium. However, it also introduces the possibility of multiple equilibria. The source of multiple equilibria is pecuniary complementarities between atomistic intermediaries in $t = 0$. From the perspective of an intermediary choosing to issue money-like claims in $t = 0$, a higher *individual* leverage expands the set of states over which he expects to sell, pushing down his individual revenue curve and requiring higher break-even fire-sale prices, which justify more aggregate money issuance. In what follows, we provide sufficient conditions for unique equilibria and characterize intermediary sorting and fire-sale prices under these conditions.

Household preferences with liquidity premia As in the main text, households are risk neutral over $t = 2$ consumption and pay a premium γ_r for safe, money-like claims which contractually deliver a guaranteed unit of consumption in $t = 2$. On top of this premium, households in this extension pay a premium γ_e for any risk-neutral $t = 2$ unit of consumption which may be redeemed early:

$$U = C_0 + \beta \mathbb{E}[C_2] + \gamma_r M_r + \gamma_e M_e, \quad 0 < \gamma_e < \gamma_r. \quad (71)$$

For simplicity throughout, we refer to γ_r as a safety premium, and to γ_e as an option-value premium: households pay γ_e for the option to redeem a claim before maturity, whether or not they exercise it. We interpret γ_e here as compensation to the fund manager for open-ending.⁵⁸ M_r is the quantity of claims whose conversion into hard-currency consumption is *contractually guaranteed*. M_e is the quantity of redeemable, equity-like claims. The difference $\gamma_r - \gamma_e > 0$ captures the idea that a promise enforced by contract is worth more to households than an option they must exercise themselves, even if the two claims were to deliver the same payoff in every state.

We assume that the premium on the redemption option is smaller than the safety premium. Nonetheless, we find that both safe, money-like claims and risky, redeemable claims coexist in

⁵⁷In the expanded state-space, the fundamental downside risk constrains the repo fund as well: they must be able to honor obligations even in the worst-case fire-sale outcome. Fundamental downside risk constrains the repo intermediary more than it does the mutual fund, but less than it does the stable intermediary strategy, who must be able to honor obligations even without being able to liquidate bonds early.

⁵⁸Or, conversely, as the additional value created by overcoming whatever contracting problems inhibit households from delegating their savings to a closed-end equity structure.

equilibrium.

Extended environment. At $t = 1$, good news arrives with probability g as before. With probability b , bad news arrives with a severity s drawn from a continuous distribution F on $[0, 1]$. Every bad-news object of the main text becomes a function of s . Sovereign default remains the event $\{Z < B\}$, but its conditional probability varies with s . We denote the conditional expected payoff on a bond c $\mathbb{E}_{b,s}[X^c]$, the fire-sale price $P_b^c(s)$, and the fire-sale discount factor $\zeta^c(s) = P_b^c(s)/\mathbb{E}_{b,s}[X^c]$.

Write $\underline{X}^c(s)$ for the literal worst-case payoff of bond c conditional on bad news of severity s .⁵⁹ We assume throughout that $\underline{X}^c(s)$ is strictly decreasing and differentiable in s : more severe bad news carries a strictly worse worst case. Let $\underline{s}$ denote the most severe state. Each intermediary-type keeps one subscript everywhere: r for the repo and e for the mutual fund.

Household mutual-fund redemption policy and willingness-to-pay. Households need not redeem any claim which is contractually guaranteed, but must compute the option value of redeeming their mutual-fund shares. Consider a household which owns one share in a mutual fund that owns bond c . At $t = 1$, in bad-news state s , the household chooses between two continuation values. Redeeming the share liquidates the fund at $P_b^c(s)$; the proceeds go into storage and are valued at $(\gamma_e + \beta) P_b^c(s)$. Not redeeming keeps the going-concern value of the bond $\beta \mathbb{E}_{b,s}[X^c]$, but forgoes the option value of the redemption. The household redeems when the first continuation value exceeds the second:

$$(\gamma_e + \beta) P_b^c(s) \geq \beta \mathbb{E}_{b,s}[X^c] \iff \zeta^c(s) \geq \frac{\beta}{\gamma_e + \beta}. \quad (72)$$

Define the threshold fire-sale discount factor $\zeta^* \equiv \frac{\beta}{\gamma_e + \beta}$, and the redemption region

$$\mathcal{S}_e^c \equiv \{s : \zeta^c(s) \geq \zeta^*\}, \quad (73)$$

that is, the set of states in which the mutual fund's shareholders redeem. Whether $\mathcal{S}_e^c$ contains mild or severe states depends on how $\zeta^c(s)$ moves with s in equilibrium.

In the good-news state the mutual-fund share is worth its going-concern value $\beta \mathbb{E}_g[X^c]$.⁶⁰ The value of the share in bad-news state s is the upper envelope of the continuation payoff and

⁵⁹This is a weakly positive constant, a different object from the capital floor $\underline{X}^c(\pi)$ of the main text (a quantile of the unconditional distribution).

⁶⁰If the premium attached to conversion in every state, the household would also redeem in the good state, since $(\gamma_e + \beta)\mathbb{E}_g[X^c] > \beta\mathbb{E}_g[X^c]$ at the frictionless good-state price. We follow the baseline convention that the premium is realized when the claim is converted to storage during the bad-news episode.

the current liquidation value.

$$\text{WTP}^c(s) = \max \{ (\gamma_e + \beta) P_b^c(s), \beta \mathbb{E}_{b,s}[X^c] \}, \quad (74)$$

The willingness to pay at $t = 0$ integrates over states:

$$\text{WTP}^c = \beta g \mathbb{E}_g[X^c] + b \int_0^1 \max \{ (\gamma_e + \beta) P_b^c(s), \beta \mathbb{E}_{b,s}[X^c] \} dF(s). \quad (75)$$

Option decomposition. We can write the WTP for a share as the expected cashflows on the share's underlying bond plus the option value of redeeming it. Adding and subtracting $\beta \mathbb{E}_{b,s}[X^c]$ inside the integral and using $\mathbb{E}[X^c] = g \mathbb{E}_g[X^c] + b \int_0^1 \mathbb{E}_{b,s}[X^c] dF(s)$,

$$\text{WTP}^c = \underbrace{\beta \mathbb{E}[X^c]}_{\text{closed-end value}} + \underbrace{b \int_{\mathcal{S}_e^c} ((\gamma_e + \beta) P_b^c(s) - \beta \mathbb{E}_{b,s}[X^c]) dF(s)}_{\text{option value of redemption} \geq 0}. \quad (76)$$

The first term is equal to the closed-end fund's value $\Pi_{CE}^c + P_0^c$.⁶¹ The second term is the redemption option, nonnegative by construction. The option is worth more in states where the fire-sale discount is small relative to the conditional expected payoff.

Intermediary profit functions. As in the main text, intermediaries obtain funding at households' willingness to pay for the claims they issue, and purchase bonds at market price P_0^c .

Stable intermediaries. As in the main text, the stable intermediary issues money-like claims in quantity $\underline{X}^c$ and holds its bond to maturity in every state:

$$\Pi_S^c = \gamma_r \underline{X}^c + \beta \mathbb{E}[X^c] - P_0^c. \quad (77)$$

The floor $\underline{X}^c = F_c^{-1}(\pi)$ is a constant, set by the fixed stringency π of the capital rule. It is a quantile of the unconditional payoff distribution and does not vary with the bad-news state.

Repo funds. The repo fund contractually looks exactly like the repo of the main text. The repo issues money-like claims (or "paper") in quantity M_{repo}^c . A forced sale in state s occurs only when it makes the paper safe. If $M_{\text{repo}}^c \leq \underline{X}^c(s)$, the bond held to maturity covers the repo money in

⁶¹If $\mathcal{S}_e^c = \emptyset$, then $\text{WTP}^c = \beta \mathbb{E}[X^c]$: a share nobody ever redeems is priced as closed-end equity, and the mutual fund is dominated just as the closed-end equity fund is dominated in Lemma B.3. If $\mathcal{S}_e^c = [0, 1]$, then (76) simplifies to $\gamma_e b \int_0^1 P_b^c(s) dF(s) + \beta \left(b \int_0^1 P_b^c(s) dF(s) + g \mathbb{E}_g[X^c] \right)$, which, in the case of a single bad-news state, is equal to the unstable-fund intermediary in (66). One difference from the main text's $\gamma P_b^c + \beta(b P_b^c + g \mathbb{E}_g[X^c])$ survives even at this corner: the premium here is weighted by b , because it is earned on realized conversion rather than attached unconditionally to an ex-ante money stock. We return to this asymmetry when comparing the fund to repo below.

every $t = 2$ outcome of state s , and the household rolls the paper over. Define the sale function

$$\ell_r^c(s) = \begin{cases} 1, & \underline{X}^c(s) < M_{\text{repo}}^c, \\ 0, & \underline{X}^c(s) \geq M_{\text{repo}}^c, \end{cases} \quad (78)$$

and write $\mathcal{S}_r^c \equiv \{s : \ell_r^c(s) = 1\}$ for the set of states in which the repo sells. The repo issues paper M_{repo}^c earning γ_r , plus expected residual equity. The residual is $P_b^c(s) - M_{\text{repo}}^c$ (stored to $t = 2$) in states where the sale occurs and the random $X^c - M_{\text{repo}}^c$ in states where it does not:

$$\begin{aligned} \Pi_r^c &= (\gamma_r + \beta)M_{\text{repo}}^c + \beta g\left(\mathbb{E}_g[X^c] - M_{\text{repo}}^c\right) - P_0^c \\ &\quad + \beta b \int_0^1 \left[\ell_r^c(s) P_b^c(s) + (1 - \ell_r^c(s)) \mathbb{E}_{b,s}[X^c] - M_{\text{repo}}^c \right] dF(s). \end{aligned} \quad (79)$$

Because the claim is debt-like, the amount M_{repo}^c never varies with s ; only the composition of the residual does. As in the main text, to maintain contractibility of the repo's paper, it is subject to the constraint

$$M_{\text{repo}}^c \leq P_b^c(\underline{s}), \quad (80)$$

where $P_b^c(\underline{s})$ is the liquidation value of bond c in the most severe bad-news state.⁶²

Mutual funds. Households are atomistic and take fire-sale discounts as given. Each redemption in the mutual fund is met by selling the underlying bond pro rata. Let $\ell_e^c(s) \in [0, 1]$ denote the fraction of the fund's shareholders who redeem in bad-news state s .⁶³ Writing $\zeta^* \equiv \beta/(\gamma_e + \beta)$ for the redemption threshold from (72), individual optimality gives

$$\ell_e^c(s) = \begin{cases} 1, & \zeta^c(s) > \zeta^*, \\ \frac{\eta(1 - \zeta^*) - \mu_r^c \ell_r^c(s)}{\mu_e^c} \in (0, 1), & \zeta^c(s) = \zeta^*, \\ 0, & \zeta^c(s) < \zeta^*. \end{cases} \quad (81)$$

When the discount is shallower than the threshold every household strictly prefers to redeem. When it is deeper every household strictly prefers to stay. The middle outcome is a fixed point: at $\zeta^c(s) = \zeta^*$ households are indifferent, so the redeeming mass is whatever quantity makes the

⁶²For (80) to make the paper safe in every state, the worst state must carry the lowest liquidation value, $P_b^c(\underline{s}) \leq P_b^c(s)$ for all s . This is not an extra assumption; rather, we verify it in the equilibrium of Proposition B.2.

⁶³In the two-state model this object does not appear: redemption is all-or-nothing by conjecture, verified by the incentive condition. With a gradient of states, $\ell_e^c(s)$ becomes an equilibrium object because redemption determines the market-clearing price of the bond.

market-clearing discount exactly ζ^* .

The mutual fund finances its bond purchase by selling shares at the willingness to pay (75):

$$\Pi_e^c = \text{WTP}^c - P_0^c. \quad (82)$$

The redemption function determines the states in which the option value in (76) is realized. We write the profit function state by state after solving for the discount schedule below.

The two sale functions differ in one key way. The repo's sale function depends only on the state's tail payoff: the comparison in (78) is between the repo money and the worst-case payoff $\underline{X}^c(s)$, and no price enters. The mutual fund's sale function depends on the continuation value of the bond, which is embedded in the discount $\zeta^c(s)$ that (81) compares to the threshold.

Market clearing Residual-investor demand has the same form as in the main text, state by state. At price P in state s , residual investors absorb

$$Q^c(P; s) = \eta^c \left(1 - \frac{P}{\mathbb{E}_{b,s}[X^c]} \right), \quad \eta^c = \eta B_0^c, \quad (83)$$

We assume throughout that η is small enough that $\mu_r^c + \mu_e^c < 1$ in every equilibrium below. All this means is that intermediaries cannot create an infinite amount of money out of risky bonds.

Let μ_r^c and μ_e^c be the shares of the bond supply held by the repo and mutual funds.⁶⁴ Secondary bond markets clear state by state:

$$[\mu_r^c \ell_r^c(s) + \mu_e^c \ell_e^c(s)] B_0^c = \eta B_0^c (1 - \zeta^c(s)), \quad (84)$$

which solves for the discount schedule

$$\zeta^c(s) = 1 - \frac{1}{\eta} [\mu_r^c \ell_r^c(s) + \mu_e^c \ell_e^c(s)], \quad P_b^c(s) = \zeta^c(s) \mathbb{E}_{b,s}[X^c]. \quad (85)$$

The two sale functions enter asymmetrically. $\ell_r^c(s)$ is exogenous state by state, a function of the payoff distribution through (78). $\ell_e^c(s)$ depends on $\zeta^c(s)$ through (81), so (85) is really a fixed point in each state. If no one sells in state s , then $\zeta^c(s) = 1$ and $P_b^c(s) = \mathbb{E}_{b,s}[X^c]$. There are no fire sales, and prices equal fundamental value.

The discount schedule $\zeta^c(s)$. We solve for the fixed point in (85) case by case, writing $\Gamma \equiv 1/\eta$ for the inverse market elasticity. In states where the repo sells ($\ell_r^c(s) = 1$):

⁶⁴Note that, consistent with the assumptions of contractibility, these shares are determined in $t = 0$ and do not vary by state. Only the sale functions ℓ_r^c, ℓ_e^c are state-dependent.

