Global Financial Intermediaries, Emerging-Market Debt, and Exchange Rates*

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Abstract. When global financial intermediaries (GFIs) lose net worth, emerging-market (EM) currencies fall. We show this is causal: around the Lehman bankruptcy, currencies of countries whose lenders suffered larger equity losses depreciated more against the dollar. GFI net worth is also a priced factor in currency returns. To understand the mechanisms, we build a two-country model in which leverage-constrained GFIs hold both U.S. risky assets and long-duration EM sovereign debt, so the same balance sheets price EM credit risk and move the exchange rate. A loss of GFI net worth raises the return GFIs require, cuts EM borrowing and spending, and weakens EM currencies. Without being targeted, the model accounts for most of the Lehman elasticity, and for nearly all of it when EMs borrow in dollars, which raises the response through the borrower's debt burden rather than through defaults. GFI balance sheets amplify the transmission of U.S. shocks to EM exchange rates by 40 to 50 percent, and shocks to GFI net worth alone account for much of the dollar's appreciation in 2008–09. About half of EM spreads compensates GFIs for expected default losses; the rest compensates them for their balance-sheet constraint and for risk, including currency risk.

Keywords: Global financial intermediaries; Emerging markets; Sovereign debt; Exchange rates; Currency of debt
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1. Introduction

Episodes of distress in global financial intermediaries are accompanied by sharp depreciations of emerging-market currencies against the dollar. Salient examples include the global financial crisis of 2008–09, in which the collapse of U.S. and European banks' equity values coincided with a broad dollar appreciation and large depreciations of most EM currencies, and the dash for dollars of March 2020. These episodes are consistent with a commonly held view in policy circles and in the international-finance literature: the balance sheets of global financial intermediaries (GFIs)—banks, broker-dealers, and other leveraged institutions that hold risky assets across borders—shape the value of EM currencies, and more so when EMs borrow in dollars.

In this paper, we study how shocks to GFI net worth move EM exchange rates, and how the transmission mechanism depends on the currency in which EMs borrow. We do so by providing new evidence on the relationship between GFI net worth and exchange rates, and developing a two-country model in which leverage-constrained GFIs both lend to EMs and hold U.S. risky assets. In the model, GFIs price exchange-rate and EM credit risk, and the currency denomination of EM debt determines who loses when the EM currency depreciates: GFIs, whose EM holdings lose dollar value when the debt is in local currency, or the EM, whose debt burden rises when the debt is in dollars. A quantitative version of the model shows that GFI net worth is an important driver of EM exchange-rate dynamics, that dollar debt strengthens this channel the more indebted the EM, and that GFIs amplify the transmission of U.S. shocks to EM currencies.

Section 2 presents our empirical evidence in three steps. First, in the time series, declines in the equity value of U.S. financial firms coincide with dollar appreciation, more strongly when that equity value is low. Second, in the cross-section of currencies, GFI net worth is a priced risk factor: currencies that perform poorly when intermediary equity falls earn higher average excess returns, for advanced and emerging economies alike, and the price of this risk rises with financial-sector leverage. Third, to identify a causal effect, we exploit the bankruptcy of Lehman Brothers, which hit intermediaries differentially, as in Chodorow-Reich (2014) and Morelli et al. (2022). Countries whose lenders suffered larger equity losses depreciated more against the dollar, with no pre-trends: weighting lenders by their pre-Lehman claims, the elasticity of the exchange rate to lenders' equity value is -0.15 over the following fifteen trading days, and it is robust to controls for country characteristics.

Motivated by this evidence, in Section 3 we develop a two-country model of GFIs, EM debt and exchange rates. The United States and an EM each receive an endowment of a distinct

good, with home bias in consumption. GFIs hold long-duration EM debt and U.S. risky capital (alongside households) and finance them with deposits and their own net worth. They face an incentive constraint as in Gertler and Karadi (2011). The EM is a family of small sovereigns that borrow from GFIs, in local currency or in dollars. Each period a fraction of them default, more so when the debt burden is high, EM output is low, or borrowing costs are high, and GFIs bear the losses.

In Section 5, we show that GFI net worth and the exchange rate affect each other. First, GFIs move the exchange rate. A fall in GFI net worth raises the return GFIs require on EM debt and lowers EM borrowing and consumption. Because the real exchange rate moves with EM spending, the EM currency depreciates. Second, the exchange rate moves GFI net worth. With local-currency debt, an EM depreciation lowers the dollar value of GFIs' EM holdings; with dollar debt, it raises the EM's debt burden, which lowers EM spending, and its default risk, which is priced by the same GFI net worth. Because a default costs the EM traded goods, defaults lower EM spending and, as they accumulate, strengthen the dollar. GFIs lose on impact as EM debt is repriced, and over time as defaults are realized. The strength of these forces is governed by the frictions GFIs face in financing their risky assets. When GFIs face no financial frictions, shocks to their net worth move neither EM debt prices nor the exchange rate.

In Section 4, we calibrate the model to the volatility of U.S. bank stocks and of EM spreads, among other targets, and use it to assess the role of GFIs in the determination of EM exchange rates in Section 6. Our first main quantitative result is that the model accounts for most of the Lehman evidence. Without being targeted, the elasticity of the EM exchange rate to GFI equity value after a shock to GFI net worth is -0.09 with local-currency debt and -0.14 with dollar debt, against -0.15 in the data, when EM debt held by GFIs is 50% of EM GDP. The elasticity rises roughly in proportion to EM borrowing from GFIs relative to EM GDP. The model therefore predicts that countries more exposed to GFIs depreciate more after a given loss of their lenders' equity.

Our second main result is that the currency of EM debt shapes the transmission, and more so the more indebted the EM. With dollar debt, a depreciation raises the cost, in EM consumption, of servicing and rolling over the debt. This burden is itself proportional to debt relative to GDP, so dollar debt raises the elasticity by about 50% when debt is 50% of GDP and by about 10% when it is 15%. Defaults rise with the debt burden but account for only about 10% of the extra depreciation. Defaults matter more when debt is spread unevenly across EM sovereigns, because more debt then sits with sovereigns close to default. When the cross-country standard

deviation of debt to GDP is 25 percentage points, in line with the data, the dollar appreciation after a shock to GFI net worth is about a fifth larger with dollar debt and unchanged with local-currency debt, and the peak dollar appreciation after an increase in EM default risk triples with dollar debt.

We then conduct a set of exercises that highlight the value of modeling the exchange rate and EM credit risk as priced by the same intermediaries. First, GFI balance sheets amplify the transmission of U.S. shocks to EM exchange rates: relative to unconstrained lenders, the dollar appreciation after a fall in the U.S. endowment is 40 to 50% larger on impact, and somewhat more persistent. Local-currency debt shifts currency losses onto GFIs, but GFIs amplify U.S. shocks by about as much under either denomination. With their current exposure to EMs, GFIs barely amplify EM-specific shocks, but they tilt the exchange-rate response toward the dollar. Second, we feed the model shocks to GFI net worth that reproduce the fall and recovery of U.S. bank stocks around the collapse of Lehman Brothers. This shock alone accounts for between half and four-fifths of the real appreciation of the dollar by early 2009 and for the rise in EM spreads. As bank stocks recover in 2009, the dollar depreciates and spreads fall, as in the data. Without the incentive constraint, the same shocks move neither the exchange rate nor spreads.

Finally, because the same intermediaries price EM debt, U.S. assets and EM currencies, Section 7 decomposes EM spreads into three parts: expected default losses, compensation for the balance-sheet constraint of GFIs, and risk premia. Expected default losses account for about half of the average spread and, together with the balance-sheet constraint, for most of its fluctuations. The rest of the average spread is split between the balance-sheet constraint and risk premia, including a currency risk premium that accounts for about a tenth of the spread with local-currency debt. All of these premia rise when GFI net worth is low: the price of GFI-equity risk is about three times as high when GFI net worth is below its median and, as in the data, it rises with GFI leverage. EM currencies also carry a risk premium. They depreciate when GFI net worth falls, more so with dollar debt, so GFIs would require a premium to hold them: about 140 basis points a year with local-currency debt and 170 with dollar debt, and more than three times as much when GFI net worth is low. As in the evidence of Section 2, currencies more exposed to GFI net worth earn higher premia.

Related literature. Our paper contributes to several strands of the literature. First, a large literature makes financial frictions central to exchange-rate determination, including Gabaix and Maggiori (2015), Itskhoki and Mukhin (2021), and Akinci et al. (2022). Our evidence that GFI net worth prices currency returns relates to intermediary asset pricing, in which the

health of financial intermediaries prices returns across many asset classes (Adrian et al., 2014; He et al., 2017), to work on common risk factors in currency markets (Lustig et al., 2011), and to evidence that the risk limits of currency dealers move exchange rates (Barbiero et al., 2024). Oskolkov and Perez (2026) show how the risk-bearing capacity of a global intermediary, together with countries' commodity exports and dollar asset holdings, shapes the cross-section of exchange rates. We add causal evidence from the Lehman episode and a model in which the same intermediaries price EM credit and currency risk, and in which the currency of EM debt shapes how exposed a currency is to their net worth. Closest to our approach, Kekre and Lenel (2024) develop a quantitative model of the international monetary system in which shifts in the demand for safe dollar assets and differences in risk-bearing capacity drive the dollar: a flight to safety appreciates the dollar and lowers global output. We complement their analysis on the lending side of intermediary balance sheets. In our model the intermediaries that price the exchange rate also hold defaultable EM debt, so EM credit risk and the exchange rate are priced jointly, the currency of EM debt determines who bears exchange-rate risk, and EM spreads compensate intermediaries for currency risk as well as default risk. We also test the model against the cross-sectional Lehman evidence.

Second, our paper is related to the literature on sovereign debt and default (see, e.g., Eaton and Gersovitz, 1981; Arellano, 2008), and in particular to work that enriches the lender side of sovereign-debt models (Bocola, 2016). Morelli et al. (2022) show that global banks transmit shocks to EM sovereign spreads and account for a large share of their fluctuations. We turn to a different price, the exchange rate, which intermediaries move through the EM spending they finance. The currency of EM debt then determines whether a depreciation hits lenders' balance sheets or the borrower's debt burden, and the exchange rate feeds back into the pricing of EM credit risk, including through a premium for currency risk in EM spreads.

Third, our comparison of denominations relates to work on EM borrowing in local currency. Carstens and Shin (2019) argue that it moves currency mismatches onto foreign lenders rather than removing them ("original sin redux"); Hofmann et al. (2020) show that EM local-currency bond spreads rise when EM currencies depreciate against the dollar; and Hofmann et al. (2022) build a two-country model in which local-currency borrowing leaves EMs exposed to foreign monetary tightening through the constraints of global lenders. Du and Schreger (2016) measure the credit risk of local-currency sovereign debt, and Ottonello and Perez (2019) study the choice of currency composition with unconstrained lenders. We take the denomination as given and compare the two for shocks to the lenders' own balance sheets, with defaultable debt.

Finally, the paper is related to the literature on the global financial cycle, which links the dollar to global risk and to the balance sheets of global banks (Rey, 2015; Miranda-Agrippino and Rey, 2020). Bruno and Shin (2015) document the link between the dollar, global bank leverage and cross-border lending, and Avdjiev et al. (2019) show that a stronger dollar tightens bank balance sheets and widens deviations from covered interest parity. We study the reverse direction: our model explains why the dollar strengthens when global intermediaries lose net worth, and gives this link a quantitative counterpart.

The rest of the paper is organized as follows. Section 2 presents the empirical evidence. Section 3 lays out the model, and Section 4 describes its calibration. Section 5 shows how the exchange rate and GFI net worth respond to EM credit risk, Section 6 presents the main quantitative results, and Section 7 studies risk premia and the sources of EM spreads. Section 8 concludes.

2. Evidence: GFI net worth and EM exchange rates

The empirical analysis examines whether GFIs act as marginal investors in currency markets, building evidence in three steps. First, we show that declines in GFIs' net worth coincide with dollar appreciation, especially during periods of financial stress. Second, we test whether currencies more exposed to intermediary net-worth risk earn higher average excess returns. Third, we use the Lehman episode as a shock with heterogeneous effects on GFIs' balance sheets and ask whether countries more exposed to distressed lenders depreciated more. The first two are correlational; the third is causal. Appendix A provides details on data construction and the empirical implementation.

2.1. *Aggregate patterns*

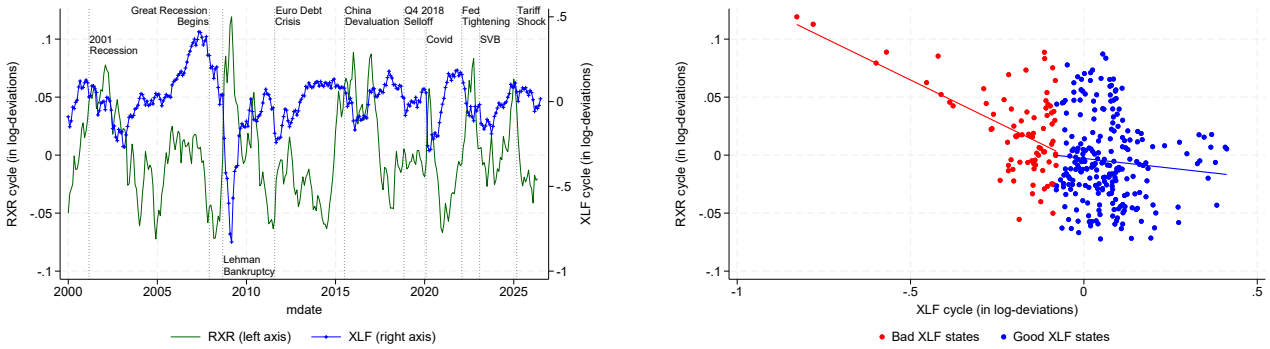
We begin with the unconditional relationship between GFI net worth and exchange rates. Panel (a) of Figure 1 plots the HP-filtered log cycle of XLF, our proxy for the market value of GFI net worth, together with the real exchange rate index (RXR).[1] Declines in intermediary net worth coincide with dollar appreciation, most visibly during the global financial crisis.

Panel (b) shows that this relationship is stronger in bad intermediary-net-worth states: the RXR–XLF correlation is -37% unconditionally, and rises in magnitude to -56% when the XLF

[1]XLF is an imperfect market-based proxy for the market value of GFI net worth and includes firms that are not leveraged intermediaries, such as payment networks. The RXR is the BIS narrow effective real exchange rate index, a trade-weighted average of bilateral real exchange rates against 27 economies, deflated by relative consumer prices. An increase denotes real dollar appreciation.

cycle is more than one standard deviation below its mean.[2] Balance-sheet conditions therefore appear to matter most in periods of financial stress, as in models where intermediary constraints bind primarily in bad states. These patterns are suggestive but not causal.

FIGURE 1. Comovement Between GFI Net Worth and the Real Exchange Rate



(a) Time-series variation

(b) Comovement by state of net worth

Notes: Panel (a) plots the HP-filtered log cycles of the effective real exchange rate (an index of 27 countries) and of the XLF index; vertical lines mark major financial and macroeconomic events. Panel (b) plots the same monthly observations as a scatter of the RXR cycle against the XLF cycle. Bad XLF states are months in which the XLF cycle lies more than one standard deviation below its mean; remaining months are good XLF states. Fitted lines are estimated separately for each state. Sources: BIS and authors' calculations.

2.2. *GFI net worth as a priced risk factor*

If GFI net worth is a priced risk factor, currencies that perform poorly when intermediary equity values fall should compensate investors with higher average excess returns. We test this prediction using a two-pass Fama–MacBeth regression: we first estimate each currency's exposure (its factor loading) to log changes in the XLF total return index, our proxy for the risk factor, and then ask whether those loadings explain average excess returns across countries. The slope of this second-stage relationship is the price of risk.[3]

Panel (a) of Figure 2 reports the second-stage fit for short-term assets subject to exchange-rate risk.[4] Each point plots a country's average excess return against the return predicted

[2]The same asymmetry appears in monthly log differences: the XLF–dollar correlation is −0.50 in weak-XLF months and −0.12 otherwise (Figure A.3, panel a).