- *Full redemption* ($\ell_e^c(s) = 1$): clearing gives $\zeta^c(s) = 1 - \Gamma(\mu_r^c + \mu_e^c)$, consistent with the top branch of (81) when $1 - \Gamma(\mu_r^c + \mu_e^c) > \zeta^*$.
- *Partial redemption* ($\ell_e^c(s) \in (0, 1)$): $\zeta^c(s) = \zeta^*$, arising when $1 - \Gamma\mu_r^c \geq \zeta^* \geq 1 - \Gamma(\mu_r^c + \mu_e^c)$.
- *No redemption* ($\ell_e^c(s) = 0$): clearing gives $\zeta^c(s) = 1 - \Gamma\mu_r^c$, consistent with the bottom branch when $1 - \Gamma\mu_r^c < \zeta^*$ — the repo overhang alone depresses the price enough that households prefer to ride out the sale.

In states where the repo holds ($\ell_r^c(s) = 0$):

- *Full redemption*: $\zeta^c(s) = 1 - \Gamma\mu_e^c$, when $1 - \Gamma\mu_e^c > \zeta^*$.
- *Partial redemption*: $\zeta^c(s) = \zeta^*$, when $1 - \Gamma\mu_e^c \leq \zeta^*$.
- *No redemption*: $\zeta^c(s) = 1$, possible only if $\mu_e^c = 0$ — with any mutual-fund presence, $\zeta^c(s) = 1 > \zeta^*$ contradicts the bottom branch of (81), so some redemption always occurs.

In each state exactly one case is consistent, so given (μ_r^c, μ_e^c) the schedule is unique. Figure B.1 illustrates the fire-sale discount step function.

Lemma B.4 (The fire-sale discount is a step function with two regimes). *Given (μ_r^c, μ_e^c) , the discount $\zeta^c(s)$ takes at most one value on $\mathcal{S}_r^c$ and one value on $(\mathcal{S}_r^c)^c$. The price schedule $P_b^c(s) = \zeta^c(s) \mathbb{E}_{b,s}[X^c]$ depends on the state s through two channels: continuously through the fundamental $\mathbb{E}_{b,s}[X^c]$, and discretely where $\ell_r^c(s)$ switches from 0 to 1 and repo-driven sales worsen the fire-sale discount.*

We write ζ_r^c for the discount on $\mathcal{S}_r^c$ and ζ_e^c for the discount off it. The labels are justified below: in equilibrium, ζ_r^c is the price in the states where the repo sells, and ζ_e^c the price in the states where only the mutual fund redeems. In particular $\zeta_r^c = \zeta^c(\underline{s})$, the worst-state discount. Both levels are solved below.

Intermediary profit functions in terms of the step function. We restate the two profit functions in terms of the fire-sale discount schedule. For the repo fund, expand (79), use $g + b = 1$ so the M_{repo}^c terms collect, and substitute $P_b^c(s) = \zeta^c(s) \mathbb{E}_{b,s}[X^c]$:

$$\Pi_r^c = \gamma_r M_{\text{repo}}^c + \beta g \mathbb{E}_g[X^c] + \beta b \int_0^1 [\ell_r^c(s) \zeta^c(s) + 1 - \ell_r^c(s)] \mathbb{E}_{b,s}[X^c] dF(s) - P_0^c. \quad (86)$$

The βb -part is the expected value of the portfolio along its realized path. On this path, the bond is sold at the discount $\zeta^c(s)$ where the sale is forced, and held to maturity where it is not. The fund's profit is written the same way. In every bad-news state the household's realized value is

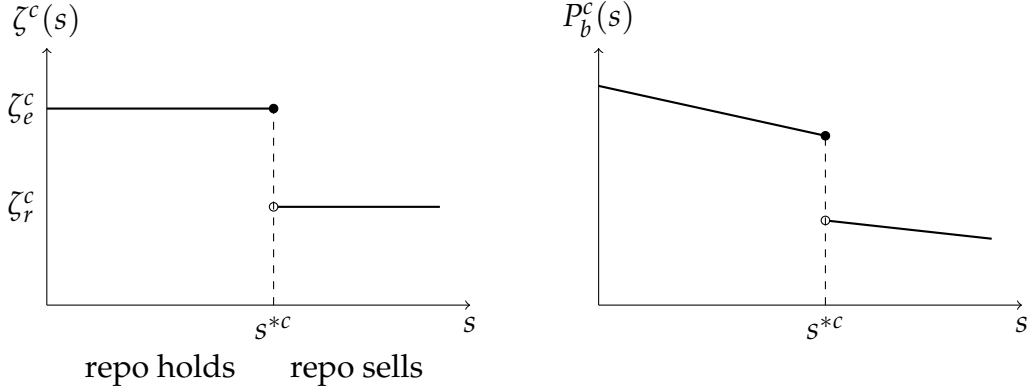


Figure B.1: The two-regime schedule of Lemma B.4, drawn for the severity-ordered case in which the selling set is the upper interval $(s^{*c}, 1]$. Left: the discount is a step function of the state. It takes a shallow value where the repo holds and a deep value where the repo sells. In the equilibrium of Proposition B.2 the two values are $\zeta_e^c = 1 - \Gamma\mu_e^c$ and ζ_r^c . Right: the price $P_b^c(s) = \zeta^c(s) \mathbb{E}_{b,s}[X^c]$ declines continuously with severity through the fundamental and drops discretely at the cutoff, where the repo's sales begin. The location of the step on the s -axis is an equilibrium object, pinned with the repo money by the fixed point below.

the ℓ_e -weighted average of the two continuations. Substituting the redemption schedule into the willingness to pay (75),

$$\Pi_e^c = \beta g \mathbb{E}_g[X^c] + b \int_0^1 [\ell_e^c(s) (\gamma_e + \beta) \zeta^c(s) + (1 - \ell_e^c(s)) \beta] \mathbb{E}_{b,s}[X^c] dF(s) - P_0^c. \quad (87)$$

The difference between the two intermediation strategies can be registered from the position of the premia earned in the profit functions. The repo's premium does not depend directly on the distribution of states, only indirectly through its effect on equilibrium fire-sale prices and the contractibility constraint. In contrast, the mutual fund earns a premium because of its expected option value, so the premium appears inside the integral.

Equilibrium

Definition (Competitive equilibrium with three intermediation strategies). *Given the initial bond supply B_0^c and the conditional payoff distributions, a competitive equilibrium in bond market c is a triple of intermediation measures $(\mu_s^c, \mu_r^c, \mu_e^c)$, a quantity of repo money M_{repo}^c , and prices P_0^c and $\{P_b^c(s)\}_{s \in [0,1]}$ such that:*

- (i) **Zero profits.** *Intermediaries have free entry: every strategy operated at positive measure earns zero profit, and no strategy earns positive profit — $\Pi_s^c = 0$, $\Pi_r^c \leq 0$, and $\Pi_e^c \leq 0$, with equality for any strategy operated at positive measure.*
- (ii) **Individual optimality.** *The repo money satisfies (80) and sales follow (78); mutual-fund redemp-*

tions follow (81).

- (iii) **Market clearing.** The primary market clears at $t = 0$ (implied by free entry and linear preferences, as in the main text), and secondary markets clear state by state at $t = 1$: $[\mu_r^c \ell_r^c(s) + \mu_e^c \ell_e^c(s)] B_0^c = Q^c(P_b^c(s); s)$ for every s .

The solution proceeds as in the model for the main text, with a few new steps. We make three conjectures to reach a solution, and verify these conjectures in the proof that follows.

The stable condition pins the bond price, $P_0^c = \gamma_r \underline{X}^c + \beta \mathbb{E}[X^c]$. Next, we pin μ_r^c using the indifference condition between the stable and repo intermediation strategies. According to profit maximization, the constraint (80) binds: $M_{\text{repo}}^c = P_b^c(\underline{s})$. Issuing less leaves premium on the table whenever the marginal forced-sale opportunity costs remain below the premium.⁶⁵ The indifference condition $\Pi_r^c = \Pi_s^c$, using (79) reads

$$\begin{aligned} \gamma_r \underline{X}^c + \beta \mathbb{E}[X^c] &= (\gamma_r + \beta) M_{\text{repo}}^c + \beta g \left(\mathbb{E}_g[X^c] - M_{\text{repo}}^c \right) \\ &\quad + \beta b \int_0^1 \left[\ell_r^c(s) P_b^c(s) + (1 - \ell_r^c(s)) \mathbb{E}_{b,s}[X^c] - M_{\text{repo}}^c \right] dF(s), \end{aligned} \quad (88)$$

with $\ell_r^c(s) = \mathbb{1}\{\underline{X}^c(s) < M_{\text{repo}}^c\}$. Rearranging and solving for M_{repo}^c ,

$$M_{\text{repo}}^c = \underline{X}^c + \frac{\beta b}{\gamma_r} \int_0^1 \ell_r^c(s) (\mathbb{E}_{b,s}[X^c] - P_b^c(s)) dF(s), \quad (89)$$

which is affine in $\underline{X}^c$, $\int_0^1 \mathbb{E}_{b,s}[X^c] dF(s)$, and $\int_0^1 [\ell_r^c P_b^c + (1 - \ell_r^c) \mathbb{E}_{b,s}[X^c]] dF(s)$, just as the fire-sale price of the main text is affine in $\underline{X}^c$ and $\mathbb{E}_b[X^c]$. The repo's paper equals the stable floor plus its expected fire-sale losses, capitalized at the rate β/γ_r .⁶⁶ We next pin down the value μ_r^c using (89) and a guess.

Conjecture #1: No mutual-fund shareholder redeems in the worst state, $\ell_e^c(\underline{s}) = 0$. This is an intuitive guess, since redemption is more enticing when discounts are shallow and $\underline{s}$ is a bad state. The conjecture has a stark implication, however: If true, states in which mutual funds and repo funds sell are mutually exclusive. By Lemma B.4 the discount $\zeta^c(s)$ is one number across $\mathcal{S}_r^c$, so whether or not $\zeta^c(s) > \zeta^*$ holds across $\mathcal{S}_r^c$. Therefore, $\ell_e^c(\underline{s}) = 0$ implies $\ell_e^c(s) = 0$ on all of $\mathcal{S}_r^c$.

Next we derive the equilibrium fire-sale discount ζ_r^c as a function of model primitives. Lemma B.4 tells us that if we know the fire-sale discount ζ_r^c in any state in which the repo sells, we know the

⁶⁵This is the uniqueness condition, which we derive below.

⁶⁶In the single-bad-state limit, $\ell_r^c \equiv 1$ and $P_b^c(s) = M_{\text{repo}}^c$, and (89) rearranges to $M_{\text{repo}}^c = (\gamma_r \underline{X}^c + b\beta \mathbb{E}_b[X^c]) / (\gamma_r + b\beta)$, which is the fire-sale price of the main text

discount in *all* states where the repo sells. By Lemma B.4 and Conjecture 1, the market clearing equation above extends from $\underline{s}$ to every state in which the repo sells:

$$\zeta^c(s) = 1 - \Gamma\mu_r^c \quad \text{for } s \in \mathcal{S}_r^c.$$

While *prices* vary state by state with fundamentals, states within a repo-selling regime have a common factor, the fire sale discount, which can be taken out of the integral in (89):

$$\int_0^1 \ell_r^c(s) (\mathbb{E}_{b,s}[X^c] - P_b^c(s)) dF(s) = (1 - \zeta_r^c) \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF(s).$$

Substituting this and the binding constraint (80) into (89), and collecting terms:

$$\zeta_r^c = \frac{\gamma_r \underline{X}^c + \beta b \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF(s)}{\gamma_r \mathbb{E}_{b,\underline{s}}[X^c] + \beta b \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF(s)}. \quad (90)$$

which mirrors the fire-sale discount of the main text. Define the worst-state safety ratio and the weight

$$\lambda_{\underline{s}}^c \equiv \frac{\underline{X}^c}{\mathbb{E}_{b,\underline{s}}[X^c]}, \quad \omega^c \equiv \frac{\gamma_r \mathbb{E}_{b,\underline{s}}[X^c]}{\gamma_r \mathbb{E}_{b,\underline{s}}[X^c] + \beta b \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF(s)}.$$

Dividing the numerator and denominator of (90) through and regrouping condenses it to one line,

$$\zeta_r^c = \omega^c \lambda_{\underline{s}}^c + (1 - \omega^c) :$$

the same weighted average of a safety ratio and one as the main text's $\zeta^c = \omega \lambda^c + 1 - \omega$, with the safety ratio evaluated at the worst state and the weight's βb term scaled by the mass of fundamental value in the repo's selling states.

Next, we characterize μ_e^c using μ_r^c in the market clearing conditions of the other states and the indifference condition between the repo and the mutual fund. Subtracting (87) from (86) and

grouping terms,

$$\begin{aligned} \Pi_r^c - \Pi_e^c = & \underbrace{\gamma_r M_{\text{repo}}^c - b \gamma_e \int_0^1 \zeta^c(s) \ell_e^c(s) \mathbb{E}_{b,s}[X^c] dF(s)}_{\text{difference in money premia earned}} \\ & + \underbrace{b\beta \int_0^1 (\zeta^c(s) - 1) (\ell_r^c(s) - \ell_e^c(s)) \mathbb{E}_{b,s}[X^c] dF(s)}_{\text{difference in residual portfolio value}}. \end{aligned} \quad (91)$$

The γ_e integral is the premium paid to the fund for the option value of redemption.⁶⁷ The second integral is the difference in portfolio market value: since $\zeta^c(s) - 1 \leq 0$, whichever strategy sells more in state s eats more of the fire-sale loss.

Conjecture #2: Households redeem mutual-fund shares in full. Every mutual-fund shareholder redeems in every state where the repo does not sell: $\ell_e^c(s) = 1$ on $(\mathcal{S}_r^c)^c$. Market clearing in those states then gives one common discount, which we name:

$$\zeta_e^c \equiv 1 - \Gamma \mu_e^c. \quad (92)$$

Under Conjectures 1 and 2 the two integrals in (91) evaluate directly. In the first, $\ell_e^c = 0$ on $\mathcal{S}_r^c$ while $\ell_e^c = 1$ and $\zeta^c = \zeta_e^c$ off it, so

$$\int_0^1 \zeta^c(s) \ell_e^c(s) \mathbb{E}_{b,s}[X^c] dF(s) = \zeta_e^c \int_{(\mathcal{S}_r^c)^c} \mathbb{E}_{b,s}[X^c] dF(s).$$

In the second, $\ell_r^c - \ell_e^c$ equals $+1$ on $\mathcal{S}_r^c$ and -1 off it, and $\zeta^c - 1$ equals $\zeta_r^c - 1$ on $\mathcal{S}_r^c$ and $\zeta_e^c - 1$ off it, so

$$\begin{aligned} \int_0^1 (\zeta^c(s) - 1) (\ell_r^c(s) - \ell_e^c(s)) \mathbb{E}_{b,s}[X^c] dF(s) = & (\zeta_r^c - 1) \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF(s) \\ & - (\zeta_e^c - 1) \int_{(\mathcal{S}_r^c)^c} \mathbb{E}_{b,s}[X^c] dF(s). \end{aligned}$$

Substitute both into (91) = 0, along with the value of the repo's premium income from (89),

$$\gamma_r M_{\text{repo}}^c = \gamma_r \underline{X}^c + \beta b (1 - \zeta_r^c) \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF(s).$$

⁶⁷As you read these objects, keep in mind that the fund's expected premium is not derived from the contractual nature of the claim but from the households' ex-ante willingness to pay for it, taking into account their own incentive-compatible behavior in every state.