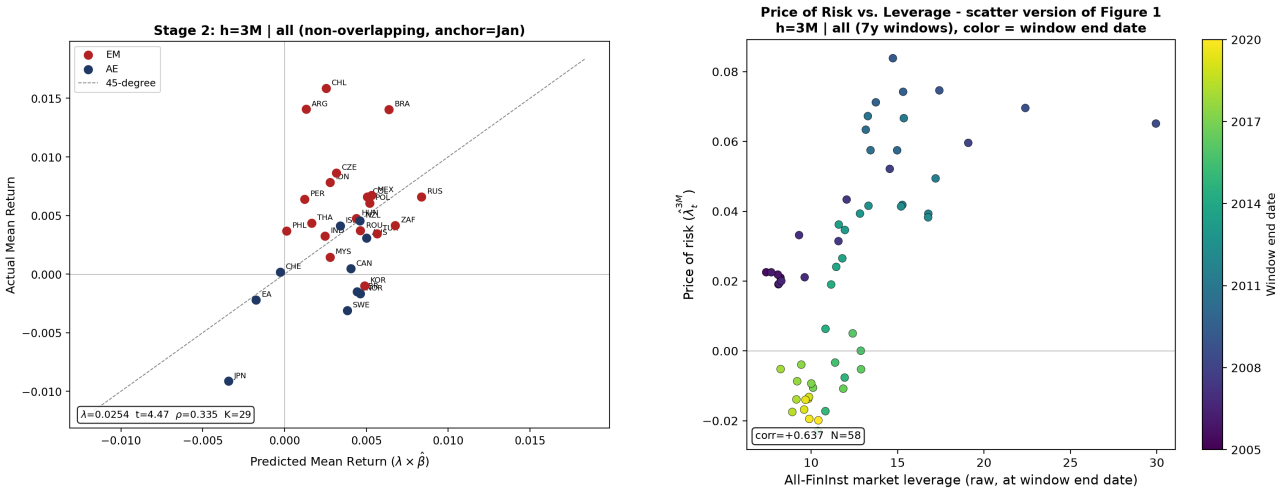
[3]XLF tracks U.S. financial companies in the S&P 500, including banks, insurance companies, and asset managers. Appendix A2 provides details on the empirical implementation.

[4]Short-term asset returns for each country in our sample are measured as an average of 12-month rates on deposits, government bonds, and central bank notes.

by its loading on the GFI net-worth factor; points closer to the 45-degree line indicate a better cross-sectional pricing fit. The relationship holds for both advanced-economy (AE) and emerging-market (EM) assets, which fall along a common line, suggesting that the factor is not merely an emerging-market phenomenon but prices currency risk broadly.[5] Most first-stage loadings are positive, meaning that excess returns tend to fall when XLF falls (Figure A.1); Japan, the euro area, and Switzerland are the main exceptions, consistent with their currencies acting as safe havens during intermediary distress.

Panel (b) of Figure 2 shows that the price of GFI net-worth risk varies over time. Estimated in seven-year rolling windows, the price of risk is generally positive and is highest when financial-sector leverage is high; the correlation between the two series is 64%.[6]

FIGURE 2. GFI Net Worth as a Risk Factor for Currency Returns



(a) Unconditional regression

(b) Rolling window

Notes: Panel (a) shows realized against predicted average excess returns on short-term claims subject to exchange-rate risk, from the two-pass regression of Appendix A2. Each point is a country, with emerging markets and advanced economies in different colors; the dashed line is the 45-degree line. Panel (b) plots the price of risk, estimated in seven-year rolling windows, against the leverage of the financial sector, with colors denoting years.

As a complementary full-sample exercise, panel (b) of Figure A.3 traces the cumulative change in the dollar around months with unusually large XLF declines. The dollar appreciates in the

[5]The same factor also prices expected returns on EM bonds (Morelli et al., 2022). GFI net worth thus acts as a common pricing factor across asset classes with different risk characteristics. Figure A.2 shows similar results when using expected depreciation instead of realized depreciation, with tighter results when sorting portfolios by carry.

[6]Data on the financial sector's leverage, book assets over market equity, are from Hubrich et al. (2026).

event month and continues appreciating in the following month, with a similar pattern when the Lehman episode is excluded. The relationship between intermediary net worth and the dollar is therefore not purely contemporaneous, but unfolds over time.

Taken together, these results link intermediary net worth to currency returns, but they do not establish causality. Factor loadings may reflect omitted global risks, and XLF declines may coincide with shocks that independently move exchange rates. We therefore turn to the Lehman episode, in which intermediary net worth fell sharply and heterogeneously across lenders.

2.3. *The causal effect of GFI net worth: the Lehman episode*

Identification. We exploit the bankruptcy of Lehman Brothers on September 15, 2008, as a large and largely unanticipated shock that affected financial intermediaries differentially, depending on their exposure to distressed assets. The key idea is to relate each asset's price response, measured in a narrow window around the episode, to the average net-worth contraction of the intermediaries holding it.[7] This isolates variation in intermediary net worth that is plausibly orthogonal to borrowing-country fundamentals: the differential contractions were driven primarily by events in developed markets, while the short window limits the scope for confounding shocks originating in the borrowing economies.

Data and shock construction. We measure each intermediary's net-worth shock, Δe_j, as the log change in its stock price from five trading days before to three days after September 15, 2008. We then use FFIEC 009 bank-level cross-border claims to construct each country k's exposure to distressed intermediaries as the claims-weighted average shock of the intermediaries lending to it:

$$\Delta \hat{e}_k = \sum_{j \in \mathcal{J}_k} w_{jk}\, \Delta e_j, \qquad w_{jk} = \frac{\text{Claims}_{jk}}{\sum_{j' \in \mathcal{J}_k} \text{Claims}_{j'k}}, \tag{1}$$

where w_{jk} is intermediary j's share of total claims on country k and $\mathcal{J}_k$ is the set of intermediaries with available stock-price data. Claims weights are measured in 2008:Q2, before the Lehman episode, so the exposure measure is predetermined. Since stock-price changes are negative for distressed intermediaries, a more negative $\Delta \hat{e}_k$ indicates greater exposure to distressed banks.

[7] Chodorow-Reich (2014) uses the dispersion in lenders' health after Lehman to identify the effect of credit supply on firm employment; Morelli et al. (2022) use the dispersion in intermediaries' net-worth losses to identify their effect on sovereign bond prices.

Results. We estimate the dynamic effect of intermediary net worth on exchange rates using local projections, estimated separately at each horizon h:

$$\Delta s_{k,h} = a_h + \gamma_h \, \Delta \hat{e}_k + \delta_h' X_k + u_{k,h}, \tag{2}$$

where $\Delta s_{k,h}$ is the cumulative log change in country k's bilateral exchange rate against the U.S. dollar between five trading days before the Lehman episode and horizon h (a positive value denotes depreciation), and X_k is a vector of predetermined controls. A negative γ_h indicates that countries more exposed to distressed intermediaries (more negative $\Delta \hat{e}_k$) experienced larger depreciations.

Figure 3 plots the estimated γ_h across horizons. The estimates show no pre-trend before Lehman, then become negative and significant about five to ten trading days after the event. The average elasticity over the following fifteen trading days, γ^{data}, is -0.15: countries whose lenders lost one percent more equity value depreciated by 0.15 percent more.[8] Evidence on months with unusually large XLF declines (Section 2.2) suggests that the same qualitative dollar–intermediary pattern is not unique to the Lehman event.

A remaining concern is sorting: distressed intermediaries may have lent systematically to countries that were already more vulnerable. Table A.2 addresses this by comparing predetermined country characteristics across above- and below-median exposure countries, and by regressing each characteristic on $\Delta \hat{e}_k$. The shock is largely uncorrelated with macro fundamentals, openness and financial integration, and external-financing vulnerability. The characteristics that differ most between high- and low-exposure countries are GDP growth, financial openness, banks' assets over GDP, credit ratings and debt dollarization. The dashed line in Figure 3 adds them to X_k, together with the depreciation between August 25 and 29, 2008, and the coverage of the claims data. The estimated response is essentially unchanged.[9]

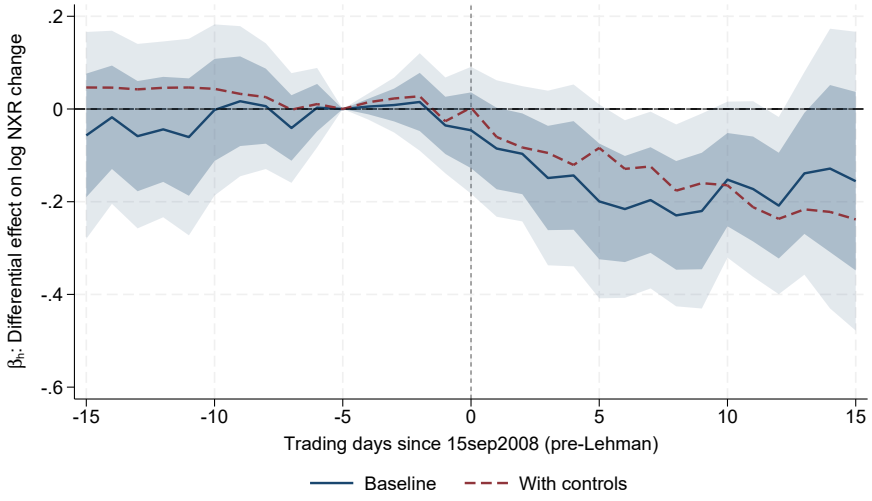
We use $\gamma^{\text{data}} = -0.15$ as an untargeted moment for the model.[10] The model also predicts that the response is larger for countries that borrow in dollars (Section 6.2). The current specification controls for debt dollarization.

[8]Table A.3 provides suggestive quantity evidence: countries more exposed to distressed intermediaries experienced larger contractions in cross-border claims in the quarters after Lehman. The estimates are imprecise, given the small cross-section and noisy quarterly claims data, so we interpret them as corroborating rather than independent evidence.

[9]Figure A.5 shows that substantial variation in the shock remains after residualizing on these characteristics.

[10]The same design applied to EM sovereign bonds shows that bonds held by intermediaries with a one-standard-deviation larger net-worth contraction had yield increases about 1.5 times as large as the average bond (Morelli et al., 2022).

FIGURE 3. The Dynamic Effect of Intermediary Net Worth: The Lehman Episode



Notes: Estimated elasticity γ_h of the bilateral exchange rate against the dollar to the net-worth shock of the country's lenders at horizon h, from (2). The solid line (baseline) excludes controls; the dashed line includes the controls described in the text. Darker and lighter areas are 68% and 90% confidence intervals.

3. MODEL

3.1. *Environment*

There are two countries, the United States and an emerging market (EM), each with a representative household and an endowment of its own good. U.S. capital income follows

$$Z_t = (1 - \rho_z) + \rho_z Z_{t-1} + \sigma_z \varepsilon_{z,t}, \tag{3}$$

and EM output follows

$$Y_{E,t} = (1 - \rho_E)\bar{Y}_E + \rho_E Y_{E,t-1} + \sigma_E \varepsilon_{E,t}. \tag{4}$$

Global financial intermediaries (GFIs) hold U.S. risky capital and EM sovereign debt, financed with U.S. deposits and their own net worth. Besides the two endowment shocks, we study an exogenous shock to GFI net worth, the model counterpart of the Lehman episode, and a shifter of EM default risk that we use only as an exercise.

3.2. *Goods, prices, and the real exchange rate*

Consumption baskets are Cobb–Douglas with home bias,

$$C_t = \left(\frac{C_{H,t}}{\omega}\right)^{\omega} \left(\frac{C_{E,t}}{1-\omega}\right)^{1-\omega}, \qquad C_t^E = \left(\frac{C_{E,t}^E}{\omega_E}\right)^{\omega_E} \left(\frac{C_{H,t}^E}{1-\omega_E}\right)^{1-\omega_E}, \tag{5}$$

where $C_{H,t}$ and $C_{E,t}$ are U.S. consumption of the U.S. and EM goods, and the superscript E denotes EM consumption. The price indices are $P_t = P_{H,t}^{\omega} P_{E,t}^{1-\omega}$ and $P_t^E = (P_{E,t}^E)^{\omega_E}(P_{H,t}^E)^{1-\omega_E}$, and each household spends a constant share of its consumption on each good:

$$\frac{P_{H,t}C_{H,t}}{P_tC_t} = \omega, \qquad \frac{P_{E,t}C_{E,t}}{P_tC_t} = 1-\omega, \qquad \frac{P_{E,t}^E C_{E,t}^E}{P_t^E C_t^E} = \omega_E, \qquad \frac{P_{H,t}^E C_{H,t}^E}{P_t^E C_t^E} = 1-\omega_E. \tag{6}$$

Under the law of one price, the terms of trade and the real exchange rate are

$$\mathcal{T}_t \equiv \frac{P_{E,t}}{P_{H,t}}, \qquad \mathcal{S}_t \equiv \frac{P_t^E}{P_t} = \mathcal{T}_t^{\omega+\omega_E-1}, \tag{7}$$

with $P_{H,t}/P_t = \mathcal{T}_t^{-(1-\omega)}$ and $P_{E,t}/P_t^E = \mathcal{T}_t^{1-\omega_E}$. An increase in $\mathcal{S}_t$ is a real depreciation of the dollar. Home bias, $\omega + \omega_E > 1$, makes the real exchange rate move with the terms of trade.

3.3. *U.S. households*

The U.S. household chooses consumption, deposits, and direct holdings $K_{H,t}$ of U.S. capital to maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\varrho}-1}{1-\varrho} - \frac{\alpha}{1+\eta} K_{H,t}^{1+\eta} \right]. \tag{8}$$

With $\Lambda_{t+1} \equiv \beta(C_{t+1}/C_t)^{-\varrho}$, the Euler equations for deposits and capital are

$$1 = \mathbb{E}_t[\Lambda_{t+1}]R_t, \qquad Q_t + \alpha K_{H,t}^{\eta} C_t^{\varrho} = \mathbb{E}_t\left[\Lambda_{t+1}\left(\frac{P_{H,t+1}}{P_{t+1}}Z_{t+1} + Q_{t+1}\right)\right], \tag{9}$$

where Q_t is the price of U.S. capital. The management cost makes household demand for capital finite, so GFIs hold the rest of the unit supply. When GFIs sell, households absorb capital only at a lower price.

3.4. *Global financial intermediaries*

GFIs stand for the broad set of intermediaries—banks, broker-dealers, asset managers and other institutions—whose capacity to bear risk depends on their net worth. They hold U.S. capital and EM debt and finance these positions with deposits and net worth:

$$Q_t K_{B,t} + e_t Q_{E,t} A_{E,t} = D_t + N_t, \tag{10}$$

where $Q_{E,t}$ is the price of EM debt in its unit of denomination, $A_{E,t}$ is the quantity held by GFIs, and e_t is the price of the unit of denomination in U.S. consumption: $e_t = \mathcal{S}_t$ when EM debt is in local currency (EM consumption) and $e_t = 1$ when it is in dollars (U.S. consumption).

The return on U.S. capital is

$$R_{k,t+1} \equiv \frac{\frac{P_{H,t+1}}{P_{t+1}}Z_{t+1} + Q_{t+1}}{Q_t}. \tag{11}$$

GFIs hold a diversified pool of the debt of all EM sovereigns, like a position in an EM bond index (Section 3.5). A fraction p_{t+1} of the pool defaults at $t+1$ and loses a fraction h of its value, so the return in units of denomination is

$$R^{\text{loc}}_{E,t+1} = \frac{(1 - hp_{t+1})(1 + \xi Q_{E,t+1})}{Q_{E,t}}, \tag{12}$$

where $\xi \in [0, 1)$ governs duration, and the return in U.S. consumption is

$$R_{E,t+1} = \frac{e_{t+1}}{e_t} R^{\text{loc}}_{E,t+1}. \tag{13}$$

With local-currency debt the EM exchange rate is part of GFIs' payoff. With dollar debt it is not, but it moves the EM's debt burden and its default risk (Section 3.5).

A banker survives with probability σ, and its net worth if it continues is

$$N^c_{t+1} = R_t N_t + (R_{k,t+1} - R_t) Q_t K_{B,t} + (R_{E,t+1} - R_t) e_t Q_{E,t} A_{E,t}. \tag{14}$$

The value of a banker is $V_t = \mathbb{E}_t[\Lambda_{t+1}((1-\sigma)N_{t+1} + \sigma V_{t+1})] = \Psi_t N_t$, so bankers price assets with the kernel $\mathcal{M}_{t+1} \equiv \Lambda_{t+1}\Omega_{t+1}$, where $\Omega_{t+1} \equiv 1 - \sigma + \sigma\Psi_{t+1}$ is the marginal value of net worth. Bankers can divert a fraction θ of their assets, so

$$V_t \geq \theta \left(Q_t K_{B,t} + \vartheta_E \, e_t Q_{E,t} A_{E,t} \right), \tag{15}$$

where ϑ_E is the weight of EM debt relative to U.S. capital. Let $\phi_{H,t} \equiv Q_t K_{B,t}/N_t$ and $\phi_{E,t} \equiv e_t Q_{E,t} A_{E,t}/N_t$ be the two positions relative to net worth, and

$$\nu_t \equiv \mathbb{E}_t[\mathcal{M}_{t+1}] R_t, \qquad \mu_{H,t} \equiv \mathbb{E}_t[\mathcal{M}_{t+1}(R_{k,t+1} - R_t)], \qquad \mu_{E,t} \equiv \mathbb{E}_t[\mathcal{M}_{t+1}(R_{E,t+1} - R_t)]. \tag{16}$$

Dividing the value of a banker and the incentive constraint by net worth, the banker's problem is

$$\begin{aligned} \Psi_t = \max_{\phi_{H,t},\, \phi_{E,t}} & \left\{ \nu_t + \phi_{H,t}\mu_{H,t} + \phi_{E,t}\mu_{E,t} \right\} \\ \text{subject to} \quad & \nu_t + \phi_{H,t}\mu_{H,t} + \phi_{E,t}\mu_{E,t} \geq \theta \left(\phi_{H,t} + \vartheta_E \phi_{E,t} \right). \end{aligned} \tag{17}$$

With an interior portfolio and a binding constraint,

$$\mu_{E,t} = \vartheta_E \, \mu_{H,t}, \qquad \phi_{H,t} + \vartheta_E \phi_{E,t} = \frac{\nu_t}{\theta - \mu_{H,t}}. \tag{18}$$

The first condition prices EM debt off U.S. capital in risk-adjusted terms. The second is risk-weighted leverage: a fall in net worth forces GFIs to sell both assets unless their expected excess returns rise. Section 7 decomposes EM spreads into expected default losses, a balance-sheet wedge and risk premia.

Including surviving and newly entering bankers, aggregate net worth evolves as

$$N_{t+1} = \big(1+\varepsilon_{N,t+1}\big)\Big\{\sigma\big[R_t N_t + (R_{k,t+1}-R_t)Q_t K_{B,t} + (R_{E,t+1}-R_t)e_t Q_{E,t}A_{E,t}\big] + (1-\sigma)\,\xi_N\big(Q_t K_{B,t} + e_t Q_{E,t}A_{E,t}\big)\Big\}, \tag{19}$$

where ξ_N is the endowment of entering bankers and $\varepsilon_{N,t+1}$ is an exogenous shock to GFI net worth, i.i.d. with mean zero and standard deviation σ_N, so that it destroys or adds a fraction $\varepsilon_{N,t+1}$ of net worth without changing its mean.

3.5. *Emerging-market borrowers*

A family of sovereigns. The EM is a family of a unit mass of small sovereigns, indexed by $i \in [0,1]$, that issue debt and default individually and pool their consumption. The family allocates its debt across sovereigns according to a fixed distribution relative to the aggregate: sovereign i owes

$$b_{i,t+1} = b_{t+1}\, e^{s\eta_i - s^2/2}, \tag{20}$$

where η_i is standard normal across sovereigns and $s \geq 0$ is the cross-sectional dispersion of log debt, so that $\int_0^1 b_{i,t+1}\, di = b_{t+1}$. The family is therefore summarized by its aggregate debt b_t, and a law of large numbers turns individual defaults into a default rate on the aggregate debt stock. Appendix B discusses these assumptions.

Debt. Debt has long duration. Let b_t be the face value of debt carried into t. A fraction p_t of it defaults. Creditors of a defaulting sovereign lose a fraction h of their claim, both the current payment and the remaining debt, and keep the rest, which continues to pay like any other EM debt. Debt evolves as

$$b_{t+1} = \xi(1-hp_t)b_t + \ell_t, \tag{21}$$

where ℓ_t is new issuance and $\xi \in [0,1)$ governs duration. GFIs hold the entire stock of EM debt as a diversified pool, which pays $1-hp_{t+1}$ per unit, where p_{t+1} is the default rate weighted by debt, defined in (24) below. GFIs price each sovereign's bonds given its own default risk. When sovereigns owe the same ($s=0$, our baseline), every bond trades at the price of the pool, $Q_{E,t}$. With dispersion, more indebted sovereigns' bonds trade at lower prices, and the price of the pool is the debt-weighted average of the individual prices. Each sovereign takes the price of its own bonds as given, so it does not internalize that more borrowing lowers that price (Appendix B). Because every bond trades at $Q_{E,t}$ in the baseline, the resource constraint and Euler equation below use that price; with dispersion, they use the individual prices instead. One unit of debt

payments is worth $e_t/\mathcal{S}_t$ units of EM consumption: one with local-currency debt and $1/\mathcal{S}_t$ with dollar debt.

Default. Sovereign i defaults at $t+1$, after $Y_{E,t+1}$ is realized, when its distance to default is positive:

$$\begin{aligned} \delta_{i,t+1} &= \mathbf{1}\left\{x_{i,t+1} + \varepsilon_{i,t+1} > 0\right\}, \\ x_{i,t+1} &\equiv a_0 + a_b \log \frac{e_{t+1} b_{i,t+1}}{\mathcal{S}_{t+1}} - a_y \log Y_{E,t+1} - a_q \log \frac{Q_{E,t+1}}{\bar{Q}_E} + \chi^{\delta}_t, \end{aligned} \tag{22}$$

where $\varepsilon_{i,t+1}$ is i.i.d. standard logistic across sovereigns and over time. Default risk rises with the debt burden measured in EM consumption and falls with EM output; with dollar debt, a dollar appreciation raises the burden. Default risk also rises when the price of EM debt falls below its steady-state value $\bar{Q}_E$: the price at which a sovereign rolls over its debt when it decides whether to default. In models of strategic default, higher borrowing costs make repayment less attractive. Through this term, a fall in GFI net worth—which lowers the price of EM debt—raises default risk (Morelli et al., 2022). Because the term is zero at $\bar{Q}_E$, it does not change the steady state. The rule is a reduced form of strategic default with extreme-value taste shocks, in which the index stands in for the gap between the values of default and repayment, as in quantitative models in which default risk follows a reduced-form process (Bocola, 2016). Appendix F reports results without the borrowing-cost term ($a_q = 0$). The term χ^{δ}_t shifts default risk given fundamentals,

$$\chi^{\delta}_t = \rho_\delta \chi^{\delta}_{t-1} + \sigma_\delta \varepsilon^{\delta}_t, \tag{23}$$

and we use it only as an exercise (Section 5).[11]

By the law of large numbers, the fraction of EM debt that defaults at $t+1$, weighting sovereigns by their debt, is

$$\begin{aligned} p_{t+1} \equiv \int_0^1 \frac{b_{i,t+1}}{b_{t+1}} \delta_{i,t+1}\, di &= \mathbb{E}_\eta \left[e^{s\eta - s^2/2}\, F\big(x_{t+1}(\eta)\big) \right], \\ x_{t+1}(\eta) &\equiv a_0 + a_b \log \frac{e_{t+1} b_{t+1}}{\mathcal{S}_{t+1}} + a_b\Big(s\eta - \frac{s^2}{2}\Big) \\ &\quad - a_y \log Y_{E,t+1} - a_q \log \frac{Q_{E,t+1}}{\bar{Q}_E} + \chi^{\delta}_t, \end{aligned} \tag{24}$$

where $F(x) = e^x/(1+e^x)$. For a given aggregate debt, more dispersion places more debt with highly indebted sovereigns close to their default threshold and raises the default rate. With

[11] A shift in χ^{δ}_t can be rationalized as a shock to beliefs about the government's type, which changes perceived default risk for given fundamentals. Morelli and Moretti (2023) model this reputation mechanism explicitly.

$s = 0$, all sovereigns owe the same and

$$p_{t+1} = F\Big(a_0 + a_b \log \frac{e_{t+1} b_{t+1}}{\mathcal{S}_{t+1}} - a_y \log Y_{E,t+1} - a_q \log \frac{Q_{E,t+1}}{\bar{Q}_E} + \chi_t^{\delta}\Big). \tag{25}$$

Because b_{t+1} and χ_t^{δ} are known at t but $Y_{E,t+1}$ and $Q_{E,t+1}$ (and, with dollar debt, $\mathcal{S}_{t+1}$) are not, p_{t+1} is random as of t. It covaries with the state at $t+1$, so default risk is priced by GFIs (Appendix D).

Recovery and default costs. Creditors recover a fraction $1-h$ of the value of defaulted debt, so the loss rate on the pool is hp_t. A sovereign that defaults enters default status and leaves it with probability θ_d each quarter, so the share of sovereigns in default status evolves as

$$\zeta_t = (1-\theta_d)\,\zeta_{t-1} + p_t, \tag{26}$$

where p_t is the default rate. Each quarter in default status, a sovereign loses a fraction c of the value of its output in traded goods. This captures the disruption of trade and trade credit that follows sovereign defaults (Rose, 2005; Mendoza and Yue, 2012) and, as in Na et al. (2018), places the cost of default on tradables. Section 5 shows how large it has to be.

The family's problem. The family's resource constraint, in EM consumption units, is

$$C_t^E = (1 - c\,\zeta_t)\,\mathcal{T}_t^{1-\omega_E} Y_{E,t} + \frac{e_t}{\mathcal{S}_t}\Big[Q_{E,t}\big(b_{t+1} - \xi(1-hp_t)b_t\big) - (1-hp_t)b_t\Big], \tag{27}$$

where $\mathcal{T}_t^{1-\omega_E} = P_{E,t}/P_t^E$ values EM output in EM consumption. Each sovereign is small, so the family takes the price of debt and the default rate as given and solves

$$V_E(Y_{E,t}, b_t, \mathbf{S}_t) = \max_{b_{t+1}} \big\{u(C_t^E) + \beta_E \mathbb{E}_t\left[V_E(Y_{E,t+1}, b_{t+1}, \mathbf{S}_{t+1})\right]\big\} \tag{28}$$

subject to (27), where $\mathbf{S}_t$ collects the aggregate states, including GFI net worth and the U.S. endowment, and $u(C) = C^{1-\varrho_E}/(1-\varrho_E)$. The Euler equation is

$$u'(C_t^E)\,\frac{e_t}{\mathcal{S}_t}\big[Q_{E,t} - \Phi'(b_{t+1})\big] = \beta_E\,\mathbb{E}_t\Big[u'(C_{t+1}^E)\,\frac{e_{t+1}}{\mathcal{S}_{t+1}}\,(1-hp_{t+1})(1+\xi Q_{E,t+1})\Big], \tag{29}$$

where Φ is a small debt-adjustment cost, rebated to the family, that makes the steady state stationary (Appendix C).

3.6. *Market clearing and solution*

Goods markets clear,

$$C_{H,t} + C^E_{H,t} + c\,\zeta_t \mathcal{T}_t Y_{E,t} = Z_t, \qquad C_{E,t} + C^E_{E,t} = Y_{E,t}, \tag{30}$$

where the last term on the left of the first condition is the default cost, in units of the U.S. good. The markets for U.S. capital and EM debt clear,

$$K_{H,t} + K_{B,t} = 1, \qquad A_{E,t} = b_{t+1}. \tag{31}$$

We solve the model by perturbation (third order, with pruning) around the deterministic steady state. Appendix C describes what this requires: default as a fraction of the debt stock, the debt-adjustment cost, and the treatment of unanticipated (MIT) shocks.

3.7. *How the exchange rate is determined*

The terms of trade are determined in the goods markets. Combining the two market-clearing conditions (30) with the demands (6) and the relative prices in (7), and eliminating U.S. consumption, gives

$$\mathcal{T}_t Y_{E,t} = \frac{1-\omega}{\omega} Z_t + \frac{\omega + \omega_E - 1}{\omega} \mathcal{T}_t^{\omega_E} C^E_t - \frac{1-\omega}{\omega} c\,\zeta_t \mathcal{T}_t Y_{E,t}. \tag{32}$$

The left side is the value of EM output in units of the U.S. good, and the right side is the demand for it. The first term is U.S. demand. U.S. households spend a share ω of their spending on their own good and a share $1-\omega$, their import share, on the EM good. So for each unit of the U.S. good they consume, they buy $(1-\omega)/\omega$ worth of the EM good. The second term is EM demand, net of the U.S. demand it crowds out. It is positive when both countries are biased toward their own good, $\omega + \omega_E > 1$: EM spending then raises the demand for the EM good on net.[12] The last term captures the default cost: defaults cost the EM $c\,\zeta_t \mathcal{T}_t Y_{E,t}$ units of the U.S. good, which are lost to both economies and so tilt the terms of trade toward the U.S.

Given the supplies of the two goods, (32) determines the relative price of the EM good. Spending that shifts from the U.S. to the EM raises $\mathcal{T}_t$, and so does a larger U.S. endowment. A larger supply of the EM good and a larger default cost lower $\mathcal{T}_t$. With home bias, a higher $\mathcal{T}_t$ is

[12]Suppose the EM spends one more unit. It spends ω_E on its own good and $1-\omega_E$ on the U.S. good, which leaves $1-\omega_E$ less of the U.S. good for U.S. households. Because they spend a share ω on their own good, consuming $1-\omega_E$ less of it means spending $(1-\omega_E)/\omega$ less in total, and $(1-\omega)(1-\omega_E)/\omega$ less on the EM good. Demand for the EM good therefore rises by $\omega_E - (1-\omega)(1-\omega_E)/\omega = (\omega + \omega_E - 1)/\omega$, the coefficient on EM spending in (32).

a real appreciation of the EM currency, $\mathcal{S}_t = \mathcal{T}_t^{\omega+\omega_E-1}$, so a shift of spending toward the EM appreciates its currency. Linearizing (32) gives

$$\hat{\mathcal{S}}_t = \kappa_E\, \hat{c}_t^E - \kappa_Y\, \hat{y}_{E,t} + \kappa_Z\, \hat{z}_t - \kappa_\zeta\, (\zeta_t - \zeta), \tag{33}$$

where hats denote log deviations from steady state, ζ is the steady-state share in default status, and

$$\kappa_E = \frac{(\omega+\omega_E-1)\, D}{B+(1-\omega_E)D}, \qquad \kappa_Y = \frac{(\omega+\omega_E-1)\,(B+D)}{B+(1-\omega_E)D},$$
$$\kappa_Z = \frac{(\omega+\omega_E-1)\, B}{B+(1-\omega_E)D}, \qquad \kappa_\zeta = \frac{(\omega+\omega_E-1)\,(1-\omega)\, c\, \mathcal{T} Y_E}{\omega\,[B+(1-\omega_E)D]},$$

with $B = (1-\omega)Z/\omega$ and $D = (\omega+\omega_E-1)\mathcal{T}^{\omega_E} C^E/\omega$ the first two terms on the right of (32) in steady state.

4. Calibration

A period is a quarter. Table 1 lists the parameters calibrated to targets: in the steady state, in the default-risk exercise of Section 5, or in simulations. Table 2 lists the predetermined parameters, which we discuss at the end of this section. The debt-adjustment cost ψ_b is small and only ensures that EM debt is stationary (Appendix C). Our baseline sets $s = 0$, so that all sovereigns owe the same; Section 6.5 raises it.

Size of the EM and its debt. The EM stands for emerging and developing economies excluding China, whose GDP is about 93% of U.S. GDP (IMF WEO, 2024); this ratio pins down the terms of trade and, through EM-good market clearing, the EM home bias ω_E. We target the market value of EM debt relative to annual EM GDP, which we denote d_y, at the observed unweighted mean of gross external debt relative to GDP across emerging and developing economies, $d_y = 0.5$ (World Bank Quarterly External Debt Statistics).

GFI exposure to EMs. We target EM debt at 10% of GFI risky assets, the share of EM securities in global banks' risky assets measured by Morelli et al. (2022). Because GFIs hold only U.S. capital and EM debt, the EM share of their assets is approximately

$$\frac{\mathcal{S} Q_E A_E}{Q K_B + \mathcal{S} Q_E A_E} \approx \frac{4 d_y r}{4 d_y r + Q K_B \,/\, (P_H Z/P)}, \tag{34}$$

where $r = 0.93$ is the EM's relative size and Q is about 75 quarters of U.S. GDP. The target therefore pins down GFI holdings of U.S. capital, $K_B \approx 0.445\, d_y$. With the GFI parameters of

TABLE 1. Calibrated Parameters

Parameter	Description	Value	Targeted moment
Steady-state targets			
ω_E	EM home bias	0.966	EM GDP 93% of U.S. GDP
b	EM debt	0.132	Debt/GDP of 50%
β_E	EM discount factor	0.987	$\beta_E \mathbb{E}[R_E] = 1$
a_0	default intercept	-0.83	Default rate of 3% a year
K_B	GFI holdings of U.S. capital	0.223	EM debt 10% of GFI assets
α	household management cost	4.39	Households hold $1 - K_B$
Default-risk exercise			
c	default cost, share of output a quarter	0.035	Just above break-even $c^* = 0.032$
Simulated moments			
σ_z	s.d. of U.S. endowment innovations	0.0079	SD of HP-filtered U.S. GDP, 1.0%
σ_N	s.d. of GFI net-worth shock	0.075	SD of bank stock returns, 11.7%
a_q	default log-odds elasticity to $-\log Q_E$	5.07	SD of EM dollar-bond spreads, 173 bp

Notes: Steady-state targets refer to the deterministic steady state, which is the same under both denominations. The parameters a_q and σ_N are set under dollar debt and used under both denominations. Data: standard deviation of HP-filtered ($\lambda = 1{,}600$) log U.S. real GDP, 1985Q1–2019Q4; standard deviation of quarterly log returns on the value-weighted portfolio of U.S. banks (Ken French "Banks"), 1985–2019; standard deviation of EMBI spreads on EM dollar bonds.

Table 2, $\sigma = 0.95$, $\theta = 0.29$ and $\xi_N = 0.1$, which are common in the literature, risk-weighted leverage is then 5.0 and the excess return on U.S. capital 127 basis points a year.