The $\int_{\mathcal{S}_r^c}$ terms cancel, leaving

$$\gamma_r \underline{X}^c = b [(\gamma_e + \beta) (1 - \Gamma \mu_e^c) - \beta] \int_{(\mathcal{S}_r^c)^c} \mathbb{E}_{b,s}[X^c] dF(s).$$

This equation contains two equilibrium objects, μ_e^c and the complement of the repo selling set $(\mathcal{S}_r^c)^c$. The set is not a primitive: it is pinned jointly with the repo money by the fixed point of Conjecture 3 below. Taking the set as given, the equation has one remaining unknown, μ_e^c . Dividing through, using $1 - \beta/(\gamma_e + \beta) = \gamma_e/(\gamma_e + \beta)$, and solving:

$$\mu_e^c = \frac{\eta}{\gamma_e + \beta} \left[\gamma_e - \frac{\gamma_r \underline{X}^c}{b \int_{(\mathcal{S}_r^c)^c} \mathbb{E}_{b,s}[X^c] dF(s)} \right]. \quad (93)$$

Define the share of bad-news fundamental value in the repo's selling states,

$$\rho^c \equiv \frac{\int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF(s)}{\mathbb{E}_b[X^c]} \in (0, 1)$$

— like the set itself, an equilibrium object rather than a primitive. Splitting the bad-news mean across the two regimes, $b \int_{(\mathcal{S}_r^c)^c} \mathbb{E}_{b,s}[X^c] dF(s) = b (1 - \rho^c) \mathbb{E}_b[X^c]$, and writing $\lambda^c = \underline{X}^c / \mathbb{E}_b[X^c]$ for the main text's safety ratio, (93) becomes

$$\mu_e^c = \frac{\eta}{\gamma_e + \beta} \left(\gamma_e - \frac{\gamma_r}{b} \frac{\lambda^c}{1 - \rho^c} \right). \quad (94)$$

This is the form of the unstable share in the main text: the measure is the demand slope $\eta/(\gamma_e + \beta)$ times the premium in excess of an entry hurdle. The fund operates in positive measure, $\mu_e^c > 0$, if and only if

$$\gamma_e > \gamma_e^- \equiv \frac{\gamma_r}{b} \frac{\lambda^c}{1 - \rho^c}. \quad (95)$$

The premium earned per unit of option value created must be at least the per-unit value of intermediating the bond under the stable strategy — the safety ratio, in the main text's currency. The constraint is tighter than $\gamma_r \lambda^c / b$, because the mutual fund can only generate value in certain states of the world : the safety ratio is scaled up by $1/(1 - \rho^c)$. The measure μ_e^c is increasing in γ_e and in the fundamental value on those states, and decreasing in γ_r and in the stable floor $\underline{X}^c$.

Conjecture #3: The discount ζ_r^c is a fixed point which justifies the money issued per repo fund.

The discount determines the money through the binding constraint, $M_{\text{repo}}^c = \zeta_r^c \mathbb{E}_{b,s}[X^c]$. The

money determines the selling set through the sale function (78). The selling set determines the break-even discount through (90). The conjecture is that this loop closes: the discount computed from the selling set reproduces the set it was computed on. Writing T for the composite map

$$T(\zeta) \equiv \zeta^c(\underline{s}; \mathcal{S}_r^c(\zeta)),$$

where

$$\mathcal{S}_r^c(\zeta) = \{s : \underline{X}^c(s) < \zeta \mathbb{E}_{b,\underline{s}}[X^c]\}, \quad \zeta^c(\underline{s}; \mathcal{S}_r^c) = \frac{\gamma_r \underline{X}^c + \beta b \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF}{\gamma_r \mathbb{E}_{b,\underline{s}}[X^c] + \beta b \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF}, \quad (96)$$

the conjecture is that T has a fixed point, $T(\zeta_r^c) = \zeta_r^c$. These maps come from substituting M_{repo}^c out of the repo sale function (78) and writing (90) as a function of the selling set. We establish this conjecture first, since the objects in the other two are defined relative to its solution.

Lemma B.5 (The selling set is consistent). *The map T has a fixed point: there exists a worst-state discount ζ_r^c with $\lambda_{\underline{s}}^c \leq \zeta_r^c < 1$ that reproduces its own selling set. Fixed points may be multiple; each one supports the construction above.*

Proof. First, T is nondecreasing in ζ . Raising ζ raises the repo money $\zeta \mathbb{E}_{b,\underline{s}}[X^c]$ and so weakly enlarges the selling set (the sets in (96) are nested). And the solved discount is increasing in the integral $\int_{\mathcal{S}_r^c(\zeta)} \mathbb{E}_{b,s}[X^c] dF(s)$, since $\gamma_r (\mathbb{E}_{b,\underline{s}}[X^c] - \underline{X}^c) > 0$. Second, T maps the interval $[\lambda_{\underline{s}}^c, 1]$ into itself. When the integral $\int_{\mathcal{S}_r^c(\zeta)} \mathbb{E}_{b,s}[X^c] dF$ is zero, the fraction equals $\gamma_r \underline{X}^c / \gamma_r \mathbb{E}_{b,\underline{s}}[X^c] = \lambda_{\underline{s}}^c$. As the integral rises, the fraction rises but stays below one. So $\lambda_{\underline{s}}^c \leq T(\zeta) < 1$ for every candidate ζ . A nondecreasing map of an interval into itself has a fixed point.

Multiplicity in repo claims M_{repo}^c . The fixed point need not be unique, but next we establish the condition for uniqueness and assume it going forward. Here we pause to describe where multiplicity arises.

The discount ζ_r^c is the price that makes the marginal entrant indifferent between the repo and stable strategies ex ante. The extensive margin of entry, μ_r^c , adjusts to ensure ζ_r^c is the market-clearing price in the fire sale. Conjecture that each atomistic repo fund issues a bit more money per unit of bond purchased, $M' > M_{\text{repo}}^c$. All else equal, extra money means the repo fund must sell in more states, by (78). Thus, the opportunity cost of operating as the repo fund rises, and profit per bond falls. Ex-ante indifference with operating as a stable fund then requires a shallower break-even fire-sale discount ζ_r^c , and a shallower discount can only come from fewer entrants. Fewer entrants and a shallower ζ_r^c relax the constraint on money-issuance, which is $M_{\text{repo}}^c = \zeta_r^c \mathbb{E}_{b,\underline{s}}[X^c]$. The conjectured M' therefore could validate itself: more leverage, fewer funds, shallower fire sales, relaxed borrowing constraints, and more leverage.

Uniqueness. The potential for multiplicity arises from a pecuniary complementarity between atomistic repo funds. Each repo issuer's best response is to issue money up to the contractibility constraint, which is a function of the equilibrium fire-sale discount. The loop described above implies that the constraint is increasing in the aggregate quantity of repo money issued per unit of bond, meaning that the individual fund's best response rises with the aggregate quantity of repo money. Uniqueness holds if the marginal opportunity costs associated with an additional unit of money are small enough. We clarify this by differentiating T . It's easier to write the map T in terms of M_{repo}^c rather than the set $\mathcal{S}_r^c$. To do so, define

$$m(\zeta) \equiv \mathbb{E}_{b,\underline{s}}[X^c]\zeta, \quad x(m) \equiv \int_0^1 \mathbb{1}\{\underline{X}^c(s) < m\} \mathbb{E}_{b,s}[X^c] dF(s), \quad \zeta(x) \equiv \frac{\gamma_r \underline{X}^c + b\beta x}{\gamma_r \mathbb{E}_{b,\underline{s}}[X^c] + b\beta x} \quad (97)$$

with these objects defined, we can write instead

$$T(\zeta) \equiv \zeta(x(m(\zeta))) \quad (98)$$

and therefore $T'(\zeta) = m'(\zeta) x'(m) \zeta'(x)$. We have immediately that $m', \zeta' > 0$. Since $\underline{X}^c(s)$ is strictly decreasing and differentiable, $x' > 0$ as well. Formally, there is a threshold state $s^*(m) = (\underline{X}^c)^{-1}(m)$ such that, in every better state $s < s^*(m)$, there is no selling. Then

$$x'(m) = \frac{d}{dm} \int_{s^*(m)}^1 \mathbb{E}_{b,s}[X^c] dF(s) = -\mathbb{E}_{b,s^*(m)}[X^c] \cdot \frac{ds^*(m)}{dm} \cdot f(s^*(m)) > 0. \quad (99)$$

Therefore, T is increasing in ζ with slope

$$T'(\zeta) = -\mathbb{E}_{b,\underline{s}}[X^c] \cdot \mathbb{E}_{b,s^*(m)}[X^c] \cdot \frac{ds^*(m)}{dm} \cdot f(s^*(m)) \cdot \gamma_r \frac{b\beta(\mathbb{E}_{b,\underline{s}}[X^c] - \underline{X}^c)}{(\gamma_r \mathbb{E}_{b,\underline{s}}[X^c] + b\beta x)^2} \quad (100)$$

We have immediately that $(\gamma_r \mathbb{E}_{b,\underline{s}}[X^c])^2 \leq (\gamma_r \mathbb{E}_{b,\underline{s}}[X^c] + b\beta x)^2$. Therefore,

$$\begin{aligned} T'(\zeta) &\leq \mathbb{E}_{b,s^*(m)}[X^c] f(s^*(m)) \left| \frac{ds^*(m)}{dm} \right| \frac{b\beta}{\gamma_r} (1 - \lambda_{\underline{s}}^c) \\ &< \mathbb{E}_{b,s^*(m)}[X^c] f(s^*(m)) \left| \frac{ds^*(m)}{dm} \right| \frac{b\beta}{\gamma_r}. \end{aligned} \quad (101)$$

A sufficient condition for uniqueness is therefore

$$b\beta \cdot \mathbb{E}_{b,s^*(m)}[X^c] f(s^*(m)) \cdot \left| \frac{ds^*(m)}{dm} \right| \leq \gamma_r \quad \text{for every } m. \quad (102)$$

The left side becomes legible after a change of variables. The product of $f(s^*(m))$ and $|ds^*(m)/dm|$ is the density of the worst-case payoff $\underline{X}^c(s)$ across bad-news states, evaluated at the money level m : since $\Pr_b(\underline{X}^c(s) < m) = 1 - F(s^*(m))$, differentiating in m gives

$$\frac{d}{dm} \Pr_b(\underline{X}^c(s) < m) = -f(s^*(m)) \frac{ds^*(m)}{dm} = f(s^*(m)) \left| \frac{ds^*(m)}{dm} \right|. \quad (103)$$

And $\Pr_b(\underline{X}^c(s) < m)$ is the probability that a given state s is in the selling set, $\Pr_b(s \in \mathcal{S}_r^c(m))$. Dropping $\mathbb{E}_{b,s^*(m)}[X^c] \leq 1$, (102) follows from

$$b\beta \frac{d}{dm} \Pr_b(s \in \mathcal{S}_r^c(m)) \leq \gamma_r \quad \text{for every } m : \quad (104)$$

the discounted probability mass of states recruited into the selling set by one more unit of repo money must not exceed the premium that unit earns.

The condition is the loop of the preceding paragraphs with its gain below one. Issuing dm more repo money earns premium revenue $\gamma_r dm$ in every state, because the claim is money-like by contract. Its cost is the discounted fundamental value newly exposed to forced sale: the mass of marginal states recruited into the selling set, weighted by the value forgone there because of forced sales. When the premium covers that exposure at every m , a conjectured expansion of the selling set cannot finance its own break-even money, and the fixed point is unique.

The same comparison verifies the claim, made at (80), that individual profit maximization binds the constraint. An atomistic fund takes the equilibrium schedule as given and contemplates issuing $M < M_{\text{repo}}^c$. Its profit satisfies

$$\frac{d\Pi_r^c}{dM} = \gamma_r - \beta b (1 - \zeta_r^c) \mathbb{E}_{b,s^*(M)}[X^c] f(s^*(M)) \left| \frac{ds^*(M)}{dM} \right|. \quad (105)$$

The right side is the slope condition's object scaled by $1 - \zeta_r^c < 1$, so under (102) we have $d\Pi_r^c/dM > 0$ at every feasible M : the only feasible deviations are $dM < 0$, which is strictly unprofitable.

Lemma B.6 (Uniqueness). *Suppose the slope condition (102) holds for every m .⁶⁸ Then $T'(\zeta) < 1$ everywhere, T has exactly one fixed point ζ_r^c , and the constraint (80) binds for every repo fund.*

Proof. Under (102) the bound above gives $T'(\zeta) \leq 1 - \lambda_{\zeta}^c < 1$, so $T(\zeta) - \zeta$ is strictly decreasing

⁶⁸The global quantifier can be weakened. If (104) holds only in a neighborhood of a fixed point M_{repo}^{c*} , then T crosses the diagonal from above at that point, and the equilibrium it selects is locally isolated and stable under the conjecture-revision iteration: a conjectured increment of money returns a cap increase smaller than the increment, and the rounds shrink back to M_{repo}^{c*} . The model then has locally stable equilibria without global uniqueness, and other fixed points may exist where the condition fails.

and crosses zero exactly once on $[\lambda_{\underline{s}}^c, 1]$. Existence is Lemma B.5. The corner follows from (105).

Interior fixed points. The equilibrium needs two interiority properties of the chosen fixed point. The worst state must belong to the selling set, $\underline{s} \in \mathcal{S}_r^c$, which holds whenever $\underline{X}^c(\underline{s}) < \underline{X}^c$, since the solved repo money satisfies $M_{\text{repo}}^c \geq \underline{X}^c$ (equivalently $\zeta_r^c \geq \lambda_{\underline{s}}^c$). And the set must leave states out, $F(\mathcal{S}_r^c) < 1$ — a positive-mass set of mild states whose worst-case payoff weakly exceeds the repo money outstanding — so the mutual fund has states to live on. Because $\underline{X}^c(s)$ is strictly decreasing in severity, every induced set is an upper interval and the fixed point reduces to a scalar cutoff s^* with $\underline{X}^c(s^*) = M_{\text{repo}}^c$: the repo sells above the cutoff severity and holds below it.