Predetermined parameters. The U.S. discount factor, $\beta = 0.99$, risk aversion, $\varrho = 4$, and home bias, $\omega = 0.94$, are common in the literature; with this home bias, EM goods account for 6% of U.S. spending. The curvature of the households' management cost, $\eta = 12$, governs how much the price of U.S. capital must fall for households to absorb the capital that GFIs sell. It is close to the elasticity of the marginal cost of household holdings in the calibration of Gertler et al. (2020), about 11. Both endowments have a persistence of 0.9, common in the literature. Given this persistence, σ_z matches the volatility of HP-filtered U.S. output, a moment that in the model barely depends on ρ_z, and $\sigma_E = 0.02$ gives a standard deviation of HP-filtered EM output of about 2.5%, close to the 2.7% average across emerging markets in Aguiar and Gopinath (2007). EM debt and U.S. capital have the same weight in the incentive constraint, $\vartheta_E = 1$, so differences in their expected returns reflect only covariance risk (Section 7). The EM's risk aversion, $\varrho_E = 2$, and the average life of EM debt, five years, are common in quantitative models

TABLE 2. Predetermined Parameters

Parameter	Description	Value
U.S. households		
β	discount factor	0.99
ϱ	CRRA	4
ω	home bias	0.94
η	curvature of the capital management cost	12
ρ_z	persistence of the endowment	0.90
Financial intermediaries		
σ	survival probability	0.95
θ	divertible share	0.29
ξ_N	endowment of new bankers	0.1
ϑ_E	weight of EM debt in the incentive constraint	1
Emerging market		
$\bar{Y}_E$	EM output: mean	1
ρ_E	EM output: persistence	0.90
σ_E	EM output: s.d. of innovations	0.02
ϱ_E	EM CRRA (curvature of u)	2
ξ	EM debt decay (average life 5 years)	0.95
ψ_b	debt-adjustment cost (local-currency debt)	0.01
s	cross-sectional dispersion of log debt	0
Default		
h	haircut on defaulted debt (recovery $1-h$)	0.37
θ_d	exit rate from default status	0.0385
a_b	default log-odds elasticity to the debt burden	2
a_y	default log-odds elasticity to $-\log Y_E$	10

Notes: Under dollar debt, ψ_b is set so that EM debt has the same persistence as under local-currency debt.

of sovereign default. The haircut, $h = 0.37$, is the average in Cruces and Trebesch (2013), and $\theta_d = 0.0385$ implies 6.5 years in default status, as in Chatterjee and Eyigungor (2012). Finally, $a_b = 2$ and $a_y = 10$ imply that a 1% increase in the debt burden raises the odds of default by 2%, and a 1% fall in EM output raises them by 10%, so default risk rises sharply in recessions, consistent with quantitative models of sovereign default (Arellano, 2008).

5. Mechanism: how the exchange rate and GFI net worth respond to EM credit risk

This section uses a default-risk exercise to show how the model works. The exercise is not a result: it moves one thing, the EM's credit risk, and lets us show each piece of the transmission before Section 6 combines them. We raise the default-risk shifter by an unanticipated $\chi_0^\delta = 0.93$ and let it decay at rate $\rho_\delta = 0.9$. At first order, the shock doubles the default rate expected for next quarter, from 3% to 6% a year.[13] We describe the responses with local-currency debt (solid blue lines in Figure 4) and then point out where dollar debt differs (dashed red lines). Responses are first order, where the decompositions below hold exactly.[14] Appendix E compares the baseline with versions without recovery or default costs.

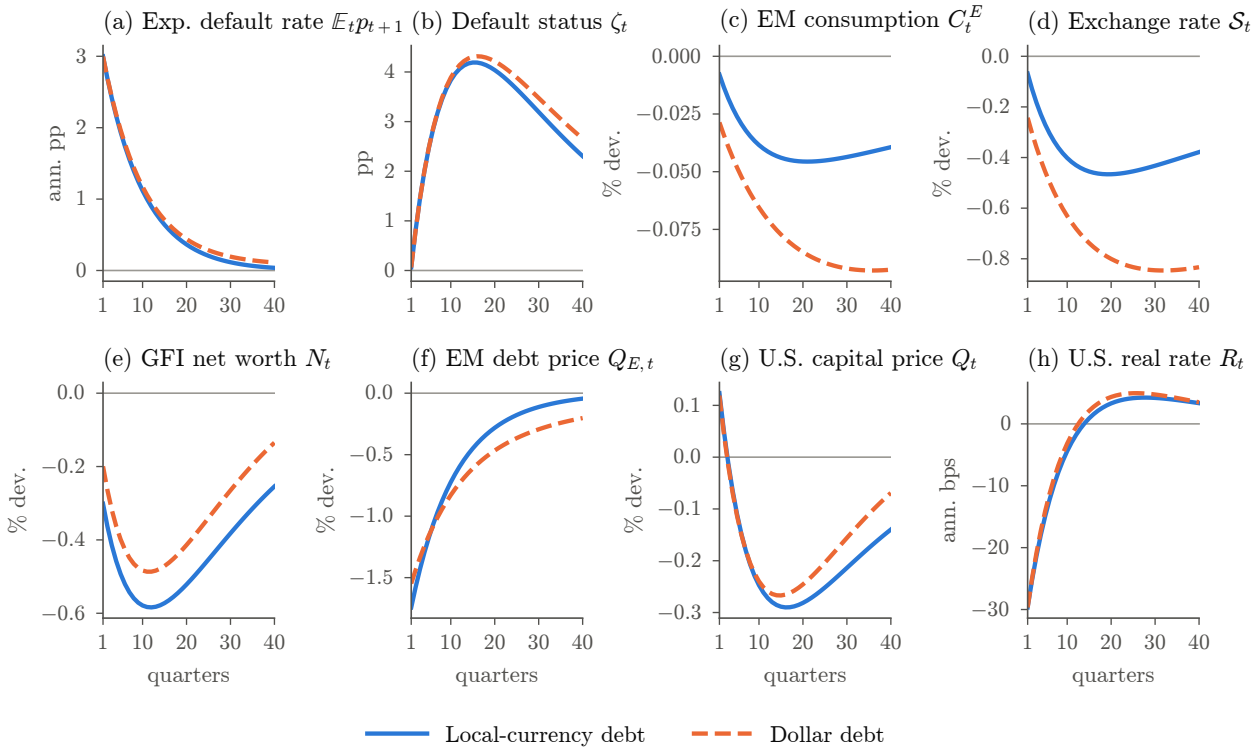
Timing. Because χ_t^δ enters the default rate of $t+1$, most of the extra defaults start in quarter 2. On impact, the price of EM debt capitalizes the higher default risk. Through the borrowing-cost term in (22), this raises the current default rate slightly (0.3 percentage points, annualized). EM consumption also responds on impact: the anticipated debt relief raises it and the default costs lower it. At our calibration the costs dominate slightly. Default status then builds up according to (26), peaking about 4 percentage points above steady state after 15 quarters. With dollar debt, the default rate and default status respond almost identically (Figure 4, panels a and b), but EM consumption falls by more, for reasons we turn to below.

The exchange rate follows EM consumption. The dollar appreciates as EM consumption falls (Figure 4, panels c and d): by 0.07% on impact and by 0.47% at its peak, in quarter 19. Both come from the default cost: it lowers EM consumption, which with home bias lowers the demand for the EM good, and it makes the U.S. good scarcer. As default status builds up, EM consumption falls further below steady state and the U.S. goods used up by the cost add a direct effect. Figure 5(a) separates the two with the terms of (33) (Section 3.7). At our calibration,

[13] At first order the responses are linear in the size of the shock, which only scales them. Of the 3 percentage points, 2.76 come from the shifter itself and 0.24 from the fall in the price of EM debt, through the borrowing-cost term in (22).

[14] At third order, from the stochastic steady state, no response changes sign on impact or after eight quarters. The responses are larger, because the default rule is convex: on impact the expected default rate rises by 5.4 percentage points a year with local-currency debt and 5.0 with dollar debt, against 3.0 at first order, and the discounted cumulative responses of the exchange rate and EM consumption are about 1.5 times their first-order values.

FIGURE 4. Default-Risk Exercise



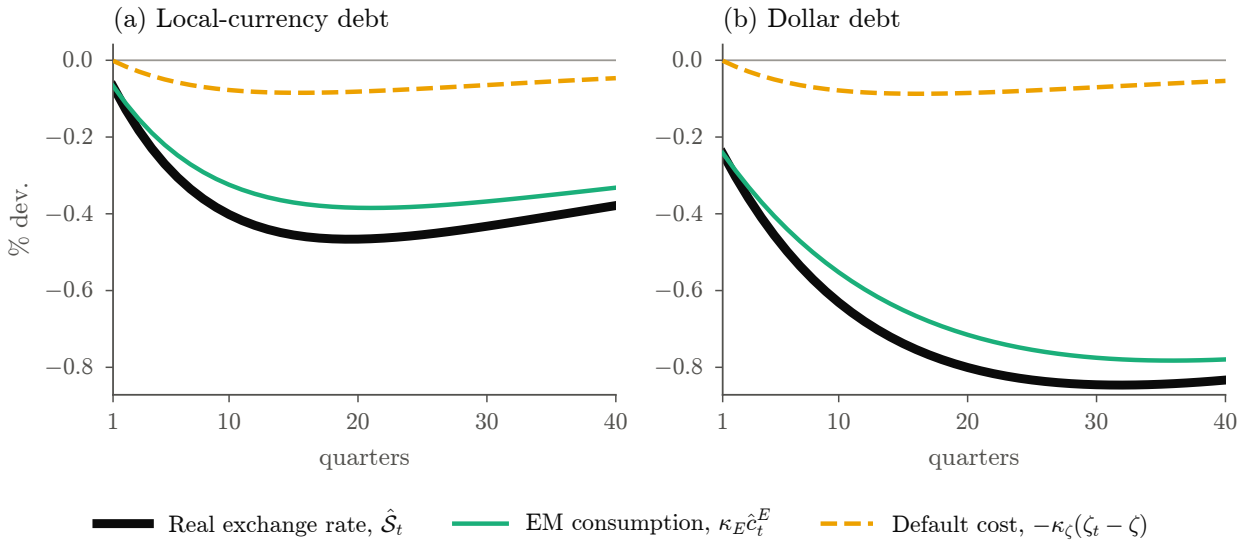
Notes: Responses to an unanticipated increase in the default-risk shifter ($\chi_0^\delta = 0.93$, $\rho_\delta = 0.9$), first order, baseline calibration. Solid blue: local-currency debt; dashed red: dollar debt. An increase in $\mathcal{S}$ is a real depreciation of the dollar.

$\kappa_E \approx 8.4$ and $\kappa_\zeta \approx 2.0$.[15] At the peak, EM consumption is 0.046% below steady state, which accounts for 0.38% of the appreciation, and default status is 4.1 percentage points higher, which accounts for 0.08% through the cost. With dollar debt, the dollar appreciation raises the EM's debt burden in EM consumption. EM consumption falls by more, which appreciates the dollar further, and the higher burden raises default risk. The dollar appreciates by 0.24% on impact and by 0.85% at its peak, in quarter 32 (Figure 5(b) shows the decomposition). In present value, discounted at β_E, EM consumption falls by the equivalent of a permanent 0.028% decline with local-currency debt and 0.065% with dollar debt.

Debt relief against the default cost. Whether a default makes the EM richer or poorer decides the sign of the response of EM consumption, and with it of the exchange rate. A default on

[15]The coefficient κ_E is large because import shares are small: the denominator of κ_E is the sum of two terms proportional to $1-\omega$ and $1-\omega_E$, so when both economies spend most of their income on their own good, absorbing a small change in EM spending takes a large change in the terms of trade.

FIGURE 5. Default-Risk Exercise: Real Exchange Rate



Notes: Baseline, first order. The real exchange rate (black) and the terms of (33), with local-currency and dollar debt; the black line is the sum of the colored lines; the two supply terms are zero.

a unit of the default rate relieves the EM of debt worth $h(1+\xi Q_E)b$. It also puts a unit of sovereigns in default status, which costs $c\mathcal{T}^{1-\omega_E}Y_E$ a quarter for as long as they stay there. Discounting at β_E, the cost outweighs the relief when c exceeds

$$c^{PV} = \frac{h\,(1+\xi Q_E)\,b\,\left[1-\beta_E(1-\theta_d)\right]}{\mathcal{T}^{1-\omega_E}Y_E}. \tag{35}$$

At $c = c^{PV}$ an additional default leaves the EM's wealth unchanged at given prices, the counterpart of the indifference of a marginal defaulter in a model of strategic default. In units of quarterly output, the debt relief is about $4hd_y$, where d_y is the debt-to-GDP ratio of Section 4, and default status lasts $1/[1-\beta_E(1-\theta_d)] \approx 19.6$ quarters after discounting. So $c^{PV} \approx 4hd_y/19.6 = 0.038$ at $h = 0.37$ and $d_y = 0.5$.

In general equilibrium, the break-even cost c^*, at which EM consumption does not move on impact, is somewhat below c^{PV}. We set c just above c^* (Table 1), so that EM consumption falls slightly on impact. The dollar appreciation does not depend on that choice: because default status builds up after the shock, the cost bites with a lag, and even at c^* the dollar appreciates by 0.36% by quarter 20, against 0.47% in the baseline. Appendix E plots the responses against c and discusses the size of the cost and its sensitivity to h, d_y and θ_d.

GFI net worth. From (19), the impact response of GFI net worth reflects asset revaluations and the defaults that the fall in the price of EM debt triggers on impact:

$$\hat{N}_1 = \underbrace{\varpi_H\left[\hat{Q}_1 - \iota\,(1-\omega)\hat{\mathcal{T}}_1\right]}_{\text{U.S. capital price}} + \underbrace{\varpi_E\, w\, \hat{Q}_{E,1}}_{\text{EM debt price}} + \underbrace{\varpi_E\, \hat{e}_1}_{\text{exchange rate}} - \underbrace{\varpi_E\, \frac{h\,\Delta p_1}{1-h\bar{p}}}_{\text{defaults}}, \tag{36}$$

where $\varpi_H \equiv \sigma\phi_H \approx 4.3$ and $\varpi_E \equiv \sigma\phi_E\bar{R}_E \approx 0.48$ are the exposures of net worth to U.S. capital and EM debt: $\phi_H \approx 4.5$ and $\phi_E \approx 0.5$ are the steady-state positions relative to net worth and $\bar{R}_E$ is the steady-state gross return on EM debt. The weight $w \equiv \xi Q_E/(1+\xi Q_E) \approx 0.94$ is the share of the payoff on EM debt that is the value of the remaining debt, $\hat{e}_1 = \hat{\mathcal{S}}_1$ with local-currency debt and zero with dollar debt, and Δp_1 is the change in the default rate on impact. The term in $\iota \equiv (P_H Z/P)/Q$, the dividend yield on U.S. capital, is negligible.

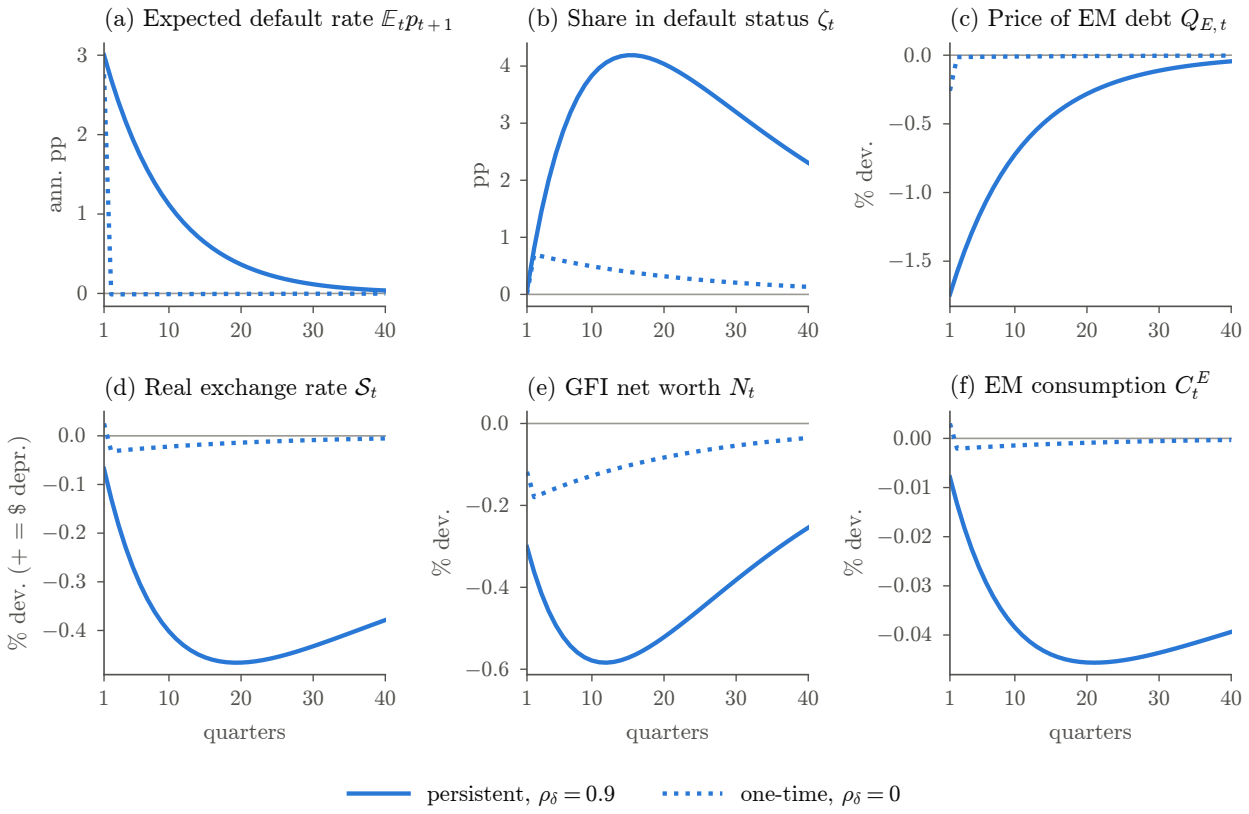
On impact, the fall in the price of EM debt lowers net worth by 0.79%; the exchange rate and the defaults triggered on impact subtract only 0.03% and 0.01%. The U.S.-capital term is positive (+0.53%). U.S. households lose from the defaults through their ownership of GFIs, and with the default cost, their consumption declines gradually as default status builds up rather than at once (Table E.1). The expected decline lowers the real rate by 30 basis points (annualized) on impact and raises the price of U.S. capital (Figure 4, panels g and h). The gain is short-lived: from quarter 3 on, the price of U.S. capital is below steady state. Net worth falls by 0.30% on impact and by 0.58% at its peak, in quarter 12. By then, GFIs have lost about 1% of net worth on EM debt, mostly through realized defaults, and another 1% on U.S. capital; cheaper funding, as the real rate falls, offsets 1.5%.[16] Without default costs, the price of U.S. capital falls already on impact, and the fire sale of U.S. capital accounts for most of the fall in net worth (Appendix E). With dollar debt, GFIs bear no exchange-rate risk and the price of EM debt falls by less, so net worth falls by less: 0.20% on impact and 0.49% at its peak.

Persistence of default risk. Figure 6 compares a one-time increase in default risk with a persistent one, with the same initial shift in default risk. Persistence of default risk moves asset prices: long-duration debt capitalizes the whole path of expected losses, so the price of EM debt falls by 0.3% with a one-time shock and by 1.7% with $\rho_\delta = 0.9$ (panel c). Default status accumulates realized defaults, by (26), and the exchange rate and GFI net worth track it (panels b, d and e).

[16] From (19), the growth rate of net worth is $\sigma[\phi_{H,t-1}(R_{k,t} - R_{t-1}) + \phi_{E,t-1}(R_{E,t} - R_{t-1}) + R_{t-1}]$ plus the endowment of entering bankers. To first order, its cumulated deviation since the shock splits into the realized return on EM debt (from its price, the exchange rate and realized defaults), the realized return on U.S. capital, and funding: the deposit rate, plus small terms from changes in portfolio weights and from entering bankers. On impact, these terms reduce to (36).

After a one-time shock, the default rate returns to steady state in quarter 3. What remains is the stock of sovereigns in default status, which shrinks as they exit at rate θ_d, and every response, including EM consumption (panel f), moves in proportion to it: from quarter 2 on, $\hat{\mathcal{S}}_t \approx -0.045(\zeta_t - \bar{\zeta})$ and $\hat{N}_t \approx -0.26(\zeta_t - \bar{\zeta})$, with ζ in percentage points. Because a one-time shock adds few defaults, default status rises by only 0.7 points and the exchange rate barely moves. With persistent risk, defaults keep adding to default status and the dollar appreciates by 0.47% at its peak. Dollar debt makes little difference for a one-time shock. For a persistent one, it deepens the appreciation (0.85% at its peak), which continues after default status peaks.

FIGURE 6. Persistence of Default Risk



Notes: Default-risk exercise with different persistence of default risk, $\chi_0^\delta = 0.93$, first order, baseline calibration, local-currency debt. Solid lines: persistent risk ($\rho_\delta = 0.9$, as in Figure 4); dotted lines: one-time increase ($\rho_\delta = 0$).

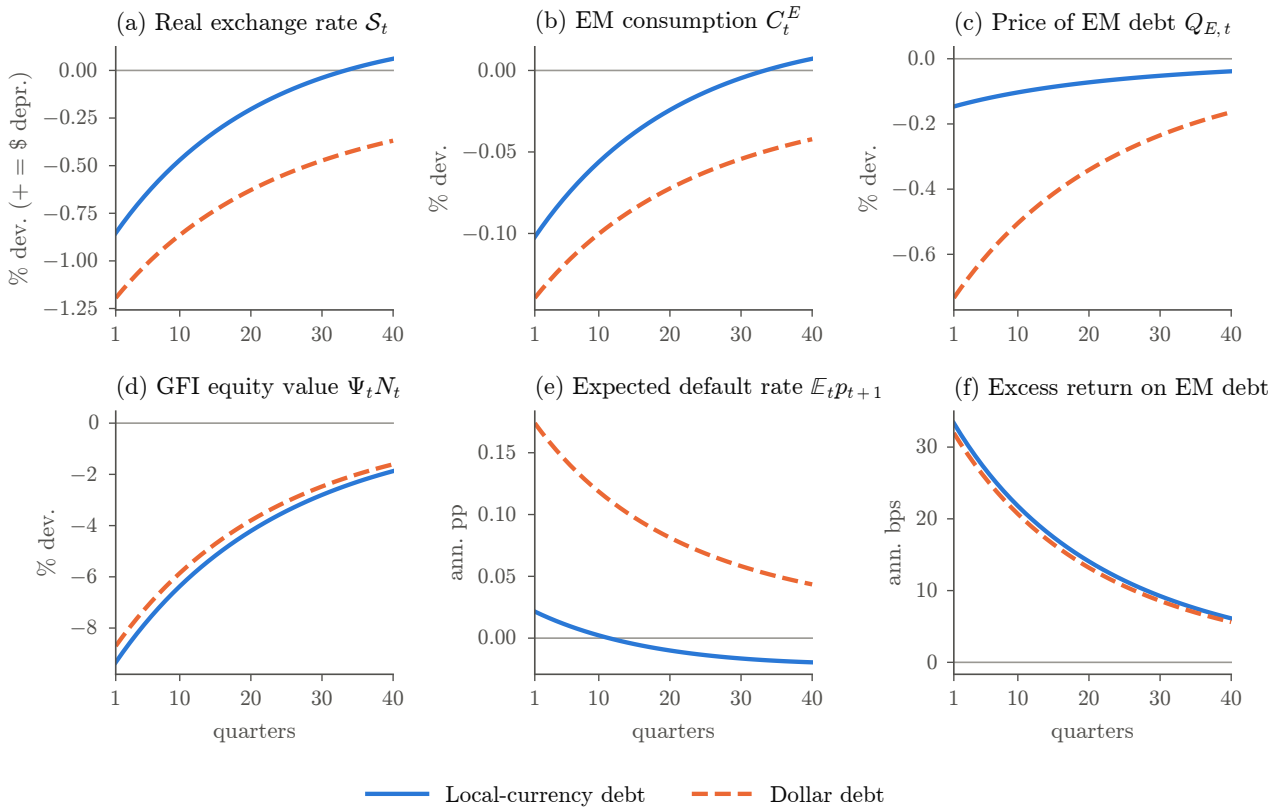
6. TRANSMISSION OF FINANCIAL AND MACROECONOMIC SHOCKS

6.1. *GFI net-worth shocks and the Lehman elasticity*

The model counterpart of the Lehman episode is a shock that destroys 10% of GFI net worth, $\varepsilon_N = -0.10$ in (19). As in the empirical design, we measure GFI equity at market

value, $V_t = \Psi_t N_t$, and compute $\gamma^{\text{model}} = -\Delta \log \mathcal{S}_1 / \Delta \log V_1$, the counterpart of γ^{data}, so that $\gamma^{\text{model}} < 0$ when the EM currency depreciates as GFI equity falls. No parameter is chosen to match it. Figure 7 and Table 3 report the responses under both denominations, at third order and from the stochastic steady state.

FIGURE 7. GFI Net-Worth Shock



Notes: Responses to a shock that destroys 10% of GFI net worth, third order (pruned), from the stochastic steady state. Panel (c): price of EM debt in its unit of denomination. Panel (f): expected excess dollar return on EM debt over the deposit rate.

Local-currency debt. GFI net worth falls by 16.3% on impact: 10 points are the shock itself, and most of the rest comes from the fire sale of U.S. capital. GFIs require a higher return on EM debt, so the EM borrows less, EM consumption falls by 0.10%, and the EM currency depreciates by 0.85%. The elasticity is −0.09. The price of EM debt in local currency falls by only 0.15%, but in dollars the debt loses about 1% of its value, mostly through the depreciation. As the EM currency recovers, it delivers most of the higher dollar return GFIs require, so the local-currency price needs to fall little. Default risk, which responds to this price in (25), barely moves.

TABLE 3. Responses to the GFI Net-Worth Shock

	Local-currency debt	Dollar debt
Lehman elasticity γ^{model}, impact ($\gamma^{\text{data}} = -0.15$)	-0.091	-0.137
RER $\mathcal{S}$, impact (%)	-0.85	-1.19
EM consumption, impact (%)	-0.10	-0.14
Price of EM debt Q_E, impact (%)	-0.15	-0.73
GFI net worth N, impact (%)	-16.3	-15.6
GFI equity value ΨN, impact (%)	-9.3	-8.7

Notes: The shock destroys 10% of GFI net worth. Third-order (pruned) responses from the stochastic steady state.

Dollar debt. The EM currency depreciates by about 40% more, and the elasticity is -0.14, close to the data. The extra depreciation runs through EM consumption: a depreciation raises the cost, in EM consumption, of servicing and rolling over dollar debt. It does not run through defaults. The depreciation raises the debt burden in the default rate, but removing the exchange rate from the default rate changes the depreciation by only about a tenth,[17] because with a haircut of 37% the extra defaults move EM borrowing costs little and bring debt relief. This holds also when default risk does not respond to borrowing costs (Appendix F). Finally, GFIs lose less: their EM holdings carry no currency risk, so dollar debt shifts exchange-rate risk from lenders to the EM. With local-currency debt, the shock is absorbed by the valuation of EM debt through the exchange rate, on GFIs' balance sheets; with dollar debt, it is absorbed by the price of EM debt and the EM's debt burden.

6.2. *Exposure*

The elasticity is proportional to EM debt relative to GDP (Table 4): with local-currency debt, $\gamma^{\text{model}} \approx -0.21\, d_y$. The dollar burden is itself proportional to debt, so the difference between denominations also grows with d_y: the ratio of the two elasticities is 1.49 at $d_y = 0.5$ and 1.09 at 0.15. Across countries, the model therefore predicts larger responses where borrowing from GFIs, and in particular dollar borrowing, is larger relative to GDP. The Lehman design weights lenders by their share of claims on each country, so the -0.15 is an average over countries with different exposures.

[17] This comparison is at first order.

TABLE 4. Sensitivity to EM Debt Relative to GDP

	$d_y = 0.50$	0.25	0.15
Lehman elasticity γ^{model}, local-currency debt	−0.105	−0.055	−0.033
Lehman elasticity γ^{model}, dollar debt	−0.156	−0.064	−0.036
Amplification of U.S. endowment shock (RER, impact)	1.41	1.24	1.15
Break-even default cost c^* (% of output a quarter)	3.2	1.7	1.1

Notes: First order. The default cost is scaled with the break-even cost; GFI holdings of U.S. capital are backed out at each d_y to keep EM debt at 10% of GFI assets, so GFIs are smaller when d_y is lower. Amplification: local-currency debt, relative to the benchmark without the incentive constraint (Section 6.3).

6.3. *U.S. and EM shocks, and amplification by GFIs*

Figure 8 plots the responses to a fall in the U.S. endowment (top row) and in EM output (bottom row). To measure how much GFI balance sheets add, we compare them with a benchmark without the incentive constraint, in which EM debt and U.S. capital are priced by U.S. households; Table 5 reports the differences between the responses with GFIs and those in the benchmark.

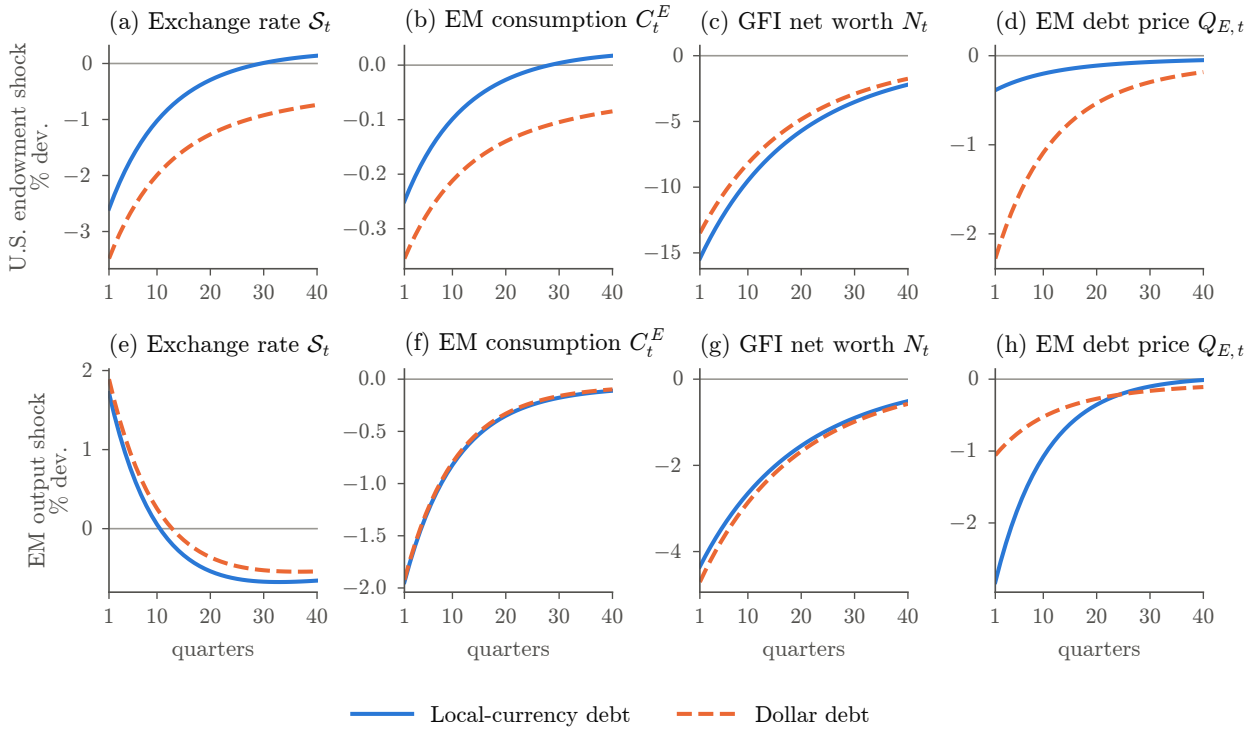
TABLE 5. Amplification

Shock	Debt	RER $\mathcal{S}$		EM consumption	
		impact	sum 1–20	impact	sum 1–20
U.S. endowment	Local currency	−0.76	−8.1	−0.08	−0.85
	Dollar	−1.12	−16.4	−0.12	−1.75
EM output	Local currency	−0.26	−3.8	−0.05	−0.51
	Dollar	−0.36	−5.7	−0.06	−0.78

Notes: Response with GFIs minus the response in the benchmark without the incentive constraint, one-standard-deviation shocks, first order. Impact: difference in quarter 1, in percentage points; sum 1–20: difference of the cumulative responses over the first 20 quarters, in percentage points × quarters. A negative entry for $\mathcal{S}$ is an additional dollar appreciation.

U.S. shocks. A fall in the U.S. endowment (top row) appreciates the dollar by 2.6% on impact with local-currency debt and by 3.5% with dollar debt. GFIs lose about 15% of their net worth, mostly through the price of U.S. capital, and the excess return they require on EM debt rises by 31 basis points. With dollar debt, the dollar appreciation also raises the EM's debt burden and its default risk, so the price of EM debt falls by 2.3% on impact, against 0.4% with local-currency

FIGURE 8. U.S. Endowment and EM Output Shocks



Notes: Responses to a one-standard-deviation fall in the U.S. endowment (top row) and in EM output (bottom row), with GFIs, first order, in percent deviations from steady state. Solid blue: local-currency debt; dashed red: dollar debt. An increase in $\mathcal{S}$ is a real depreciation of the dollar. Table 5 compares these responses with the benchmark without the incentive constraint.

debt (panel d). GFI balance sheets add 0.8 percentage points to the dollar appreciation on impact with local-currency debt and 1.1 points with dollar debt (Table 5), about 40% and 50% of the response in the benchmark: shifting currency losses onto GFIs does not make them a stronger amplifier. GFIs also make the responses somewhat more persistent. The dollar appreciation, which is largest on impact, takes 6.8 quarters to fall to half its impact value with local-currency debt, against 6.0 in the benchmark, and 11.6 quarters against 9.0 with dollar debt.