Proposition B.2 (Coexistence of the repo and mutual funds). *Let ζ_r^c be a fixed point from Lemma B.5 whose selling set $\mathcal{S}_r^c$ satisfies $\underline{s} \in \mathcal{S}_r^c$ and $F(\mathcal{S}_r^c) < 1$. Its equilibrium value is the solved discount (90), evaluated on $\mathcal{S}_r^c$, and $\mathcal{S}_r^c$ solves the fixed-point problem (96). If $\gamma_e \in (\gamma_e^-, \gamma_e^+)$, where*

$$\gamma_e^- = \frac{\gamma_r}{b} \frac{\lambda^c}{1 - \rho^c}, \quad \gamma_e^+ \equiv \frac{\beta \gamma_r (\mathbb{E}_{b, \underline{s}}[X^c] - \underline{X}^c)}{\gamma_r \underline{X}^c + \beta b \int_{\mathcal{S}_r^c} \mathbb{E}_{b, s}[X^c] dF(s)}, \quad (106)$$

then an equilibrium with three intermediation types exists:

- Stable intermediaries operate in measure $1 - \mu_r^c - \mu_e^c$.
- The repo operates in measure $\mu_r^c = \eta(1 - \zeta_r^c)$, issues repo money $M_{\text{repo}}^c = \zeta_r^c \mathbb{E}_{b, \underline{s}}[X^c]$, and sells on $\mathcal{S}_r^c$.
- Mutual funds hold $\mu_e^c > 0$ given by (93), and their households redeem shares on $(\mathcal{S}_r^c)^c$.

Sales are mutually exclusive state by state, every operated strategy earns zero profit, the initial price is $P_0^c = \gamma_r \underline{X}^c + \beta \mathbb{E}[X^c]$, and fire-sale prices follow the two-regime schedule of Lemma B.4, with discount ζ_r^c from (90) on $\mathcal{S}_r^c$ and $\zeta_e^c = 1 - \Gamma \mu_e^c$ off it. If, in addition, the slope condition (102) of Lemma B.6 holds, this equilibrium is unique.

Proof. What remains to be shown is that the three conjectures hold under the conditions stated, the positivity of the shares μ_e^c, μ_r^c , and the regularity behind the constraint on M_{repo}^c . We start by verifying the conjectures.

1. The first conjecture is that no mutual-fund shares are redeemed in the worst state. By the redemption rule (81), the conjecture holds when $\zeta_r^c < \zeta^* = \beta/(\gamma_e + \beta)$. By Lemma B.4 the discount equals ζ_r^c everywhere on $\mathcal{S}_r^c$, so we have that if the inequality holds, it holds in every state in which the repo sells. Substitute the solved value (90) and use the fact that

both denominators are positive:

$$\begin{aligned}\zeta_r^c < \zeta^* &\iff (\gamma_e + \beta) \left(\gamma_r \underline{X}^c + \beta b \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF \right) \\ &< \beta \left(\gamma_r \mathbb{E}_{b,\underline{s}}[X^c] + \beta b \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF \right).\end{aligned}$$

Expanding both sides and canceling the common term $\beta^2 b \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF$ leaves

$$\gamma_e \gamma_r \underline{X}^c + \beta \gamma_r \underline{X}^c + \gamma_e \beta b \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF < \beta \gamma_r \mathbb{E}_{b,\underline{s}}[X^c],$$

and moving $\beta \gamma_r \underline{X}^c$ across and grouping the γ_e terms,

$$\gamma_e \left(\gamma_r \underline{X}^c + \beta b \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF \right) < \beta \gamma_r (\mathbb{E}_{b,\underline{s}}[X^c] - \underline{X}^c), \quad (107)$$

which is exactly $\gamma_e < \gamma_e^+$, the upper bound in (106).

2. The second conjecture is that *mutual-fund shares are redeemed in full off $\mathcal{S}_r^c$* . This requires $\zeta_e^c = 1 - \Gamma \mu_e^c > \zeta^*$. From the equation preceding (93), $1 - \Gamma \mu_e^c = \zeta^* + \gamma_r \underline{X}^c / [(\gamma_e + \beta) b \int_{(\mathcal{S}_r^c)^c} \mathbb{E}_{b,s}[X^c] dF]$, strictly above ζ^* whenever $\underline{X}^c > 0$.
3. The third conjecture is that *the set $\mathcal{S}_r^c$ is consistent with the selection of repo money M^** . It holds by the choice of the fixed point in Lemma B.5, whose repo money is $M^* = \zeta_r^c \mathbb{E}_{b,\underline{s}}[X^c]$.

Positivity: $\mu_e^c > 0$ is the lower bound, since (93) is positive exactly when $\gamma_e > \gamma_e^-$ by (95); $\mu_r^c > 0$ follows from $\zeta_r^c < \zeta^* < 1$ and worst-state clearing, $\mu_r^c = \eta(1 - \zeta_r^c)$; the stable measure is positive by the maintained assumption on η . Regularity of the contractibility constraint (80): $P_b^c(\underline{s})$ is the minimum of the price schedule, since $\underline{s} \in \mathcal{S}_r^c$ by hypothesis, the discount on $\mathcal{S}_r^c$ lies below the discount off it (items 1–2 give $\zeta_r^c < \zeta^* < \zeta_e^c$), and $\mathbb{E}_{b,\underline{s}}[X^c]$ is the lowest conditional fundamental. Zero profits hold by construction: the stable condition pins P_0^c , and the indifferences $\Pi_r^c = \Pi_s^c$ and $\Pi_e^c = \Pi_s^c$ are the equations that produced M^* and μ_e^c . With the conjectures verified, the case analysis of the discount schedule confirms each state's outcome, and the construction satisfies the Definition.

For the uniqueness clause, take any equilibrium in which all three types operate. Zero profits for the stable strategy pin P_0^c . Zero profits for the repo and the stable strategy give the repo-stable indifference, and Lemma B.6 binds the constraint, so ζ_r^c is a fixed point of T — and the lemma leaves exactly one, hence one M_{repo}^c and one $\mathcal{S}_r^c$. The redemption pattern is then forced. On $\mathcal{S}_r^c$, $\gamma_e < \gamma_e^+$ is exactly $\zeta_r^c < \zeta^*$, so no household redeems there. Off $\mathcal{S}_r^c$, with $\mu_e^c > 0$ the

no-redemption case is inconsistent ($\zeta^c = 1 > \zeta^*$), and the threshold case makes the mild states contribute zero to the fund–stable comparison, leaving $\Pi_e^c - \Pi_S^c = -\gamma_r \underline{X}^c < 0$: full redemption is the only consistent case. Zero profits for the mutual fund then pin μ_e^c through (93), worst-state clearing pins $\mu_r^c = \eta(1 - \zeta_r^c)$, and the discount schedule follows from Lemma B.4.

γ_e is the marginal premium paid to the mutual fund per share it issues. γ_e^+ is the maximum marginal premium such that redeeming is *not* the households' best response in states where the repo fund also sells. γ_e^+ falls with $\underline{X}^c$ because more stable funding for bond c means higher liquidation values, and therefore more attractive redemption options, all else equal. For $\gamma_e > \gamma_e^+$, households find it desirable to redeem mutual fund shares in all bad states of the world. We return to this result below. γ_e^- is the minimum marginal premium at which a mutual fund intermediary is willing to set up shop.

Corollary B.2 (Global uniqueness inside the interval). *Fix $\gamma_e \in (\gamma_e^-, \gamma_e^+)$ and maintain the hypotheses of Proposition B.2 and Lemma B.6. Then no equilibrium exists in which the mutual fund operates and the repo does not, and the equilibrium of Proposition B.2 is the unique equilibrium of the model at these parameters.*

Proof. The entry profit of a repo at an arbitrary candidate reduces to an identity in T . Consider any candidate schedule whose discount is a common ζ across the states where an entering repo would sell. The entrant issues repo money $M = \zeta \mathbb{E}_{b,\underline{s}}[X^c]$ and, writing $x = \int_{S_F^c(M)} \mathbb{E}_{b,s}[X^c] dF(s)$, earns relative to the stable strategy (the accounting that produced (89)):

$$\Pi_r^c - \Pi_S^c = \gamma_r (M - \underline{X}^c) - \beta b (1 - \zeta) x = \zeta (\gamma_r \mathbb{E}_{b,\underline{s}}[X^c] + \beta b x) - (\gamma_r \underline{X}^c + \beta b x),$$

so

$$\Pi_r^c - \Pi_S^c = (\gamma_r \mathbb{E}_{b,\underline{s}}[X^c] + \beta b x) [\zeta - T(\zeta)] : \quad (108)$$

repo entry is profitable at exactly the candidates whose discount exceeds the solved discount the map returns. Under (102), $\zeta - T(\zeta)$ is strictly increasing with its unique zero at the fixed point ζ_r^c , so entry is strictly profitable at any candidate with $\zeta > \zeta_r^c$.

Now take a candidate in which the mutual fund operates and the repo does not. With no repo, every bad-news state is a non-selling state for the repo, and the case analysis of the discount schedule leaves two possibilities. If the discount sits at the threshold ζ^* with interior redemption, those states contribute zero to the fund–stable comparison and $\Pi_e^c - \Pi_S^c = -\gamma_r \underline{X}^c < 0$, contradicting zero profits. So the fund's shareholders redeem in every bad state, the discount is the

common $\zeta = 1 - \Gamma\mu_e^c$, and the fund-stable zero-profit condition gives

$$\gamma_r \underline{X}^c = b[(\gamma_e + \beta)\zeta - \beta]\mathbb{E}_b[X^c] \implies \zeta = \zeta^* + \frac{\gamma_r \underline{X}^c}{(\gamma_e + \beta)b\mathbb{E}_b[X^c]} > \zeta^*.$$

Meanwhile $\gamma_e < \gamma_e^+$ is exactly $\zeta_r^c < \zeta^*$. Chaining, $\zeta > \zeta^* > \zeta_r^c$, so (108) is strictly positive: repo entry earns positive profit, condition (i) of the Definition fails, and the candidate is not an equilibrium. A candidate with no unstable type at all fails the same test at $\zeta = 1 > \zeta_r^c$, and a candidate with the repo alone fails mutual-fund entry, since $\gamma_e > \gamma_e^-$ makes (93) positive. Every equilibrium therefore has all three types active, and the uniqueness clause of Proposition B.2 delivers the rest.

The corollary is a statement at fixed parameters: inside the bounds, the equilibrium set is a singleton. Outside the bounds the equilibrium set changes. The next subsection characterizes what replaces the three-type configuration, and Proposition B.3 collects the full partition of $(0, \gamma_r)$.

We make three remarks. First, the upper bound γ_e^+ is positive whenever the repo operates, because $\mu_r^c > 0$ iff $\mathbb{E}_{b,s}[X^c] > \underline{X}^c$. Second, we can state the upper bound in primitives alone.⁶⁹ Third, the interval (γ_e^-, γ_e^+) is nonempty whenever $\underline{X}^c$ is sufficiently below 1.⁷⁰

Global solution

We now have the tools to characterize the unique equilibrium for any value of $\gamma_e \in (0, \gamma_r)$. The key to doing this is the fact that the pair $(\zeta_r^c, M_{\text{repo}}^c)$ is invariant to γ_e : the fixed point (96) is built from the repo-stable indifference and the binding constraint, and neither involves γ_e . This means we can take these fixed points as given, and solve for the remaining quantities which do depend on γ_e and ζ_r^c . The pieces so far: free entry for the stable strategy pins $P_0^c = \gamma_r \underline{X}^c + \beta \mathbb{E}[X^c]$. The repo-stable indifference and the binding constraint deliver the repo block, the fixed point $(\zeta_r^c, M_{\text{repo}}^c, \mathcal{S}_r^c)$ of (96), unique under the slope condition. Worst-state clearing turns ζ_r^c into the repo's share. What remains is the fund's side: its indifference with the stable strategy pins the mild-state discount ζ_e^c , and mild-state clearing turns that into μ_e^c .

⁶⁹The upper bound in (106) contains the selling-state integral, and the set $\mathcal{S}_r^c$ behind it is itself pinned jointly with the repo money (Conjecture 3). To state a condition in primitives alone, bound $\int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF \leq \int_0^1 \mathbb{E}_{b,s}[X^c] dF(s) = \mathbb{E}_b[X^c]$, which only enlarges the left side of (107): the condition

$$\gamma_e (\gamma_r \underline{X}^c + \beta b \mathbb{E}_b[X^c]) < \beta \gamma_r (\mathbb{E}_{b,s}[X^c] - \underline{X}^c) \quad (109)$$

is sufficient for Conjecture 1 whatever the selling set turns out to be.

⁷⁰Cross-multiplying $\gamma_e^- < \gamma_e^+$ (both denominators positive) gives $\underline{X}^c (\gamma_r \underline{X}^c + \beta b \int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF) < \beta b (\int_{(\mathcal{S}_r^c)^c} \mathbb{E}_{b,s}[X^c] dF) (\mathbb{E}_{b,s}[X^c] - \underline{X}^c)$. The left side vanishes with the floor and the right side does not, so a stringent enough capital rule delivers the interval. Bounding $\underline{X}^c \leq 1$ and $\int_{\mathcal{S}_r^c} \mathbb{E}_{b,s}[X^c] dF \leq \mathbb{E}_b[X^c]$ gives the explicit sufficient condition $\underline{X}^c < \beta b \mathbb{E}_{b,s}[X^c] \int_{(\mathcal{S}_r^c)^c} \mathbb{E}_{b,s}[X^c] dF / [\gamma_r + \beta b \mathbb{E}_b[X^c] + \beta b \int_{(\mathcal{S}_r^c)^c} \mathbb{E}_{b,s}[X^c] dF]$, which also implies $\gamma_e^- < \gamma_r$.