EM shocks. GFIs barely amplify EM-specific shocks, because EM debt is a small share of their assets. A fall in EM output (bottom row) raises the default rate and EM spreads, but on impact it appreciates the EM currency: the EM good becomes scarcer, and by (33) the supply effect outweighs the fall in EM consumption. This is a limitation of the endowment economy; a version with production, or with EM output that is partly traded, would weaken the supply effect.

The effect reverses after about three years. EM consumption recovers more slowly than EM output, and from quarter 11 (13 with dollar debt) the dollar appreciates (panel e). GFIs tilt the response toward the dollar throughout: the EM currency appreciates 0.3 points less on impact (0.4 with dollar debt), and the cumulative dollar appreciation over five years is larger (Table 5).

EM spreads. We calibrate the borrowing-cost feedback a_q so that, in a long simulation with all shocks, the standard deviation of dollar-bond spreads matches the data, 173 basis points. We measure the spread against a default-free bond of the same duration (Appendix D). The decomposition of spreads is not targeted. The intermediation premium accounts for 40% of the standard deviation of spreads and the default premium for 58%, against 39% and 76% in the estimated model of Morelli et al. (2022). The mean spread, also not targeted, is 310 basis points, against 410 in the data. Section 7 decomposes spreads further.

6.4. *The 2007–09 episode*

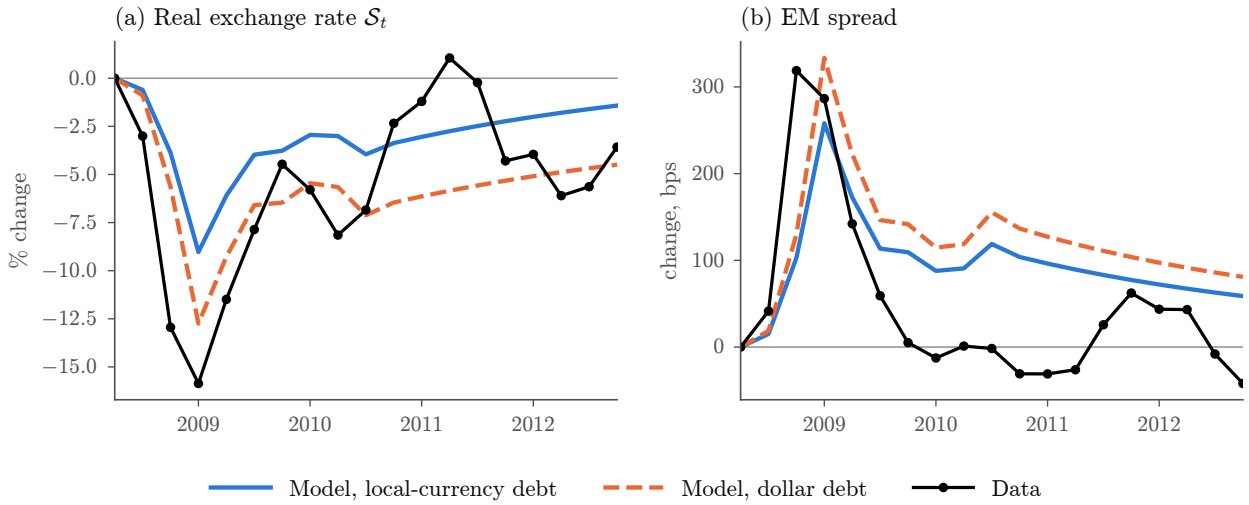
We next ask how far the shock to GFI net worth alone goes in accounting for EM spreads and the dollar around the collapse of Lehman Brothers. Starting from the steady state in 2008Q2, we feed in shocks to GFI net worth, $\varepsilon_{N,t}$ in (19), from 2008Q3 to 2010Q4, chosen so that GFI equity value V_t follows the value of U.S. bank stocks, the series whose volatility pins down σ_N (Section 4).[18] There are no other shocks.[19] Agents learn each shock when it occurs and expect no further shocks, and we solve the model nonlinearly.

Figure 9 compares the model with the data. The shock to GFI net worth alone accounts for much of the dollar appreciation: by 2009Q1 the dollar appreciates in real terms by 9.0% with local-currency debt and by 12.7% with dollar debt, against 15.9% in the data. It also accounts for the rise in EM spreads, 258 and 333 basis points by 2009Q1, against 286 in the data, which peak at 319 a quarter earlier. As bank stocks recover in 2009, the dollar depreciates and spreads fall, as in the data. By 2009Q4 the dollar is 3.8% and 6.5% stronger than in 2008Q2, against 4.4% in the data. Spreads, however, remain 110 to 140 basis points higher, because GFI net worth rebuilds slowly, while in the data they are back to their 2008Q2 level. Without the incentive constraint, the same shocks move neither the exchange rate nor spreads, so these responses come entirely from GFI balance sheets. Dollar debt makes them larger: a stronger dollar raises the EM's debt burden and its default risk, which GFIs price.

[18] The target is the quarterly average of the cumulative return on the value-weighted portfolio of U.S. banks. Relative to 2008Q2, it falls by 82 log points by 2009Q1 and recovers to −37 log points by 2009Q4.

[19] We leave out EM output shocks. In our endowment economy, a fall in EM output makes the EM good scarcer and appreciates the EM currency (Section 6.3).

FIGURE 9. The 2007–09 Episode: GFI Net-Worth Shocks and the Data



Notes: Changes relative to 2008Q2. Model: responses to GFI net-worth shocks in 2008Q3–2010Q4, chosen so that GFI equity value follows the value of U.S. bank stocks (quarterly averages of the cumulative return on the Ken French "Banks" portfolio); no other shocks; nonlinear solution, with agents learning each shock when it occurs. Solid blue: local-currency debt; dashed red: dollar debt. Data (black), quarterly averages: in panel (a), the BIS narrow real effective exchange rate of the dollar used in Figure 1, with the sign reversed; in panel (b), the equal-weighted average EMBI stripped spread of 14 EMs (Brazil, Chile, Colombia, Hungary, Indonesia, Malaysia, Mexico, Peru, Philippines, Poland, Russia, South Africa, Turkey, Uruguay). A negative change in $\mathcal{S}$ is a real appreciation of the dollar.

6.5. *The dispersion of EM debt*

Our baseline assumes that all sovereigns owe the same. With dispersion, $s > 0$ in (20), more sovereigns are close to their default threshold for a given aggregate debt. We raise s so that the cross-country standard deviation of debt to GDP rises from 0 to 12.5 and 25 percentage points around the average of 50%,[20] holding fixed the share of sovereigns that default each year, 3%, by adjusting a_0. The sovereigns that default then owe more, so the share of EM debt that defaults rises, and so does the EM spread: with a standard deviation of 25 points, by about 90 basis points with local-currency debt and 140 with dollar debt in the stochastic steady state. Because each default relieves more debt, we scale the default cost with its break-even value c^* (Section 5), as in Table 4. Table 6 reports the results.

[20] A standard deviation of 25 points is in line with the cross-country dispersion of gross external debt to GDP in the emerging and developing economies used to calibrate d_y (World Bank Quarterly External Debt Statistics).

TABLE 6. Dispersion of EM Debt

Cross-country s.d. of debt/GDP (pp)	0	12.5	25
GFI net-worth shock: peak dollar appreciation (%)			
Local-currency debt	0.85	0.85	0.84
Dollar debt	1.19	1.23	1.46
Ratio, dollar to local-currency debt	1.40	1.45	1.73
Default-risk shock: peak dollar appreciation (%)			
Local-currency debt	0.69	0.79	1.15
Dollar debt	1.26	1.58	3.83
Ratio, dollar to local-currency debt	1.84	2.01	3.33

Notes: Third order, pruned; responses from the stochastic steady state. Columns: $s = 0$, 0.246 and 0.472 in (20); the standard deviation of debt to GDP across sovereigns is $d_y\sqrt{e^{s^2}-1}$, with average debt to GDP $d_y = 0.5$. At each s, a_0 keeps the share of sovereigns that default each year at 3%, and the default cost is $c = 0.035\, c^*(s)/c^*(0)$, where $c^*(s)$ is the break-even cost under local-currency debt; ψ_b keeps the persistence of debt as at $s = 0$. GFI net-worth shock: $\varepsilon_N = -0.10$. Default-risk shock: as in Section 5, of the same size at every s. Peak: largest dollar appreciation over 200 quarters (on impact for the GFI net-worth shock).

Dispersion strengthens the default channel of the exchange rate. After a shock to GFI net worth, the dollar appreciates by 1.46% with dollar debt when the standard deviation of debt to GDP is 25 points, against 1.19% without dispersion, while the response with local-currency debt does not change. The amplification is larger after the default-risk shock of Section 5, which works through default status: the peak dollar appreciation rises from 0.69% to 1.15% with local-currency debt and from 1.26% to 3.83% with dollar debt.

7. RISK PREMIA

GFIs price EM debt, U.S. capital and EM currency risk with the same stochastic discount factor $\mathcal{M}_{t+1}$. This section measures how much of EM spreads and of the expected excess returns on these assets compensates GFIs for expected default losses, for the incentive constraint and for risk, and how these premia move with GFI net worth.

The sources of EM spreads. To measure how much default risk, exchange-rate risk and GFI balance sheets matter for the pricing of EM debt, we decompose the EM spread into three parts: expected default losses; a balance-sheet wedge, which compensates GFIs for their incentive constraint; and risk premia, which compensate them for currency, discount-rate and default risk. The decomposition extends that in Morelli et al. (2022), whose intermediation premium

combines the balance-sheet wedge with the currency and discount-rate risk premia. We price hypothetical bonds with the same coupons and currency as EM debt (Appendix D). The spread is measured against a default-free bond priced by a risk-neutral investor. A defaultable bond priced by a risk-neutral investor has a spread that compensates only for expected default losses. A default-free bond priced with the GFI discount factor, but without the compensation for the incentive constraint, has a spread that compensates only for risk: currency risk, with local-currency debt, and discount-rate risk, the risk that the price of a long bond falls when GFIs require higher returns. Adding the compensation for the incentive constraint gives the balance-sheet wedge. The remainder of the spread is the premium for default risk, which compensates GFIs for defaults that occur when their net worth is scarce. The components add up to the spread in every quarter.

Expected default losses account for about half of the average spread (Table 7): 48% with local-currency debt and 54% with dollar debt. The rest compensates GFIs for the balance-sheet wedge and for risk, in equal parts with local-currency debt (26% each) and more for the balance-sheet wedge with dollar debt (30% against 16%). With local-currency debt, the currency risk premium is 36 basis points, 11% of the spread, about as much as discount-rate risk. With dollar debt, the exchange rate does not enter the payoff, but it enters the spread through defaults: a dollar appreciation raises the burden of dollar debt and with it expected default losses. Default risk accounts for only 2% and 5% of the spread. Fluctuations in spreads come mostly from expected default losses and the balance-sheet wedge, which account for 80% of the variance of spreads with local-currency debt and 87% with dollar debt. These results are in line with those in Morelli et al. (2022), where expected default losses also account for about half of the average spread and default risk for a small share. Our decomposition further splits their intermediation premium into the balance-sheet wedge and risk premia, and identifies a currency risk premium.

Covariance risk. A similar split applies to the expected excess return over one quarter. For asset j, the GFI portfolio problem implies (Appendix D)

$$\mathbb{E}_t[R_{j,t+1}] - R_t = \frac{\mu_{j,t}}{\mathbb{E}_t[\mathcal{M}_{t+1}]} - \frac{\mathrm{Cov}_t(\mathcal{M}_{t+1}, R_{j,t+1})}{\mathbb{E}_t[\mathcal{M}_{t+1}]}. \tag{37}$$

The first term comes from the incentive constraint and the second is the covariance term. Table 8 reports medians in a long simulation.[21] The expected excess return on EM debt is 134 basis

[21]Conditional moments are computed from the third-order solution, averaging over the distribution of next quarter's shocks. The two terms in (37) are computed separately and add up to the expected excess return only approximately.

TABLE 7. Sources of EM Spreads

	Mean		Standard Deviation	
Currency	Local	USD	Local	USD
EM spread (bps a year)	317	310	119	173
Share of the spread (%)				
Expected default losses	48	54	40	55
Balance-sheet wedge	26	30	40	32
Risk premia	26	16	20	13
Currency risk	11	–	7	–
Discount-rate risk	13	11	7	5
Default risk	2	5	5	9

Notes: This table shows a decomposition of the EM-bond spreads predicted by the model into expected default losses, the balance-sheet wedge and risk premia. For definitions of each component, see Section 7. The first row is expressed in basis points a year, and the remaining rows in percent of the first row. In the Standard Deviation columns, the share of each component is its covariance with the spread divided by the variance of the spread, so that the shares add up to 100. Statistics are computed in a simulation of 50,000 quarters of the third-order solution, with all shocks. Currency: currency of denomination of EM debt.

points a year with local-currency debt and 117 with dollar debt. Covariance risk accounts for most of it, 132 and 96 basis points, against 53 and 62 for the balance-sheet term.

EM debt and U.S. capital. The portfolio condition (18) implies

$$\mathbb{E}_t[R_{E,t+1}] - \mathbb{E}_t[R_{k,t+1}] = \frac{(\vartheta_E - 1)\,\mu_{H,t}}{\mathbb{E}_t[\mathcal{M}_{t+1}]} - \frac{\mathrm{Cov}_t(\mathcal{M}_{t+1}, R_{E,t+1}) - \mathrm{Cov}_t(\mathcal{M}_{t+1}, R_{k,t+1})}{\mathbb{E}_t[\mathcal{M}_{t+1}]}. \tag{38}$$

In our calibration $\vartheta_E = 1$, so the balance-sheet terms cancel and the difference in expected returns reflects only relative covariance risk. EM debt is expected to earn 9 basis points a year less than U.S. capital with local-currency debt and 19 less with dollar debt. U.S. capital is the riskier asset for GFIs: their net worth is mostly exposed to it ($\phi_H \approx 4.5$ against $\phi_E \approx 0.5$), so its return is low when net worth is most valuable.

Time variation. All premia rise when GFI net worth is low. The price of GFI-equity risk is 2.2 when GFI net worth is below its median and 0.75 when it is above, and its correlation with GFI leverage exceeds 0.99, the model counterpart of the relation between the price of risk and leverage in Figure 2. A fall of 10% in GFI net worth raises the expected excess return on EM

TABLE 8. Risk Premia

	Local-currency debt	Dollar debt
Expected excess return over R_t (bps a year)		
EM debt	134	117
Balance-sheet term	53	62
Covariance term	132	96
U.S. capital	144	137
EM debt minus U.S. capital	−9	−19
EM-currency claim		
Currency risk premium (bps a year)	141	168
Covariance term	87	105
Loading on GFI equity growth	0.16	0.24
State dependence: GFI net worth below / above its median		
Price of GFI-equity risk λ_t	2.21 / 0.75	2.09 / 0.76
Currency risk premium (bps a year)	268 / 72	296 / 91

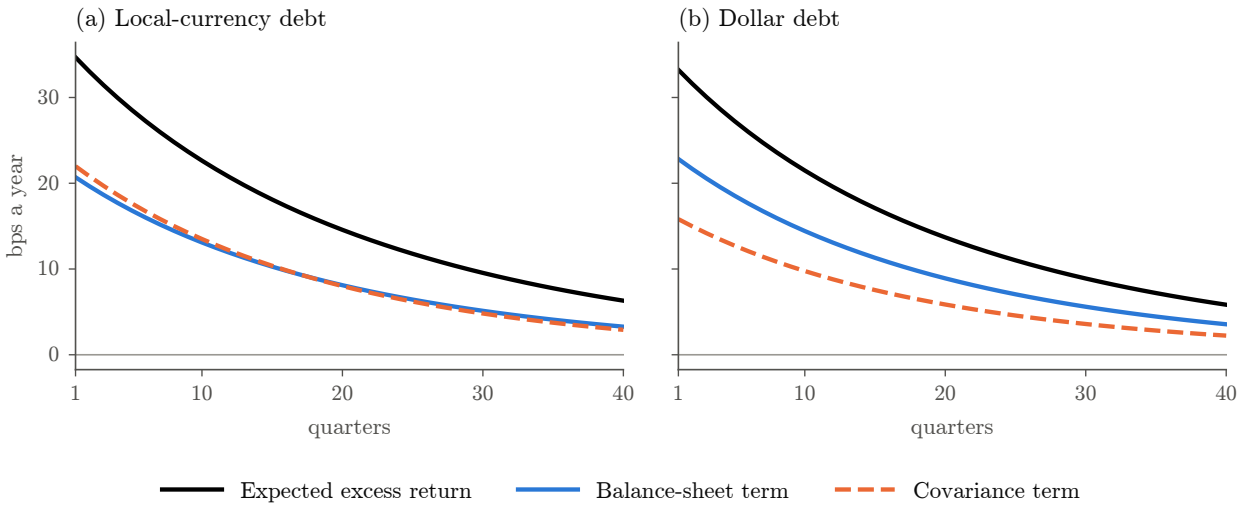
Notes: Third order, pruned; medians in a simulation of 50,000 quarters with all shocks. Expected excess returns over the U.S. risk-free rate, in dollars; covariance terms reported as $-\operatorname{Cov}_t(\mathcal{M}_{t+1}, \cdot)/\mathbb{E}_t[\mathcal{M}_{t+1}]$, so that a positive entry is a premium; components from (37). EM-currency claim: a one-quarter claim in EM currency held by GFIs, with the balance-sheet weight of EM debt; its premium is the expected dollar excess return. Loading: $\operatorname{Cov}_t(\mathcal{S}_{t+1}/\mathcal{S}_t, \Delta \log V_{t+1})/\operatorname{Var}_t(\Delta \log V_{t+1})$. Price of GFI-equity risk: $\lambda_t = -\operatorname{Cov}_t(\mathcal{M}_{t+1}, \Delta \log V_{t+1})/\operatorname{Var}_t(\Delta \log V_{t+1})$.

debt by 35 basis points on impact with local-currency debt and by 33 with dollar debt, of which about 21 to 23 come from the balance-sheet term and the rest from covariance risk (Figure 10). A fifth of the increase remains after ten years.