Formally, let ζ_r^c be the fixed point of the unique equilibrium of Proposition B.2. Define

$$K \equiv \begin{cases} \gamma_e^-, & \gamma_e \leq \gamma_e^+ \\ \gamma_e^- - (\gamma_e + \beta) (\zeta_r^c - \zeta^*) \frac{\rho^c}{1 - \rho^c}, & \gamma_e > \gamma_e^+, \end{cases} \quad (110)$$

the fund's entry hurdle net of the option value it collects on the repo's selling states. Define γ_e^{**} as the level of γ_e at which μ_e^c reaches $\eta(1 - \zeta_r^c)$ and the repo's share hits zero — equivalently, where the repo's entry profit (108) at the fund-only candidate crosses zero. Above γ_e^{**} the fund sells alone in every bad-news state, so its discount ζ_e^c rules them all, and the fund-stable indifference puts it at $\zeta_e^c = \zeta^* + \gamma_r \lambda^c / [(\gamma_e + \beta) b]$: the formula $\zeta^* + K / (\gamma_e + \beta)$ with an empty selling set, $\rho^c = 0$. The intermediation shares are

$$\mu_e^c = \begin{cases} 0, & \gamma_e \in (0, \gamma_e^-] \\ \frac{\eta}{\gamma_e + \beta} (\gamma_e - K), & \gamma_e \in (\gamma_e^-, \gamma_e^{**}] \\ \eta (1 - \zeta_e^c), & \gamma_e \in (\gamma_e^{**}, \gamma_r) \end{cases} \quad (111)$$

$$\mu_r^c = \begin{cases} \eta (1 - \zeta_r^c), & \gamma_e \in (0, \gamma_e^+] \\ \eta (1 - \zeta_r^c) - \mu_e^c, & \gamma_e \in (\gamma_e^+, \gamma_e^{**}] \\ 0, & \gamma_e \in (\gamma_e^{**}, \gamma_r) \end{cases} \quad (112)$$

and $\mu_\zeta^c = 1 - \mu_r^c - \mu_e^c$ in every region. We assume $K \geq 0$. For $\gamma_e \in (\gamma_e^-, \gamma_e^+]$, $K = \gamma_e^-$ and (111) is (93). Above γ_e^+ the subtraction in K is the option value the fund collects on the selling states, and (111) is continuous at the crossing. Behind the cases sit three equations — worst-state clearing, mild-state clearing, and the fund-stable indifference below — in three unknowns, $(\mu_r^c, \mu_e^c, \zeta_e^c)$. Next, setting $\Pi_e^c = \Pi_\zeta^c$ and using the option decomposition (76) the free-entry condition for mutual funds pins down ζ_e^c :

$$\gamma_r \underline{X}^c = b \int_{\mathcal{S}_e^c} [(\gamma_e + \beta) \zeta^c(s) - \beta] \mathbb{E}_{b,s}[X^c] dF(s). \quad (113)$$

By Lemma B.4 the schedule takes the value ζ_r^c on $\mathcal{S}_r^c$ and ζ_e^c off it. Write γ_e^+ for the level of γ_e at which ζ^* falls to ζ_r^c . The threshold ζ^* is decreasing in γ_e , so the crossing is unique: below γ_e^+ , no household redeems on $\mathcal{S}_r^c$, and above it every household does. (113) then solves region by

region:

$$\zeta_e^c = \begin{cases} 1, & \gamma_e \in (0, \gamma_e^-] \\ \zeta^* + \frac{K}{\gamma_e + \beta}, & \gamma_e \in (\gamma_e^-, \gamma_e^{**}] \\ \zeta^* + \frac{\gamma_r}{b} \frac{\lambda^c}{\gamma_e + \beta}, & \gamma_e \in (\gamma_e^{**}, \gamma_r) \end{cases} \quad (114)$$

In the first region nobody sells in the mild states and prices sit at conditional fundamentals. In the last region the repo is out and the fund's discount rules every bad-news state. Figure B.2 draws the two discounts and the intermediation shares across the regions.

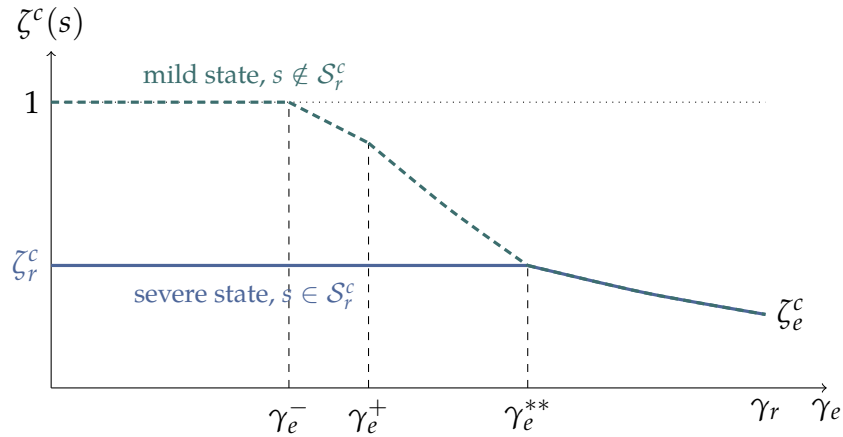


Figure B.2: The fire-sale discount in two states, as a function of γ_e : a severe state inside the repo's selling set (solid) and a mild state outside it (dashed). The severe state's discount is the repo block's ζ_r^c , flat across the first three regions. The mild state's discount is one until the fund enters at γ_e^- , falls as entry deepens the mild-state fire sale, and falls faster above γ_e^+ , where the fund redeems in the severe states too. The two curves meet at the repo's exit γ_e^{**} and coincide beyond it: one discount, ζ_e^c , rules every bad-news state.

Proposition B.3 characterizes the solutions across these regions, holding the payoff distributions and the remaining parameters fixed and maintaining, in each market, the hypotheses used above: $\underline{X}^c > 0$, $\underline{X}^c(\underline{s}) < \underline{X}^c$, an interior selling set, and the slope condition (102). The threshold γ_e^{**c} is defined above.

When γ_e is small ($\gamma_e < \gamma_e^-$), only the stable intermediaries and the repo fund operate. The option value of redemption at equilibrium fire-sale prices is too low for any mutual fund to enter. When γ_e is at intermediate values ($\gamma_e^- < \gamma_e < \gamma_e^+$), the mutual fund operates alongside the repo fund and the stable intermediaries, but always sells at a strictly higher fire-sale discount than does the repo fund (Proposition B.2). When γ_e is large ($\gamma_e > \gamma_e^+$), the mutual fund operates

alongside the repo fund, and sells at both high and low fire-sale discounts, depending on the state. However, when γ_e is large enough ($\gamma_e > \gamma_e^{**}$), the option value of redemption for the mutual fund is so great that it crowds out the value of money creation by repo funds, and the repo fund exits. Across the first three regions the worst-state discount never moves. The premium reshuffles who conducts unstable intermediation and at what mild-state price, while the repo block holds the worst state fixed. Only after the repo exits does γ_e reach the worst-state price, which then deepens as the fund's own sales grow.

Proposition B.3 (Regions of equilibrium). *Fix a market c and let $\gamma_e \in (0, \gamma_r)$ lie off the boundary points $\{\gamma_e^{-c}, \gamma_e^{+c}, \gamma_e^{**c}\}$. Then:*

- (i) *For $\gamma_e < \gamma_e^{-c}$, there is a unique equilibrium. The stable strategy and the repo operate; the mutual fund does not. Prices off $\mathcal{S}_r^c$ sit at conditional fundamentals. There is one fire-sale price, ζ_r^c .*
- (ii) *For $\gamma_e^{-c} < \gamma_e < \gamma_e^{+c}$, there is a unique equilibrium. All three intermediation types operate, and the repo's sales and the mutual fund's redemptions occur in mutually exclusive states (Proposition B.2 and Corollary B.2). There are two fire-sale prices, ζ_r^c and $\zeta_e^c > \zeta_r^c$, and the mutual fund sells at the higher one.*
- (iii) *For $\gamma_e^{+c} < \gamma_e < \gamma_e^{**c}$ (and $K > 0$), there is a unique equilibrium. All three types operate; the mutual fund redeems in every bad-news state, so sales overlap on $\mathcal{S}_r^c$. There are two fire-sale prices, and the mutual fund sells at both, depending on the state.*
- (iv) *For $\gamma_e^{**c} < \gamma_e < \gamma_r$, when $\gamma_e^{**c} < \gamma_r$, there is a unique equilibrium. The stable strategy and the mutual fund operate; the repo does not. There is one fire-sale price, ζ_e^c .*

The repo block — $(\zeta_r^c, M_{repo}^c, \mathcal{S}_r^c)$ — is the same across (i)–(iii).

Proof. Region (ii) is Proposition B.2 with Corollary B.2. The other regions reuse the same ingredients. The repo block $(\zeta_r^c, M_{repo}^c, \mathcal{S}_r^c)$ solves (96) in any configuration where the repo operates, and the slope condition makes the fixed point unique, so the block carries unchanged across (i)–(iii). In region (i), the fund–stable indifference has no admissible solution — (114) returns $\zeta_e^c \geq 1$ — so the fund stays out, and repo entry at any candidate without the repo is strictly profitable by the entry identity (108). Worst-state clearing pins μ_r^c , and nobody sells in the mild states. In region (iii), $\zeta_r^c > \zeta^*$ forces full redemption on the selling states by the redemption rule (81), the indifference pins ζ_e^c as in (114) with $K > 0$ keeping it above ζ^* , clearing pins the shares, and $\mu_r^c \geq 0$ defines the region's upper boundary. In region (iv), the fund-only configuration solves the indifference at the single discount ζ_e^c , and repo entry is unprofitable because $\zeta_e^c < \zeta_r^c$ above γ_e^{**} and (108) signs entry by $\zeta_e^c - T(\zeta_e^c)$. Uniqueness in each region follows as in the corollary: the case analysis of the discount schedule forces the redemption pattern, and zero profits pin the remaining objects.

B.2.3 Intermediary sorting across currencies

Now that we have the solution characterized, we can describe how intermediation differs across currencies in equilibrium. To do this, we first extend assumptions A1-A2 from the main text to be useful in this setting with a larger state space. A1' carries A1 over unchanged: the capital rule accepts losses less often than the sovereign defaults, so each floor $\underline{X}^c$ is a default-tail outcome. A2' extends A2 severity by severity. Conditional on every bad-news severity, default arrives with above-average depreciation, and the depreciation weakly deepens as severity rises. Under A1'–A2' the value-at-risk ordering of the main text holds state by state — $\underline{X}^L(s)$ falls relative to $\underline{X}^H(s)$ as severity rises — and the unconditional orderings $\underline{X}^L < \underline{X}^H$ and $\lambda^L < \lambda^H$ carry over.

We extend A2 to A2', which claims that the worst-case depreciation is indexed by severity of the bad news. Conditional on bad news of severity s , the local bond's conditional payoffs are the hard bond's deflated by the depreciation profile $e(s)$:

$$\mathbb{E}_{b,s}[X^L] = \frac{\mathbb{E}_{b,s}[X^H]}{e(s)}, \quad \underline{X}^L(s) = \frac{\underline{X}^H(s)}{e(s)}, \quad e(s) \geq 1 \text{ nondecreasing.} \quad (115)$$

A nondecreasing e is the severity form of the Twin-D assumption: worse news arrives with weakly deeper depreciation, and the worst state carries the deepest, $e(\underline{s}) = e(1)$. The unconditional floors $\underline{X}^c$ are not restricted. The bound they satisfy is supplied by the sale rule inside the proof.

Proposition B.4 (Sorting into local currency). *Let both markets be in the equilibrium of Proposition B.2, with the slope condition (102) holding in each, and let the payoff distributions satisfy (115). Then $\gamma_e^{-L} < \gamma_e^{-H}$, and for every γ_e inside both markets' coexistence intervals, $\mu_e^L > \mu_e^H$: the mutual fund's share is larger in the local market.*

The proof runs in three steps, each on objects already constructed. The first step orders the selling sets: $s^{*L} \geq s^{*H}$, where s^{*c} is the cutoff severity above which the repo sells, pinned by $\underline{X}^c(s^{*c}) = M_{\text{repo}}^c$. Evaluating the local market's fixed point at the hard market's cutoff, depreciation lifts the marginal state's worst case relative to the local worst-state fundamental by the full tilt $e(1)/e(s^{*H})$, while the local break-even discount cannot rise as much: it is a weighted average of the floor ratio and one, and the one does not depreciate. The floor bound this comparison needs, $\underline{X}^L \leq \underline{X}^H/e(s^{*H})$, is supplied by the sale rule — off the selling set the worst-case payoff exceeds the money, which exceeds the floor, so the floor's π -tail lives on the selling set, where depreciation is at least $e(s^{*H})$. The second step orders the value shares: $\rho^L \leq \rho^H$, because deflating by a nondecreasing profile concentrates the local bond's bad-news value in the mild states, and the higher local cutoff keeps still more value off the selling set. The third step reads the result off the entry threshold (95): γ_e^{-c} is the safety ratio over the non-selling value share, the value-at-risk

lemma orders the numerators, the second step orders the denominators, and (94) converts the threshold ordering into the share ordering.

B.3 Additional details for and extensions of the model in Section 4

B.3.1 Further details on debt supply and repayments

Section 4 states the bond payoffs per unit of face value. Here we derive them from the repayment rule. In every state the sovereign distributes its resources *pari passu*: local-currency creditors receive the share θ/B of total repayments and hard-currency creditors the share $(1 - \theta)\mathcal{E}/B$, where $B = \theta + (1 - \theta)\mathcal{E}$ is the face value of all obligations in local currency, (2). Total repayments stated in local currency are

$$\min\{Z, B\} = XB, \quad (116)$$

with $X = \min\{1, Z/B\}$ the recovery ratio. Local-currency creditors therefore receive θX units of local currency in total, or X per unit of face value, which is worth $X\mathcal{E}^{-1}$ in hard currency. Hard-currency creditors receive $(1 - \theta)\mathcal{E}X$ units of local currency, or $\mathcal{E}X$ per unit of face value, which is worth X in hard currency. These are the payoffs $X^L = X\mathcal{E}^{-1}$ and $X^H = X$ of Section 4. In the good-news state, $Z \geq B$ with certainty, so $X = 1$, $X_g^H = 1$, and $X_g^L = \mathcal{E}^{-1}$; unconditional expected payoffs decompose as

$$\mathbb{E}[X^c] = g \mathbb{E}_g[X^c] + b \mathbb{E}_b[X^c]. \quad (117)$$

B.3.2 Details of the risk-based capital regime for stable-funding intermediaries

Financiers have access to a government guarantee scheme which provides indemnities against losses on their portfolios, allowing them to issue guaranteed claims backed by risky bonds. As in many real-world schemes, participation requires meeting capital requirements: the tax authority operating the scheme accepts losses with probability at most π , and requires equity funding against any payoffs falling short with probability π or greater.⁷¹ The capital required to finance one unit of bond c is $1 - \underline{X}^c(\pi)$, with $\underline{X}^c(\pi)$ defined in (6). Lemma 1, proven in Appendix B.1.2, orders the two bonds' floors under A1–A2. Here we show that the ordering survives weaker assumptions in a lognormal parameterization.

⁷¹In 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 lognormal case under weaker assumptions. We now allow appreciation in default with positive probability. Let $(z, e) = (\log Z, \log \mathcal{E})$ be jointly normal conditional on bad news, with means (μ_z, μ_e) , variances (σ_z^2, σ_e^2) , and covariance σ_{ze} , and consider:

- (i) $\sigma_z \leq \sigma_e$: exchange rates are more volatile than the local-currency fiscal position;
- (ii) $\mu_e \geq 0$: the local currency is weakly expected to depreciate conditional on bad news;
- (iii) $\sigma_{ze} \leq 0$: depreciation accompanies bad fiscal news, $\text{Cov}(z, e) \leq 0$;
- (iv) $\pi < \Pr(\text{default})$ at the corner considered.

At the corners $\theta \in \{0, 1\}$, write the log recovery in hard currency as $x^H = \min\{0, w\}$, where

$$w = z \quad (\theta = 1), \quad w = v \equiv z - e \quad (\theta = 0),$$

and in both cases $x^L = x^H - e = \min\{-e, w - e\}$. The corner distributions are

$$\begin{aligned} F_H(x; \theta) &= \Pr(w < x), \quad x < 0, \\ F_L(x; 1) &= \Pr(z \geq 0, -e < x) + \Pr(z < 0, v < x), \\ F_L(x; 0) &= \Pr(v \geq 0, -e < x) + \Pr(v < 0, v - e < x). \end{aligned}$$

Claim: under (ii)–(iv), $\underline{X}^L(\pi) < \underline{X}^H(\pi)$ at both corners.

Proof. By (iv), $\underline{x}^H(\pi) = Q_\pi(w) = \mu_w - |\Phi^{-1}(\pi)|\sigma_w$, where Q_π denotes the π -quantile and $|\Phi^{-1}(\pi)|$ the absolute value of the standard normal π -quantile. Since $x^L \leq w - e$ pointwise, $F_L(x) \geq \Pr(w - e \leq x)$ and therefore

$$\underline{x}^L(\pi) \leq Q_\pi(w - e) = \mu_w - \mu_e - |\Phi^{-1}(\pi)|\sigma_{w-e}.$$

Subtracting,

$$\underline{x}^L(\pi) - \underline{x}^H(\pi) \leq -\mu_e - |\Phi^{-1}(\pi)|(\sigma_{w-e} - \sigma_w).$$

The variance of the difference is

$$\sigma_{w-e}^2 = \sigma_w^2 + \sigma_e^2 - 2\text{Cov}(w, e), \quad \text{Cov}(w, e) = \begin{cases} \sigma_{ze} & (\theta = 1) \\ \sigma_{ze} - \sigma_e^2 & (\theta = 0) \end{cases}$$

so under (iii), $\text{Cov}(w, e) \leq 0$ at both corners and $\sigma_{w-e}^2 \geq \sigma_w^2 + \sigma_e^2 > \sigma_w^2$. Hence $\sigma_{w-e} - \sigma_w > 0$,

and with (ii),

$$\underline{x}^L(\pi) - \underline{x}^H(\pi) \leq -|\Phi^{-1}(\pi)| (\sigma_{w-e} - \sigma_w) < 0. \quad \square$$

The exact requirement is $\mu_e > -|\Phi^{-1}(\pi)| (\sigma_{w-e} - \sigma_w)$: condition (ii) is a simple sufficient version, and the ordering tolerates expected *appreciation* up to a π -tail multiple of the volatility gap. Condition (i) delivers a primitive bound on that tolerance at $\theta = 1$: (iii) implies $\sigma_v \geq \sigma_e$, so with (i), $\sigma_v - \sigma_z \geq \sigma_e - \sigma_z \geq 0$ and the tolerance is at least $|\Phi^{-1}(\pi)|(\sigma_e - \sigma_z)$.

B.3.3 Fire-sale arbitrageurs as a third strategy

Consider an equilibrium in which both the unstable and dry-powder strategies are pursued. In this subsection b is the probability of bad news and β the household discount factor, as in Section 4. A fund that holds dry powder at $t = 0$ to arbitrage the fire-sale price earns expected discounted profit

$$\Pi_F^c = b\beta(\mathbb{E}_b[X^c] - P_b^c) - \beta.$$

Imposing $\Pi_F^c = \Pi_U^c$, substituting the $t = 0$ pricing condition $P_0^c = \gamma \underline{X}^c + \beta \mathbb{E}[X^c]$, and using $\mathbb{E}[X^c] = b \mathbb{E}_b[X^c] + g \mathbb{E}_g[X^c]$, algebra yields

$$P_b^c = \frac{\gamma \underline{X}^c + 2\beta b \mathbb{E}_b[X^c] - \beta}{\gamma + 2b\beta}.$$

This price is strictly below fundamentals: $P_b^c < \mathbb{E}_b[X^c]$ iff $\gamma(\underline{X}^c - \mathbb{E}_b[X^c]) < \beta$, which holds for any $\beta > 0$ since the left-hand side is negative by construction of $\underline{X}^c$.

Comparing to the baseline fire-sale price $\tilde{P}_b^c = \frac{\gamma \underline{X}^c + \beta b \mathbb{E}_b[X^c]}{\gamma + b\beta}$ of Lemma B.1, we have $\tilde{P}_b^c < P_b^c < \mathbb{E}_b[X^c]$ whenever the dry-powder strategy is profitable at baseline (equivalently, whenever $b\gamma(\mathbb{E}_b[X^c] - \underline{X}^c) > \gamma + b\beta$). The dry-powder strategy mitigates the fire-sale discount but does not eliminate it.

Two key results survive in this extended model: (i) unstable funds remain a positive-measure equilibrium type, and (ii) the fire-sale price is strictly below fundamentals. The profit function above treats the dry-powder unit as costing β at $t = 0$ and as earning nothing after good news.

B.3.4 Hedging

Section 5 argues that hedging by stable intermediaries does not eliminate sorting in equilibrium: providing a hedge requires some foreign agent to take the other side of the exchange-rate exposure, and that agent's claims are priced by the same households. This subsection adds a fourth strategy, in which a stable intermediary holds the local-currency bond and hedges its currency

exposure with a forward contract, and asks whether it displaces the sorting of Section 4. The forward-pricing result is exact. The conclusion that sorting survives is stated with the step that remains open.

Environment. In addition to bonds, foreign intermediaries may trade a forward contract at $t = 0$ among themselves. Households and domestic investors do not trade it. One unit of the contract pays the long side $F^{-1} - \mathcal{E}^{-1}$ units of hard currency at $t = 2$, where F is the forward exchange rate in units of local currency per unit of hard currency; the short side pays the opposite. The contract is in zero net supply and has no price at $t = 0$; F adjusts to clear it. Because a forward position has negative payoff in some states, it backs no money-like claim on its own.

Lemma B.7 (Short-dated hedges are ineffective). *Any contract settled at $t = 1$ has a payoff independent of $\mathcal{E}$.*

Proof. The exchange rate is fixed at one until $t = 2$. A contract settled at $t = 1$ is a function of $t = 1$ variables, none of which is $\mathcal{E}$.

Rolling short-dated forwards therefore cannot hedge the $t = 2$ exposure of a bond held to maturity. This is the model's version of the observation in Section 5 that long-horizon hedges are unavailable in the currencies we study. Only a forward settled at $t = 2$ hedges the bond.

Pricing by the counterparty. Consider an unstable intermediary holding one unit of the hard-currency bond that takes a short position of n units in the forward. After bad news, the intermediary liquidates. A stable intermediary, risk neutral and holding to maturity, pays the expected payoff for the forward position, so its $t = 1$ market value is $n (\mathbb{E}_b[\mathcal{E}^{-1}] - F^{-1})$, and the intermediary's liquidation value and money capacity are $M_U^H(n) = P_b^H + n (\mathbb{E}_b[\mathcal{E}^{-1}] - F^{-1})$. After good news the position is held to maturity. Expected profit is

$$\Pi_U^H(n) = (\gamma + \beta) M_U^H(n) + \beta g \left(\mathbb{E}_g[X^H] + n (\mathbb{E}_g[\mathcal{E}^{-1}] - F^{-1}) - M_U^H(n) \right) - P_0^H,$$

and the marginal profit from providing hedges is

$$\frac{d\Pi_U^H}{dn} = (\gamma + b\beta) (\mathbb{E}_b[\mathcal{E}^{-1}] - F^{-1}) + g\beta (\mathbb{E}_g[\mathcal{E}^{-1}] - F^{-1}).$$

Free entry into providing hedges sets this to zero.

Lemma B.8 (Forward premium). *When unstable intermediaries provide hedges competitively, the forward rate satisfies*

$$F^{-1} = \mathbb{E}[\mathcal{E}^{-1}] - \frac{g\gamma}{\gamma + \beta} \left(\mathbb{E}_g[\mathcal{E}^{-1}] - \mathbb{E}_b[\mathcal{E}^{-1}] \right). \quad (118)$$

Under (65), the hard currency trades at a forward premium, $F^{-1} < \mathbb{E}[\mathcal{E}^{-1}]$. The premium is proportional to γ and vanishes when $\gamma = 0$.

Proof. Setting the marginal profit to zero and collecting terms,

$$\begin{aligned} F^{-1}(\gamma + b\beta + g\beta) &= (\gamma + b\beta) \mathbb{E}_b[\mathcal{E}^{-1}] + g\beta \mathbb{E}_g[\mathcal{E}^{-1}] \\ F^{-1} &= \left[(\gamma + b\beta) \mathbb{E}_b[\mathcal{E}^{-1}] + g\beta \mathbb{E}_g[\mathcal{E}^{-1}] \right] / (\gamma + \beta), \end{aligned}$$

implying

$$\begin{aligned} \mathbb{E}[\mathcal{E}^{-1}] - F^{-1} &= \frac{(\gamma + \beta) (b \mathbb{E}_b[\mathcal{E}^{-1}] + g \mathbb{E}_g[\mathcal{E}^{-1}]) - (\gamma + b\beta) \mathbb{E}_b[\mathcal{E}^{-1}] - g\beta \mathbb{E}_g[\mathcal{E}^{-1}]}{\gamma + \beta} \\ &= \frac{g\gamma (\mathbb{E}_g[\mathcal{E}^{-1}] - \mathbb{E}_b[\mathcal{E}^{-1}])}{\gamma + \beta}. \end{aligned}$$

The counterparty's money-like claims are backed by liquidation value, and the short forward loses value exactly in the state in which they are redeemed. The counterparty is compensated through the forward rate rather than through an upfront price, and the compensation is the money-creation cost it bears, scaled by γ . This is the sense in which a transfer of carry-trade risk to unstable intermediaries is priced rather than absorbed.

The hedger's decision. A stable intermediary holding one unit of the local-currency bond and long one unit of the forward has terminal payoff $X^L + F^{-1} - \mathcal{E}^{-1} = F^{-1} - (1 - X)\mathcal{E}^{-1}$: the hedge removes currency risk in repayment states but leaves the depreciated hard-currency value of the shortfall in default. Let $\underline{X}_h^L(\pi)$ be the π -quantile of this payoff conditional on bad news and $\Delta_h \equiv \underline{X}_h^L(\pi) - \underline{X}^L(\pi) \geq 0$ the gain in the guaranteed floor. The hedged stable profit is

$$\Pi_{S,h}^L = \Pi_S^L + \gamma \Delta_h + \beta \left(F^{-1} - \mathbb{E}[\mathcal{E}^{-1}] \right) = \Pi_S^L + \gamma \left[\Delta_h - \frac{g\beta}{\gamma + \beta} \left(\mathbb{E}_g[\mathcal{E}^{-1}] - \mathbb{E}_b[\mathcal{E}^{-1}] \right) \right],$$

using (118). Hedging is privately adopted if and only if the gain in the guaranteed floor exceeds the forward premium per unit of money value,

$$\Delta_h > \frac{g\beta}{\gamma + \beta} \left(\mathbb{E}_g[\mathcal{E}^{-1}] - \mathbb{E}_b[\mathcal{E}^{-1}] \right). \quad (119)$$

Capacity. The counterparty's money capacity cannot be negative, $M_U^H(n) \geq 0$, so each unit of hard-currency bond under unstable funding can provide at most $n \leq P_b^H / (F^{-1} - \mathbb{E}_b[\mathcal{E}^{-1}])$ units of hedge. Aggregate hedge supply from unstable hard-currency intermediaries is therefore at most $\mu^H(1 - \theta)P_b^H / (F^{-1} - \mathbb{E}_b[\mathcal{E}^{-1}])$, against a local-currency book of size θ held by stable intermediaries in proportion $1 - \mu^L$. A stable counterparty can also provide hedges; its floor, rather than its liquidation value, then falls, and the same accounting applies with the π -quantile in place of the bad-news mean.

B.4 Further details and proofs for Section 7

B.4.1 Notation and bond-pricing assumptions

Section 7 indexes the fiscal surplus by period, Z_0, Z_1, Z_2 . In this appendix $Z \equiv Z_2$, so that the terminal objects $B, X, \mathcal{E}$, and D are those of Section 4 and Appendix B.3.1. We write $\mathbb{L}$ and $\mathbb{H}$ for the risk-neutral measures of the sovereign and of foreign households. The expectation operator $\mathbb{E}$ of Section 4 is $\mathbb{E}^{\mathbb{H}}$, and the discount factor β of Section 4 is β^H . Expectations conditional on bad news are subscripted with b under both measures. Assumptions A3 and A4 are as stated in Section 7: $\beta^H \mathbb{E}^{\mathbb{H}}[\mathcal{E}^{-1}] = \beta^L$ and $\mathbb{E}^{\mathbb{H}}[\mathcal{E}^{-1}] = 1$. Throughout this appendix the capital floors $\underline{X}^c$ are treated as constants, as in Section 4.

B.4.2 Government budget and net revenue

The claim in Section 7 is that under A3 and A4, net revenue from issuance equals $\gamma \left(\theta \underline{X}^L + (1 - \theta) \underline{X}^H \right)$, so that its derivative in θ is $\gamma(\underline{X}^L - \underline{X}^H) < 0$.