The currency risk premium. GFIs also price EM currency risk. Consider a one-quarter claim in EM currency, in zero net supply, held by GFIs with the balance-sheet weight of EM debt.[22] Its expected dollar excess return, the deviation from uncovered interest parity, is 141 basis points a year with local-currency debt and 168 with dollar debt, of which 87 and 105 are covariance risk. The EM currency is risky for GFIs: its return loads on GFI equity growth with a coefficient of 0.16 with local-currency debt and 0.24 with dollar debt. The premium is 268 basis points when GFI net worth is below its median, against 72 when it is above. EMs that borrow in dollars

[22]The model has no EM short-term bond, so the rate on this claim is the rate at which GFIs would hold it, not a market interest rate in the EM.

FIGURE 10. Risk Premia After a Shock to GFI Net Worth



Notes: Responses to $\varepsilon_N = -0.10$, third order (pruned), from the stochastic steady state, in basis points a year. Expected excess return on EM debt over the U.S. risk-free rate and its balance-sheet and covariance terms (37).

thus have currencies that are more exposed to GFI net worth and earn higher premia, consistent with the cross-section of currency excess returns in Section 2.2.

8. Conclusion

Global financial intermediaries lend to emerging markets and hold U.S. risky assets on the same balance sheets. We build a two-country model in which these balance sheets price EM credit risk and the exchange rate jointly. The exchange rate moves with EM spending, which GFIs finance, so a loss of GFI net worth depreciates EM currencies. Without being targeted, and at our baseline EM debt ratio, the model accounts for two-thirds of the elasticity measured around the Lehman bankruptcy with local-currency debt and for all of it with dollar debt. GFI balance sheets amplify the transmission of U.S. shocks to EM exchange rates by 40 to 50%. The currency of EM debt shapes this transmission: dollar debt raises the response through the debt burden, by more the more indebted the EM, while local-currency debt shifts currency losses onto GFIs without making them a stronger amplifier.

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Appendices

A. Empirical appendix

A1. *Data sources*

The real exchange rate in Figure 1 is the BIS narrow real effective exchange rate index for the United States. The index is a trade-weighted average of bilateral exchange rates against 27 economies, adjusted for relative consumer prices. An increase denotes a real appreciation of the U.S. dollar, or equivalently a real depreciation of foreign currencies against the dollar.[23]

Our market-based proxy for GFI net worth is the XLF total return index. In Figure 1, we use the HP-filtered log level of XLF. In the asset-pricing regressions, the GFI net-worth factor is the log change in XLF over the relevant holding period.

Currency excess returns are constructed from bilateral exchange-rate changes against the U.S. dollar and short-term local-currency interest rates. The latter are measured as an average of available 12-month rates on deposits, government bonds, and central bank notes.

For the Lehman event study, bank-level cross-border claims by counterparty country come from the FFIEC 009 reports. Bank-level net-worth shocks are measured as stock-price changes around the Lehman bankruptcy, and country-level exposure is constructed using pre-Lehman claims weights, as described in Section 2.3.

A2. *Asset-pricing regressions*

Return construction and two-pass specification. We construct three-month excess returns on short-term local-currency claims. Let $S_{k,t}$ denote the bilateral nominal exchange rate for country k, expressed so that an increase denotes a depreciation of country k's currency against the U.S. dollar. Using annualized 12-month rates scaled to a quarterly horizon, define

$$rx_{k,t} = \tfrac{1}{4}\big(i^{12m}_{k,t-3} - i^{12m}_{US,t-3}\big) - \Delta \log S_{k,t,t-3}. \tag{A.1}$$

The interest differential is measured at the beginning of the holding period, while the exchange-rate change is realized over the subsequent three months. The corresponding intermediary net-worth factor is the three-month log change in the XLF total return index, $f_t = \Delta \log XLF_{t,t-3}$.

The Fama–MacBeth procedure proceeds in two steps. In the first stage, we estimate each currency's exposure to the GFI net-worth factor using the time-series regression

$$rx_{k,t} = c_k + b_k f_t + \epsilon_{k,t}. \tag{A.2}$$

[23] See the BIS Effective Exchange Rates data portal, https://data.bis.org/topics/EER.

The estimated loading $\hat{b}_k$ measures how strongly country k's currency excess return covaries with changes in intermediary equity values. A positive loading means that the currency excess return tends to be high when XLF rises and low when XLF falls; a negative loading indicates safe-haven behavior during intermediary distress. Figure A.1 reports the estimated loadings. Most currencies have positive loadings; Japan, the euro area, and Switzerland have negative or near-zero loadings, consistent with their currencies acting as safe havens during periods of financial stress.

In the second stage, we ask whether these exposures explain the cross-section of average currency excess returns:

$$\overline{rx}_k = \lambda \hat{b}_k + \upsilon_k, \tag{A.3}$$

where $\overline{rx}_k$ is the time-series average of $rx_{k,t}$ and λ is the estimated price of intermediary net-worth risk. We estimate this regression without an intercept, imposing the asset-pricing restriction that an asset with zero exposure to the GFI net-worth factor earns zero average excess return. A positive λ implies that currencies whose returns covary more positively with XLF earn higher average excess returns.

Sample of countries. The currency-return analysis covers 12 advanced economies and 23 emerging markets from 1995 to 2026, at monthly frequency. Pegged and tightly managed exchange-rate regimes are excluded from the excess-return sample, and contiguous spells shorter than six months are omitted. Table A.1 reports the coverage by country.

Second-stage robustness. Panel (a) of Figure A.2 repeats the second-stage regression using expected depreciation rather than realized depreciation to construct currency excess returns. The relationship remains similar, indicating that the cross-sectional pricing result is not driven solely by realized exchange-rate movements over the holding period. Panel (b) repeats the analysis for five portfolios sorted by carry. The pricing relationship becomes substantially tighter, with predicted and average expected excess returns lying close to the 45-degree line.

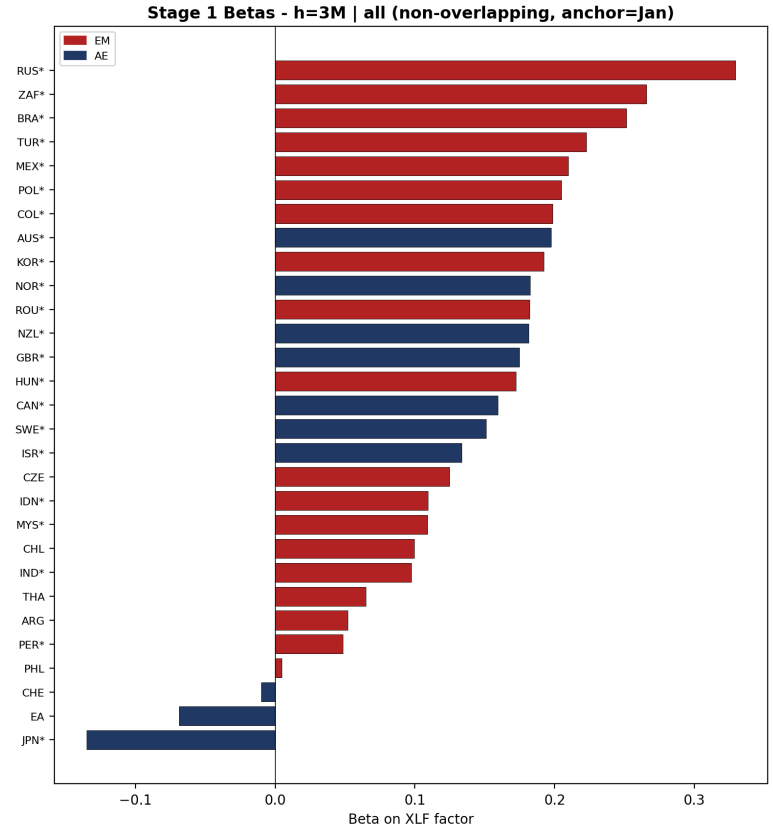
Rolling window. We build the rolling windows in panel (b) of Figure 2 by sliding forward one quarter at a time. Within each window, we re-run the full two-stage regression using only the data inside that window: the first stage estimates each country's loading on the XLF factor, and the second stage prices the cross-section of countries to produce that window's price of risk, dated at the window's end. The figure pairs each window's price of risk with the raw leverage reading from Hubrich et al. (2026). Because the leverage series ends in 2020:M1, only windows ending on or before that date appear in the plot.

TABLE A.1. Sample of Countries

Country	Type	$E[\Delta s]$	UIP	Months missing UIP due to:				UIP range(s)
		obs	obs	No IR	Pegged	Euro	No survey	
AUS	AE	374	374	0	0	0	0	1995-01–2026-02
CAN	AE	374	374	0	0	0	0	1995-01–2026-02
CHE	AE	374	333	0	41	0	0	1995-01–2011-08; 2015-02–2026-02
DEU	AE	48	47	1	0	326	0	1995-02–1998-12
DNK	AE	374	39	9	326	0	0	1995-10–1998-12
EA	AE	326	326	47	0	0	48	1999-01–2026-02
GBR	AE	374	374	0	0	0	0	1995-01–2026-02
ISR	AE	364	364	0	0	0	10	1995-11–2026-02
JPN	AE	374	374	0	0	0	0	1995-01–2026-02
NOR	AE	374	368	6	0	0	0	1995-07–2026-02
NZL	AE	374	360	14	0	0	0	1996-03–2026-02
SWE	AE	374	374	0	0	0	0	1995-01–2026-02
ARG	EM	364	161	160	53	0	10	2002-01–2014-02; 2014-12–2015-09
BRA	EM	364	316	58	0	0	10	2000-01–2021-09; 2021-11–2026-02
CHL	EM	364	291	83	0	0	10	2001-12–2026-02
CHN	EM	374	0	0	374	0	0	–
COL	EM	364	238	136	0	0	10	2002-05–2005-01; 2005-03–2009-07 2009-09–2016-05; 2017-06–2020-06 2020-10–2021-11; 2024-11–2026-01
CZE	EM	364	218	0	146	0	10	1995-11–2013-12
HUN	EM	364	306	68	0	0	10	2000-02–2000-10; 2001-01–2001-06 2002-04–2026-02
IDN	EM	374	347	27	0	0	0	1997-04–2026-02
IND	EM	374	308	66	0	0	0	2000-07–2026-02
KOR	EM	374	274	100	0	0	0	2003-05–2026-02
MEX	EM	364	358	9	0	0	10	1996-02–1998-09; 1999-02–2026-02
MYS	EM	374	293	0	81	0	0	1995-01–1998-09; 2005-07–2026-02
PER	EM	364	275	99	0	0	10	1998-09–2021-07
PHL	EM	374	312	62	0	0	0	1998-02–1998-11; 1999-07–2022-01 2024-11–2026-02
POL	EM	364	331	43	0	0	10	1998-10–2026-02
ROU	EM	364	258	116	0	0	10	2004-09–2026-02
RUS	EM	364	261	113	0	0	10	2000-08–2022-04
SVK	EM	158	82	86	0	206	10	2002-03–2008-12
THA	EM	374	311	56	7	0	0	2001-04–2026-02
TUR	EM	363	321	53	0	0	11	1998-11–2000-11; 2001-12–2026-02
UKR	EM	300	33	306	35	0	74	2016-03–2018-11
ZAF	EM	374	337	37	0	0	0	1997-10–1998-09; 1999-02–2026-02

Notes: Monthly observations with expected depreciation ($E[\Delta s]$) and with currency excess returns (UIP); months without an excess return, by reason (no interest-rate data, pegged exchange rate, euro membership, no survey of expected depreciation); and the periods with excess returns. AE: advanced economy; EM: emerging market.

FIGURE A.1. First-Stage Loadings



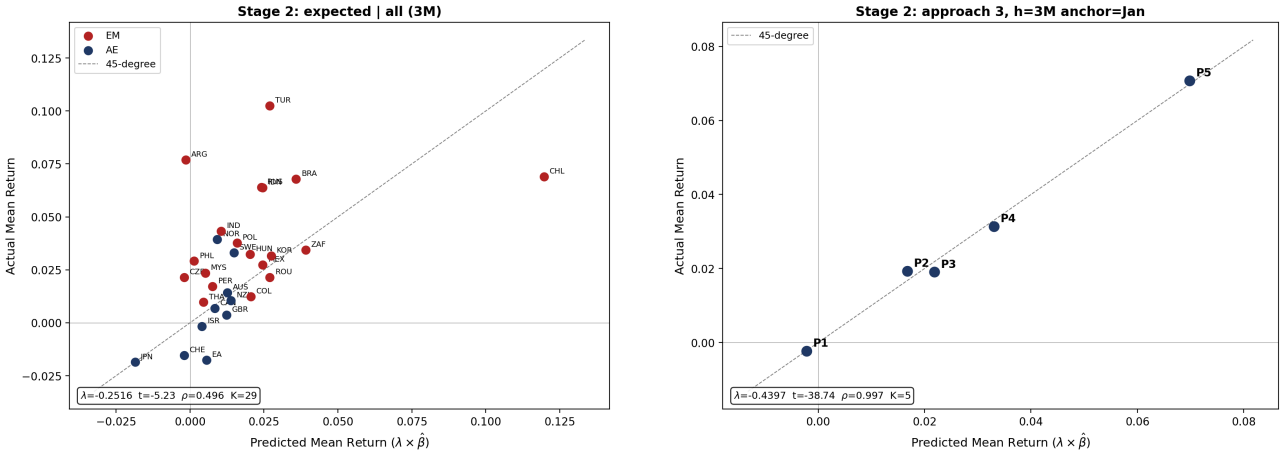
Notes: Estimated first-stage loadings $\hat{b}_k$ from (A.2), by country, with emerging markets and advanced economies in different colors.

A3. *GFI net worth and the dollar: state dependence and timing*

This subsection provides two complementary full-sample exercises on the relationship between intermediary net worth and the dollar. They characterize the strength and timing of the relationship but are not intended to provide causal identification. We measure monthly changes as log differences: $\Delta x_t = 100(\log XLF_t - \log XLF_{t-1})$ is the monthly XLF return, and $\Delta d_t = 100(\log D_t - \log D_{t-1})$ is the monthly change in the real broad dollar index, with a positive value denoting dollar appreciation.

State-dependent comovement. Panel (a) of Figure A.3 plots monthly changes in the dollar against monthly XLF returns. In the full sample, a one-percentage-point decline in XLF is associated with an appreciation of the dollar of about 0.07 percent. The relationship is substantially stronger during periods of weak bank equity performance. Defining a weak-XLF month as one in which the XLF return lies at least one-half standard deviation below its sample mean, the

FIGURE A.2. Second Stage with Expected Depreciation



(a) Countries (b) Carry portfolios

Notes: Panel (a) reports the second-stage cross-sectional fit from the two-pass regression using expected depreciation rather than realized depreciation in the currency excess-return measure. Each point is a country; the dashed line is the 45-degree line. Panel (b) reports results for five portfolios sorted by carry.

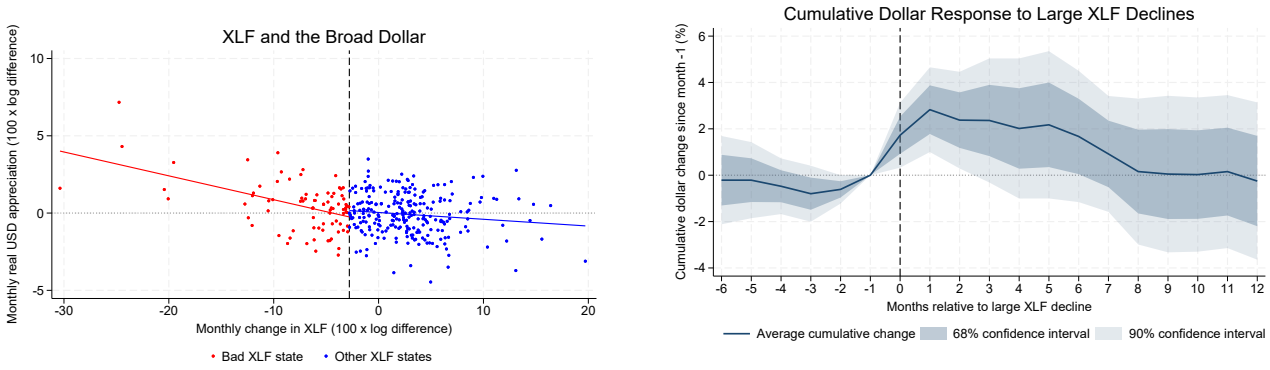
correlation between monthly XLF returns and dollar changes is about −0.50 in these months, compared with −0.12 in the remaining months.