Proof. Step 1: Government budget. The government's net transfers T_t are given by (20). Repayments in $t = 2$, stated in local currency, are XB : the local-currency bond pays X per unit and the hard-currency bond pays X units of hard currency, or $\mathcal{E}X$ units of local currency, so that

$$\theta X + (1 - \theta) \mathcal{E}X = XB = \min\{B, Z\},$$

as in (116). The sovereign values $t = 2$ resources at its discount factor β^L under $\mathbb{L}$, as in (24).

Net revenue from issuance is therefore

$$\theta P_0^L + (1 - \theta)P_0^H - \beta^L \mathbb{E}^{\mathbb{L}}[XB].$$

Step 2: Issue prices. From Lemma B.1, $P_0^c = \gamma \underline{X}^c + \beta^H \mathbb{E}^{\mathbb{H}}[X^c]$. Since the initial exchange rate is one, these prices are also in local-currency units. Gross revenue is

$$\theta P_0^L + (1 - \theta)P_0^H = \gamma \left(\theta \underline{X}^L + (1 - \theta) \underline{X}^H \right) + \beta^H \left(\theta \mathbb{E}^{\mathbb{H}}[X^L] + (1 - \theta) \mathbb{E}^{\mathbb{H}}[X^H] \right).$$

Step 3: Change of numeraire. The Radon–Nikodym derivative from $\mathbb{L}$ to $\mathbb{H}$ is $d\mathbb{H}/d\mathbb{L} = (\beta^L/\beta^H)\mathcal{E}$. It integrates to one because $\mathbb{E}^{\mathbb{L}}[\mathcal{E}] = \beta^H/\beta^L$, which is A3 restated under $\mathbb{L}$. For each bond,

$$\beta^H \mathbb{E}^{\mathbb{H}}[X^c] = \beta^H \mathbb{E}^{\mathbb{L}} \left[\frac{\beta^L}{\beta^H} \mathcal{E} X^c \right] = \beta^L \mathbb{E}^{\mathbb{L}}[\mathcal{E} X^c].$$

With $X^L = X\mathcal{E}^{-1}$ and $X^H = X$, we have $\mathcal{E}X^L = X$ and $\mathcal{E}X^H = \mathcal{E}X$. Summing over bonds,

$$\beta^H \left(\theta \mathbb{E}^{\mathbb{H}}[X^L] + (1 - \theta) \mathbb{E}^{\mathbb{H}}[X^H] \right) = \beta^L \mathbb{E}^{\mathbb{L}}[\theta X + (1 - \theta) \mathcal{E}X] = \beta^L \mathbb{E}^{\mathbb{L}}[XB].$$

Step 4: Net revenue. Substituting Steps 2 and 3 into the net-revenue expression from Step 1:

$$\theta P_0^L + (1 - \theta)P_0^H - \beta^L \mathbb{E}^{\mathbb{L}}[XB] = \gamma \left(\theta \underline{X}^L + (1 - \theta) \underline{X}^H \right). \quad (120)$$

The derivative in θ is $\gamma(\underline{X}^L - \underline{X}^H)$, which is negative by Lemma 1(i).

B.4.3 Expected payoffs under the two numeraires

The following lemma relates expected payoffs on local- and hard-currency bonds under the two numeraires. The covariance terms are the “quanto adjustments” of Du and Schreger (2016). The lemma is stated conditional on bad news, which is the only state in which payoffs are random.

Lemma B.9 (Expected payoffs under the two numeraires). *Conditional on bad news and under A2,*

$$\begin{aligned} \mathbb{E}_b^{\mathbb{H}}[X^L] &= \mathbb{E}_b^{\mathbb{H}}[X^H] \mathbb{E}_b^{\mathbb{H}}[\mathcal{E}^{-1}] + \text{Cov}_b^{\mathbb{H}}(X^H, \mathcal{E}^{-1}), & \text{Cov}_b^{\mathbb{H}}(X^H, \mathcal{E}^{-1}) &\geq 0, \\ \mathbb{E}_b^{\mathbb{L}}[X^H] &= \mathbb{E}_b^{\mathbb{L}}[X^L] \mathbb{E}_b^{\mathbb{L}}[\mathcal{E}] + \text{Cov}_b^{\mathbb{L}}(X^L, \mathcal{E}), & \text{Cov}_b^{\mathbb{L}}(X^L, \mathcal{E}) &\leq 0. \end{aligned}$$

Under the hard-currency numeraire, the local-currency bond’s expected payoff exceeds that of the hard-currency bond scaled by the expected value of the local currency; under the local-currency numeraire the

ranking reverses.

Proof. The two identities are $\mathbb{E}[XY] = \mathbb{E}[X]\mathbb{E}[Y] + \text{Cov}(X, Y)$ applied to $X^L = X^H \mathcal{E}^{-1}$ under $\mathbb{H}$ and to $X^H = X^L \mathcal{E}$ under $\mathbb{L}$.

The first covariance sign is established in the proof of Lemma 1, part (ii), under the measure of Section 4, which is $\mathbb{H}$.

For the second, A2 states that $\mathcal{E} \geq \mathbb{E}_b^{\mathbb{H}}[\mathcal{E}]$ in default. The same holds under $\mathbb{L}$: the Radon–Nikodym derivative $d\mathbb{H}/d\mathbb{L}$ is proportional to $\mathcal{E}$, also conditional on bad news, so $\mathbb{E}_b^{\mathbb{H}}[\mathcal{E}] = \mathbb{E}_b^{\mathbb{L}}[\mathcal{E}^2]/\mathbb{E}_b^{\mathbb{L}}[\mathcal{E}] \geq \mathbb{E}_b^{\mathbb{L}}[\mathcal{E}]$ by Jensen’s inequality, and therefore $\mathcal{E} \geq \mathbb{E}_b^{\mathbb{L}}[\mathcal{E}]$ in default. Now write $X^L = X\mathcal{E}^{-1} = \mathcal{E}^{-1} - \mathcal{E}^{-1}(1 - X)D$. The covariance of $\mathcal{E}^{-1}$ with $\mathcal{E}$ is nonpositive because $\mathcal{E}^{-1}$ is a decreasing function of $\mathcal{E}$. For the second term, $\text{Cov}_b^{\mathbb{L}}(-\mathcal{E}^{-1}(1 - X)D, \mathcal{E}) = -\mathbb{E}_b^{\mathbb{L}}[\mathcal{E}^{-1}(1 - X)D(\mathcal{E} - \mathbb{E}_b^{\mathbb{L}}[\mathcal{E}])]$. The factor $\mathcal{E}^{-1}(1 - X)D$ is nonnegative and vanishes outside default; in default, $\mathcal{E} \geq \mathbb{E}_b^{\mathbb{L}}[\mathcal{E}]$ as just shown. The expectation is therefore nonnegative and the covariance nonpositive. Summing the two terms, $\text{Cov}_b^{\mathbb{L}}(X^L, \mathcal{E}) \leq 0$.

B.4.4 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. Section 7 states the profit problem for domestic investors in local-currency projects in (22). Secondary-market investors in *hard-currency projects* have profit function

$$\max_{q^H} \quad \pi_b^H = \mathbb{E}^{\mathbb{L}}[\mathcal{E}R(\iota^H)] + q^H \mathbb{E}_b^{\mathbb{L}}[X^H] \quad \text{subject to} \quad \iota^H + P_b^H q^H = 1. \quad (121)$$

Both the project return and the bond payoff of the hard-currency investor are stated in hard currency, so the common exchange-rate factor cancels from the first-order condition and the solution is symmetric to the local-currency case.

Solution. With $R(\iota) = \iota^{1-\rho}/(1-\rho)$ and the budget constraint $q^c = (1 - \iota^c)/P_b^c$, the objective of an investor in currency c is $(\iota^c)^{1-\rho}/(1-\rho) + (1 - \iota^c)/\zeta^c$, using $\mathbb{E}_b[X^c]/P_b^c = 1/\zeta^c$. The first-order condition $(\iota^c)^{-\rho} = 1/\zeta^c$ gives

$$\iota_b^c = (\zeta^c)^{1/\rho}, \quad P_b^c q_b^c = 1 - (\zeta^c)^{1/\rho}. \quad (122)$$

Each investor’s hard-currency value of bond purchases is $1 - (\zeta^c)^{1/\rho}$, and with η^c investors the aggregate value absorbed is $\eta^c (1 - (\zeta^c)^{1/\rho})$. When $\rho = 1$, this is $\eta^c(1 - \zeta^c)$, the demand curve (8) of Section 4, read as the value of bonds absorbed. Section 4 equates Q^c to the number of units liquidated, $\mu^c B_0^c$, while the bad-news market-clearing statement of Section 7 equates the

value absorbed, $\mu^c B_0^c P_b^c$, to $\eta^c (1 - (\zeta^c)^{1/\rho})$. The two coincide only up to the factor P_b^c ; we flag the discrepancy and leave both statements as in the main text.

Aggregate investment in domestic projects in currency c is $I_b^c = \eta^c (\zeta^c)^{1/\rho}$ by (122), or equivalently, by each investor's budget constraint, the endowment less the value of bonds absorbed, $I_b^c = \eta^c - \mu^c B_0^c P_b^c = B_0^c (\eta - P_b^c \mu^c)$ under $\eta^c = \eta B_0^c$, as stated in Section 7.

Value of domestic investment. Substituting (122) into the objective, the profit of an investor in currency c is $\pi_b^c = \rho (\zeta^c)^{(1-\rho)/\rho} / (1 - \rho) + 1/\zeta^c$. The value of that investor's activity to the debt manager adds the spillover $\alpha R(\iota_b^c)$:

$$v(\zeta^c) \equiv \pi_b^c + \alpha R(\iota_b^c) = \frac{\alpha + \rho}{1 - \rho} (\zeta^c)^{\frac{1-\rho}{\rho}} + \frac{1}{\zeta^c}. \quad (123)$$

Summing over investors, the profits of domestic investors in the bad-news state are $\Pi_b^D = \sum_c \eta^c \pi_b^c$, and the value of domestic investment to the debt manager, profits plus spillovers, is

$$V(\theta) \equiv \Pi_b^D + \alpha \sum_{c \in \{L, H\}} \eta^c R(\iota_b^c) = \sum_{c \in \{L, H\}} \eta^c v(\zeta^c) = \eta \left[\theta v(\zeta^L) + (1 - \theta) v(\zeta^H) \right], \quad (124)$$

using $\eta^L = \eta \theta$ and $\eta^H = \eta (1 - \theta)$. V depends on the policy variable θ through the fire-sale discounts ζ^c and through the masses of investors in each market. Outside the bad-news state, the corresponding value is $\eta R(1)(1 + \alpha)$, which does not depend on θ .

B.4.5 Proof of Lemma 2

The Lemma states that local-currency debt crowds out domestic investment relative to hard-currency debt. Using (122) and $\eta^L = \eta \theta$, $\eta^H = \eta (1 - \theta)$, aggregate investment in domestic projects in the bad-news state is

$$I_b = \eta \left[\theta (\zeta^L)^{1/\rho} + (1 - \theta) (\zeta^H)^{1/\rho} \right].$$

Totally differentiating yields

$$\frac{dI_b}{d\theta} = \eta \left[\underbrace{(\zeta^L)^{1/\rho} - (\zeta^H)^{1/\rho}}_{\text{bond supply effect, } < 0} + \frac{1}{\rho} \underbrace{\left(\theta (\zeta^L)^{\frac{1}{\rho}-1} \frac{\partial \zeta^L}{\partial \theta} + (1 - \theta) (\zeta^H)^{\frac{1}{\rho}-1} \frac{\partial \zeta^H}{\partial \theta} \right)}_{\text{credit risk effect, } < 0} \right].$$

The first term is negative by Corollary 1(i), $\zeta^L < \zeta^H$. The second term is negative because ζ^c is decreasing in θ for both bonds by Lemma B.10(iii), proven in Appendix B.4.6. The display in Section 7 omits the factor $(\zeta^c)^{1/\rho-1}/\rho$ on the credit-risk term; the sign is unaffected.

B.4.6 Response of ζ^c to θ

We start with a result on how expected bond payoffs and fire-sale discounts respond to θ , which supports Lemma 2 and Proposition 2. Throughout, $\mathbb{E}_b$ denotes the bad-news expectation under either numeraire; the derivative formulas below hold pointwise and therefore under both.

Lemma B.10 (Response of expected payoffs and fire-sale discounts to the policy θ). *Under A1–A2, and treating the capital floors $\underline{X}^c$ as constants:*

(i) *the expected bad-news payoff on each bond is strictly increasing in θ ,*

$$\frac{\partial \mathbb{E}_b[X^c]}{\partial \theta} = \mathbb{E}_b \left[\frac{Z(\mathcal{E} - 1)}{B^2} \mathcal{E}^{-1\{c=L\}} D \right] > 0; \quad (125)$$

(ii) *the expected bad-news payoff on each bond is convex in θ ,*

$$\frac{\partial^2 \mathbb{E}_b[X^c]}{\partial \theta^2} = 2 \mathbb{E}_b \left[\frac{Z(\mathcal{E} - 1)^2}{B^3} \mathcal{E}^{-1\{c=L\}} D \right] \geq 0; \quad (126)$$

(iii) *the safety ratio λ^c and the fire-sale discount factor ζ^c are strictly decreasing in θ .*

Proof. Derivatives of the recovery ratio. Recall $B = \theta + (1 - \theta)\mathcal{E}$ from (2), so that $\partial B / \partial \theta = 1 - \mathcal{E}$. For $Z < B$, $X = Z/B$ and $\partial X / \partial \theta = -ZB^{-2}(1 - \mathcal{E}) = Z(\mathcal{E} - 1)B^{-2}$; for $Z > B$, $X = 1$ and the derivative is zero. X is continuous in θ at $Z = B$, and the kink has probability zero under a continuous joint distribution, so the derivative passes through the expectation. Since $X^L = X\mathcal{E}^{-1}$ and $\mathcal{E}$ does not depend on θ , the same holds for X^L with the additional factor $\mathcal{E}^{-1}$. This gives (125). Differentiating once more on the default set, $\partial [Z(\mathcal{E} - 1)B^{-2}] / \partial \theta = -2Z(\mathcal{E} - 1)B^{-3}(1 - \mathcal{E}) = 2Z(\mathcal{E} - 1)^2B^{-3}$, which gives (126).

Part (i): Monotonicity. Under A2, $\mathcal{E} > 1$ in every default state, so the integrand in (125) is strictly positive on $\{Z < B\}$ and zero elsewhere. The default set has positive probability by A1. Hence the derivative is strictly positive.

Part (ii): Convexity. The integrand in (126) is nonnegative pointwise, since $(\mathcal{E} - 1)^2 \geq 0$, $Z > 0$, and $B > 0$.

Part (iii): Fire-sale discount. From Lemma B.1, $\zeta^c = \omega\lambda^c + 1 - \omega$ with $\omega > 0$, and $\lambda^c = \underline{X}^c / \mathbb{E}_b[X^c]$ with $\underline{X}^c$ constant. Hence $\partial \lambda^c / \partial \theta = -\lambda^c \partial \ln \mathbb{E}_b[X^c] / \partial \theta < 0$ by part (i), and $\partial \zeta^c / \partial \theta =$

$\omega \partial \lambda^c / \partial \theta < 0$. Raising θ lowers the default risk of the bonds, which raises their expected fundamental value by more than the money-creation value, so the fire-sale discount declines to maintain free entry.

Remark. If A2 is weakened to require only $\mathbb{E}_b[\mathcal{E} - 1 \mid Z < B] > 0$ rather than depreciation in every default state, part (i) still holds under a sufficient condition. The sign of (125) is then that of $\mathbb{E}[Z(\mathcal{E} - 1) \mid Z < B] = \mathbb{E}[Z \mid Z < B] \mathbb{E}[\mathcal{E} - 1 \mid Z < B] + \text{Cov}(Z, \mathcal{E} \mid Z < B)$, the sum of a positive term and a weakly negative one. By the Cauchy–Schwarz inequality, a sufficient condition for positivity is

$$\frac{\mathbb{E}[Z \mid Z < B]}{\text{sd}(Z \mid Z < B)} \cdot \mathbb{E}[\mathcal{E} - 1 \mid Z < B] > \text{sd}(\mathcal{E} \mid Z < B) :$$

the level of depreciation in default states must dominate the volatility of the exchange rate in those states, after adjusting for the scale of fiscal resources.

B.4.7 Proof of Proposition 2

The Proposition states that under sufficient concavity of R , the sovereign’s problem admits interior solutions for θ^* , and θ^* is (i) decreasing in the safety premium γ , (ii) decreasing in the value-at-risk in exchange rates, (iii) increasing in the costliness of default ϕ , and (iv) ambiguously affected by the credit–currency covariance, depending on the relative strength of the default and fire-sale channels. The proof illustrates the trade-off rather than establishing it under primitive conditions: we state the two assumptions we rely on, and treat the capital floors as constants.

Objective. By (120), (21), and (124), expected discounted consumption in (24), dropping the terms that do not depend on θ , is

$$C(\theta) = \gamma \left[\theta \underline{X}^L + (1 - \theta) \underline{X}^H \right] + \beta^L (b V(\theta) - \mathcal{L}(\theta)), \quad (127)$$

where $V(\theta) = \eta [\theta v(\zeta^L) + (1 - \theta) v(\zeta^H)]$ is the value of domestic investment in the bad-news state, with v given by (123), and $\mathcal{L}(\theta) = b \mathbb{E}_b^{\mathbb{L}}[\ell] = b \phi \mathbb{E}_b^{\mathbb{L}}[(B - Z)D]$ are expected default losses. The first-order condition $C_\theta = 0$ is the indifference condition displayed in Section 7. For a parameter m , the implicit function theorem gives $\partial \theta^* / \partial m$ the sign of $C_{\theta m}$ whenever $C_{\theta \theta} < 0$. Subscripts denote partial derivatives throughout.

Assumptions. We rely on two.

- (a) *Fire sales are costly and increasingly so.* $v'(\zeta) \geq 0$ and $v''(\zeta) \leq 0$ on $[\zeta^L, \zeta^H]$. From (123), $v'(\zeta) = \zeta^{-2} \left[\frac{\alpha + \rho}{\rho} \zeta^{1/\rho} - 1 \right]$ and $v''(\zeta) = \zeta^{-3} \left[2 - \frac{(\alpha + \rho)(2\rho - 1)}{\rho^2} \zeta^{1/\rho} \right]$; both conditions hold

when α and ρ are sufficiently large. This is the sense of “sufficiently concave” in the Proposition.

- (b) *Concavity.* $C_{\theta\theta} < 0$. Expected payoffs are convex in θ and the fire-sale discounts decline in θ (Lemma B.10), and under (a) this delivers $\mathcal{L}_{\theta\theta} > 0$ and $V_{\theta\theta} \leq 0$ when expected payoffs are sufficiently convex, which we assume throughout.

Step 1: $\mathcal{L}_\theta < 0$. The boundary term in the Leibniz rule vanishes because $B - Z = 0$ at $Z = B$, so differentiating $\mathcal{L}(\theta)$ under the expectation away from the boundary yields

$$\mathcal{L}_\theta = b \phi \mathbb{E}_b^{\mathbb{L}} [(1 - \mathcal{E})D] = -b \phi \mathbb{E}_b^{\mathbb{L}} [(\mathcal{E} - 1)D] < 0, \quad (128)$$

because $\mathcal{E} > 1$ in every default state by A2 and the default set has positive probability by A1. Raising the local-currency share increases expected consumption by reducing expected default costs.

Step 2: $V_\theta < 0$. Differentiating $V(\theta)$,

$$V_\theta = \underbrace{\eta \left(v(\zeta^L) - v(\zeta^H) \right)}_{(a), < 0} + \underbrace{\eta \left(\theta v'(\zeta^L) \zeta_\theta^L + (1 - \theta) v'(\zeta^H) \zeta_\theta^H \right)}_{(b), \leq 0}. \quad (129)$$

Under (a), v is increasing on $[\zeta^L, \zeta^H]$. By Corollary 1(i), $\zeta^L < \zeta^H$, so term (a) is negative. Since $\zeta_\theta^c < 0$ by Lemma B.10(iii), each product in term (b) is nonpositive. Hence $V_\theta < 0$.

Discussion of assumptions. Fire sales in our setting constitute pecuniary externalities which reallocate wealth from foreigners toward domestic investors, at the expense of domestic investment in real projects. The intuition for α is straightforward: as investors fail to internalize positive spillovers, fire sales become more costly. For ρ : higher curvature means a small reduction in investment changes marginal returns substantially, so domestic investors give up relatively little investment in the fire sale.

Interior solutions. C_θ is continuous in θ . An interior optimum exists if $C_\theta(0) > 0 > C_\theta(1)$: at $\theta = 0$ the marginal default benefit $-\beta^L \mathcal{L}_\theta > 0$ dominates the marginal revenue and fire-sale costs, and at $\theta = 1$ the reverse. Under (b) it is unique.

Step 3: Responses of the fire-sale discounts. From Lemma B.1, $\zeta^c = \omega \lambda^c + 1 - \omega$ with $\omega = \gamma / (\gamma + b\beta)$. Hence

$$\zeta_\gamma^c = \frac{\partial \omega}{\partial \gamma} (\lambda^c - 1) < 0, \quad \frac{\partial \omega}{\partial \gamma} = \frac{b\beta}{(\gamma + b\beta)^2} > 0, \quad \zeta_\theta^c = \omega \lambda_\theta^c < 0, \quad (130)$$

where $\zeta_\gamma^c < 0$ uses $\lambda^c < 1$. For a parameter m and either bond, $\partial (v'(\zeta^c) \zeta_\theta^c) / \partial m = v''(\zeta^c) \zeta_m^c \zeta_\theta^c + v'(\zeta^c) \zeta_{\theta m}^c$, which we use repeatedly below.

Step 4: Comparative statics. (i) **Safety premium γ .** Since $\mathcal{L}_\theta$ does not depend on γ , the cross-partial is $C_{\theta\gamma} = (\underline{X}^L - \underline{X}^H) + \beta^L b V_{\theta\gamma}$. The first term is negative by Lemma 1(i). Differentiating (129),

$$V_{\theta\gamma} = \eta \left(v'(\zeta^L) \zeta_\gamma^L - v'(\zeta^H) \zeta_\gamma^H \right) + \eta \theta \left(v''(\zeta^L) \zeta_\gamma^L \zeta_\theta^L + v'(\zeta^L) \zeta_{\theta\gamma}^L \right) + \eta (1 - \theta) \left(v''(\zeta^H) \zeta_\gamma^H \zeta_\theta^H + v'(\zeta^H) \zeta_{\theta\gamma}^H \right).$$

For the level term, (130) gives $v'(\zeta^L) \zeta_\gamma^L - v'(\zeta^H) \zeta_\gamma^H = -\frac{\partial \omega}{\partial \gamma} [v'(\zeta^L)(1 - \lambda^L) - v'(\zeta^H)(1 - \lambda^H)]$. Under (a), v' is nonincreasing, so $v'(\zeta^L) \geq v'(\zeta^H) \geq 0$; and $1 - \lambda^L > 1 - \lambda^H > 0$ by Lemma 1(ii). The bracket is therefore nonnegative and the level term nonpositive. For the cross terms, $v''(\zeta^c) \zeta_\gamma^c \zeta_\theta^c \leq 0$ under (a), since $\zeta_\gamma^c < 0$ and $\zeta_\theta^c < 0$; and $\zeta_{\theta\gamma}^c = \frac{\partial \omega}{\partial \gamma} \lambda_\theta^c < 0$, so $v'(\zeta^c) \zeta_{\theta\gamma}^c \leq 0$. All pieces of $C_{\theta\gamma}$ are nonpositive and the first is strictly negative, so θ^* is **decreasing** in γ .

(ii) **Value-at-risk in exchange rates.** Define $\bar{\mathcal{E}} \equiv \underline{X}^H / \underline{X}^L > 1$, the depreciation implicit at the capital threshold; by Lemma 1(i) it exceeds one. We consider a shift in the bad-news distribution that raises $\bar{\mathcal{E}}$ while holding $\underline{X}^H$, $\mathbb{E}_b[X^L]$, and $\mathbb{E}_b[X^H]$ fixed, a thickening of the depreciation tail that leaves expected payoffs unchanged. Section 7 refers to this parameter as the value-at-risk in exchange rates. Then $\underline{X}^L = \underline{X}^H / \bar{\mathcal{E}}$, so $\partial \underline{X}^L / \partial \bar{\mathcal{E}} = -\underline{X}^L / \bar{\mathcal{E}}$, $\lambda_{\bar{\mathcal{E}}}^L = -\lambda^L / \bar{\mathcal{E}}$, $\zeta_{\bar{\mathcal{E}}}^L = -\omega \lambda^L / \bar{\mathcal{E}} < 0$, and $\zeta_{\bar{\mathcal{E}}}^H = 0$. Since λ_θ^L scales with $1/\bar{\mathcal{E}}$ as well, $\zeta_{\theta\bar{\mathcal{E}}}^L = -\zeta_\theta^L / \bar{\mathcal{E}} > 0$. The cross-partial is

$$C_{\theta\bar{\mathcal{E}}} = -\gamma \frac{\underline{X}^L}{\bar{\mathcal{E}}} + \beta^L b V_{\theta\bar{\mathcal{E}}}, \quad V_{\theta\bar{\mathcal{E}}} = \frac{\eta}{\bar{\mathcal{E}}} \left[-v'(\zeta^L) \omega \left(\lambda^L + \theta \lambda_\theta^L \right) - \theta v''(\zeta^L) \omega \lambda^L \zeta_\theta^L \right].$$

The second term in the bracket is nonpositive under (a), since $v''(\zeta^L) \leq 0$ and $\zeta_\theta^L < 0$. The first term is nonpositive when $\lambda^L + \theta \lambda_\theta^L = \partial(\theta \lambda^L) / \partial \theta > 0$. With constant floors this is the statement that the expected bad-news payoff on the local-currency bond is inelastic with respect to θ : a one percent rise in the local-currency share raises $\mathbb{E}_b[X^L]$ by less than one percent, which we assume. The direct term in $C_{\theta\bar{\mathcal{E}}}$ is strictly negative. Therefore θ^* is **decreasing** in $\bar{\mathcal{E}}$: greater tail depreciation widens the money-creation advantage of hard currency and deepens the local-currency fire sale.

(iii) **Costliness of default ϕ .** Neither revenue nor investment depends on ϕ , so by (128) the cross-partial is $C_{\theta\phi} = -\beta^L \mathcal{L}_{\theta\phi} = \beta^L b \mathbb{E}_b^L [(\mathcal{E} - 1)D] > 0$ under A1–A2. Therefore θ^* is **increasing** in ϕ : costlier default makes local currency more attractive because it reduces default exposure.

(iv) **Credit–currency covariance σ_{ze} .** In the lognormal parameterization of Appendix B.3.2, $(\log Z, \log \mathcal{E})$ is jointly normal conditional on bad news, and σ_{ze} denotes its covariance; A2 corresponds to $\sigma_{ze} \leq 0$. An increase in σ_{ze} toward zero weakens the association between depreciation

and bad fiscal outcomes. The cross-partial decomposes as

$$C_{\theta\sigma} = \beta^L \left(\underbrace{b V_{\theta\sigma}}_{\text{fire-sale channel}} + \underbrace{-\mathcal{L}_{\theta\sigma}}_{\text{default channel}} \right).$$

The *default channel*: from (128), $\mathcal{L}_\theta = -b\phi \mathbb{E}_b^{\mathbb{L}}[(\mathcal{E} - 1)D]$. As σ_{ze} rises, depreciation and default decouple, $\mathbb{E}_b^{\mathbb{L}}[(\mathcal{E} - 1)D]$ falls, and $\mathcal{L}_{\theta\sigma} > 0$: the marginal default benefit of local currency shrinks. The *fire-sale channel*: as σ_{ze} rises, expected bond payoffs rise, since the variance of $B - Z$ falls, and more so for the local-currency bond, whose payoff loads on both shocks; the fire-sale discounts narrow, $\zeta_\sigma^c \geq 0$, with $\zeta_\sigma^L > \zeta_\sigma^H$. The level term of $V_{\theta\sigma}$, $\eta (v'(\zeta^L)\zeta_\sigma^L - v'(\zeta^H)\zeta_\sigma^H)$, is then positive under (a): fire sales in local currency become less costly at the margin. We do not sign these derivatives in closed form, and the cross terms in $V_{\theta\sigma}$ are of ambiguous sign. “Fire-sale asymmetry dominates” means that the level term exceeds the sum of the cross terms and the default channel in absolute value. When it does, $C_{\theta\sigma} > 0$ and θ^* is increasing in σ_{ze} ; otherwise the default channel prevails and θ^* is decreasing.