Dollar dynamics around large XLF declines. We define an event as a month in which the XLF return is at least 1.5 standard deviations below its sample mean, and require retained events to be separated by at least 12 months. This procedure identifies 10 events, during which XLF declines by 12.2 percent on average and 10.9 percent at the median. For each event in month t_i, we compute the cumulative change in the dollar relative to the month preceding the event, $C_{i,h} = 100(\log D_{t_i+h} - \log D_{t_i-1})$, for $h = -6, \ldots, 12$. Panel (b) of Figure A.3 reports the average of $C_{i,h}$ across events. The dollar appreciates sharply during the event month and continues to appreciate in the following month, with the cumulative response peaking one month after the XLF decline; the response subsequently dissipates. The pattern is similar when the Lehman episode is excluded.

A4. *Additional Lehman results*

Pre-trends and robustness. The local projections in Figure 3 show no systematic relationship between exposure and exchange-rate movements before the episode, and the controls in the dashed line include the depreciation between August 25 and 29, 2008. As a further check, Figure A.4 adds to both specifications the claims-weighted change in lenders' stock prices

FIGURE A.3. GFI Equity Value and the Dollar: State Dependence and Timing



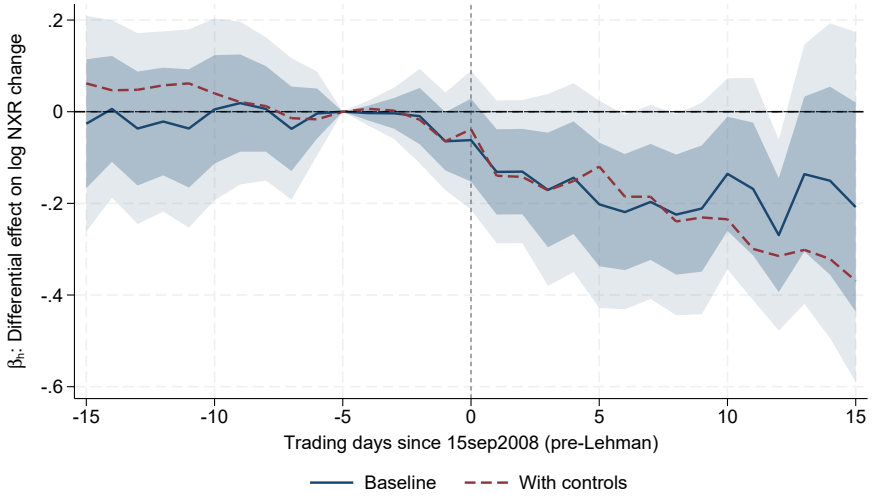
(a) XLF–dollar comovement

(b) Cumulative dollar response to large XLF declines

Notes: Panel (a) plots monthly log changes in the real broad dollar index against monthly log changes in XLF; positive changes in the dollar index denote dollar appreciation. Panel (b) reports the average cumulative change in the dollar around months in which the XLF return is at least 1.5 standard deviations below its sample mean, with events separated by at least 12 months. Darker and lighter areas are 68% and 90% confidence intervals.

between August 29 and September 5, 2008, which captures losses that lenders had suffered before the episode. The estimated response is similar.

FIGURE A.4. The Lehman Episode: Controlling for Earlier Lender Losses



Notes: As Figure 3, adding to both specifications the claims-weighted change in lenders' stock prices between August 29 and September 5, 2008.

Sorting. Table A.2 compares predetermined country characteristics across countries with above- and below-median exposure and regresses each characteristic on $\Delta\hat{e}_k$. The shock is largely uncorrelated with observable country characteristics; the characteristics that differ most between high- and low-exposure countries are included as controls in X_k, and the estimated effect is robust to their inclusion. Consistent with this result, Figure A.5 shows that substantial variation in the shock remains after residualizing on the controls.[24]

TABLE A.2. Sorting: Country Characteristics by Exposure

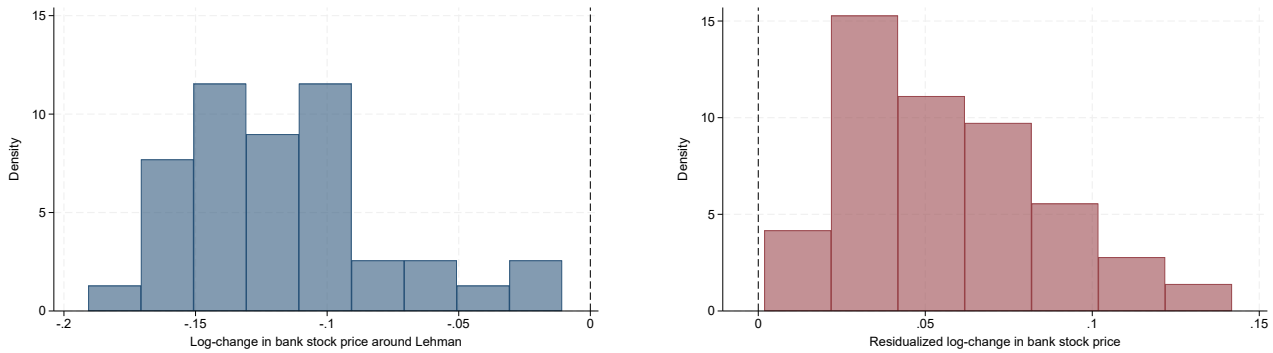
	Group means			Regression on Δe_k	
	High exp. (below med.)	Low exp. (above med.)	p -value	Coeff.	SE
Panel A: Macroeconomic fundamentals					
GDP growth (2007, %)	6.62	4.97	0.04	-20.33*	(11.11)
Current account / GDP (2008:Q2)	-3.17	0.56	0.31	75.89	(53.43)
Inflation (YoY, 2008:Q2)	7.83	7.22	0.75	-2.75	(37.60)
Panel B: Openness and integration					
Financial openness (2007)	0.54	0.76	0.04	1.41	(1.45)
Trade openness (2007)	91.87	73.65	0.40	-250.09	(194.31)
Banks' assets / GDP (2007)	61.78	87.54	0.05	348.27**	(164.16)
Panel C: External financing vulnerability					
Credit rating (2008:Q2)	9.00	5.19	0.01	-50.50***	(13.76)
ST debt / reserves	54.33	43.13	0.77	-224.24	(331.41)
Interest rate differential (2008:M8)	0.08	0.03	0.11	-0.58*	(0.31)
Dollarization BLS (2007)	99.53	92.80	0.04	-101.82*	(58.10)

Notes: Columns 1–2 report group means of each characteristic for countries with high (below-median $\Delta\hat{e}_k$) and low (above-median) exposure to distressed intermediaries. Column 3 reports the p-value from a robust t-test of equality of means. Columns 4–5 report the coefficient and standard error from a bivariate OLS regression of each characteristic on $\Delta\hat{e}_k$. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The quantity channel. The same mechanism, retrenchment by distressed intermediaries, should also be visible in quantities: countries more exposed to distressed banks should experience larger reductions in cross-border claims. Table A.3 reports regressions of the log change in cross-border claims between the second and third quarters of 2008 (column 1), and the second and fourth quarters (column 2), on realized depreciation (panel A) and on the net-worth shock

[24]The analysis focuses on countries with floating currencies and therefore excludes the euro area. Results hold when including the euro area as a single country.

FIGURE A.5. Distribution of the Net-Worth Shock



(a) Actual variation

(b) Residualized variation

Notes: Panel (a) shows the distribution of the exposure $\Delta\hat{e}_k$; panel (b) shows its distribution residualized on GDP growth, financial openness, banks' assets over GDP, credit rating, and debt dollarization.

(panel B). The estimates are consistent with retrenchment: countries more exposed to distressed intermediaries, and countries that depreciated more, experienced larger reductions in claims. The results for the net-worth shock are imprecisely estimated, reflecting the small cross-section and the noise in quarterly claims data, so we interpret the quantity evidence as suggestive and consistent with the price-channel results, rather than as independent confirmation of the mechanism.

B. Discussion of the EM block

This appendix explains the assumptions behind the EM block of Section 3.5.

The EM block keeps the elements of sovereign default that matter for GFIs—default losses, debt that can be unevenly distributed across borrowers, and long duration—while remaining solvable by perturbation. Strategic default introduces two non-smooth elements: the choice between default and repayment, and the discrete realization of default. The logistic idiosyncratic shock in (22) smooths the first, and the continuum of small sovereigns turns individual defaults into a smooth default rate, so GFIs bear default losses and no aggregate variable jumps when sovereigns default. Two simplifications keep the aggregate state small. GFIs hold EM debt as a diversified pool, so they have a single portfolio condition for EM debt, (18). The distribution of debt relative to its mean is fixed by (20), so aggregate debt summarizes it; an endogenous

TABLE A.3. The Quantity Channel: Claims Retrenchment after Lehman

	(1) (Q3 vs Q2)	(2) (Q4 vs Q2)
Panel A: Claims on realized depreciation		
Δ NXR (post-Lehman)	-0.26**	-0.70***
	(0.12)	(0.21)
	[0.04]	[0.00]
Panel B: Claims on bank-exposure shock		
$\Delta\hat{e}_k$	0.32*	0.60
	(0.17)	(0.36)
	[0.07]	[0.10]
Log claims (2008:Q1)	Yes	Yes
Weights (2008:Q1 claims)	Yes	Yes
N	38	38
R^2 (Panel A)	0.44	0.67
R^2 (Panel B)	0.37	0.45

Notes: Panel A regresses the log change in claims on realized post-Lehman currency depreciation. Panel B regresses the log change in claims on the exposure $\Delta\hat{e}_k$. All regressions are estimated by OLS weighted by 2008:Q1 claims and control for the log level of claims in 2008:Q1. Panel A additionally controls for the pre-Lehman currency trend. Standard errors in parentheses; p-values in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

distribution would be a state variable in its own right, as in Morelli et al. (2022). The family is the model counterpart of the aggregate of emerging markets used in the calibration.[25]

Decentralized borrowers. Each sovereign, and the family as a whole, takes the price of EM debt as given. Aggregate issuance raises the default rate and lowers $Q_{E,t}$, but borrowers do not internalize this effect, as in small-open-economy models with a debt-elastic interest rate (Schmitt-Grohé and Uribe, 2003). Internalizing it, as in Eaton–Gersovitz models, would make the price of EM debt a function of the family's own borrowing. With long-duration debt, that price also depends on future borrowing, which dilutes the debt issued today, so the price schedule and the borrowing policy must be solved jointly as a Markov equilibrium, usually by global methods (Hatchondo and Martinez, 2009; Chatterjee and Eyigungor, 2012).

The default rule. Default is not a choice in the model. The index in (22) is a parametric function of fundamentals that stands in for the gap between the values of default and repayment. Default

[25] The same equations describe a single sovereign that defaults partially, repaying a fraction $1 - hp_t$ of what it owes. Arellano et al. (2023) document partial defaults and model them.

therefore responds to GFI net worth and to the default cost through the variables in the index: the price of EM debt and, with dollar debt, the exchange rate. The index is in logs, so a_b and a_y are elasticities of the log odds of default, and with log-normal debt the cross-section of indices is normal with standard deviation $a_b s$.

The default-risk shifter. The shifter χ_t^δ in (23) is common to all sovereigns. We use it only as an exercise, but it can be given a structural interpretation as persistent variation in a government's willingness to repay given fundamentals. A natural microfoundation is reputation: beliefs about the government's type can shift perceived default probabilities and borrowing costs for a given set of fundamentals, as in Morelli and Moretti (2023).

Default status and the cost. Sovereigns in default status keep borrowing through the family, which pools resources; default status only determines the size of the cost. Each sovereign in default status loses $c\,\mathcal{T}_t Y_{E,t}$ units of the U.S. good, or $c\,\mathcal{T}_t^{1-\omega_E} Y_{E,t}$ in EM consumption units: the cost term in (27). The cost is an additional use of the U.S. good in (30) that no one in the model receives.

C. Quantitative implementation

We solve the model in Dynare. Results are third-order perturbations with pruning around the deterministic steady state, except in Section 5, which is first order so that its decompositions hold exactly. Perturbation requires smooth equilibrium conditions and a stationary steady state, which items 1 and 2 ensure.

1. Default as a fraction of the debt stock. Because default is realized as the fraction p_{t+1} of the debt stock, every equilibrium condition is a smooth function of the aggregate state, and perturbation applies without approximating the default event. The $\varepsilon_{i,t+1}$ are independent of everything else given the aggregate state, so the law of large numbers gives $\int_0^1 (b_{i,t+1}/b_{t+1})(1 - h\delta_{i,t+1})\,di = 1 - hp_{t+1}$ exactly, given the aggregate state. The EM pricing condition is therefore

$$\mu_{E,t} = \mathbb{E}_t\left[\mathcal{M}_{t+1}\left((1-hp_{t+1})R^{nd}_{E,t+1} - R_t\right)\right], \qquad R^{nd}_{E,t+1} = \frac{e_{t+1}}{e_t}\,\frac{1+\xi Q_{E,t+1}}{Q_{E,t}}, \tag{C.1}$$

where $R^{nd}_{E,t+1}$ is the dollar return conditional on repayment. GFI net worth (19) accumulates at the realized portfolio return, which includes default losses, and the EM pays its debt net of defaults. Two implications follow.

- Given the aggregate state at $t+1$, the realized return on the pool is $(1-hp_{t+1})R^{nd}_{E,t+1}$, with no idiosyncratic noise. GFIs earn the default premium and bear the default losses,

so realized returns equal expected returns on average. If default were priced but never realized, GFIs would earn the premium without bearing the losses, and realized returns would exceed expected returns on average, as in a peso problem.

– Default risk is priced through $\mathrm{Cov}_t(\mathcal{M}_{t+1}, 1 - hp_{t+1})$, that is, through the dependence of the default rate on the state at $t+1$: on $Y_{E,t+1}$, on $Q_{E,t+1}$ and, with dollar debt, on $\mathcal{S}_{t+1}$; b_{t+1} and χ_t^δ are known at t. Defaults also lower GFI net worth when the default rate rises, so lenders value repayment most in the states in which more sovereigns default.

2. A debt-adjustment cost for stationarity. Without an additional device, the level of EM debt is essentially not pinned down. With $\vartheta_E = 1$, the steady-state incentive constraint (15) and the law of motion for net worth (19) determine risk-weighted leverage and the excess return $R_k - R$ almost independently of the scale of the GFI balance sheet. Debt b affects them only through the EM share of GFI assets. The steady-state Euler equation (29) requires $\beta_E \mathbb{E}[R_E^{\mathrm{loc}}] = 1$, which then barely determines b. Without the cost, the model fails the Blanchard–Kahn conditions, because the debt root is at or just above one. This is the standard small-open-economy problem (Schmitt-Grohé and Uribe, 2003). We add a small quadratic cost

$$\Phi(b_{t+1}) = \frac{\psi_b}{2} \bar{Q}_E \bar{b} \left(\frac{b_{t+1}}{\bar{b}} - 1 \right)^2, \tag{C.2}$$

where $\bar{b}$ and $\bar{Q}_E$ are steady-state values. The cost is rebated lump sum to EM households, so it enters only the Euler equation and not the resource constraints. It is zero in steady state and leaves the steady state unchanged. We set $\psi_b = 0.01$ under local-currency debt, which gives a debt root of 0.990, and set ψ_b under dollar debt so that the root is the same.

3. Shocks in the stochastic solution. The U.S. endowment, EM output and GFI net-worth shocks enter the solution with their variances, so risk premia reflect all three. The default-risk shifter (23), which we use only for the exercise of Section 5, has zero variance when the policy functions are computed and is fed in only when simulating: agents assign it zero probability ex ante and, once it hits, know its full path. At third order, responses are impulse responses from the stochastic steady state with future shocks set to zero.

4. The 2007–09 episode. Starting from the deterministic steady state in 2008Q2, each quarter agents learn that quarter's shock to GFI net worth and expect no further shocks. Each quarter's path is a nonlinear perfect-foresight solution, which takes the previous quarter's state as given.

D. Risk premia: derivations

Section 7 uses two decompositions: of the expected excess return on an asset, (37), and of the EM spread, Table 7. This appendix derives both.

Expected excess returns. For either risky asset $j \in \{H, E\}$,

$$\mu_{j,t} = \mathbb{E}_t[\mathcal{M}_{t+1}]\,(\mathbb{E}_t[R_{j,t+1}] - R_t) + \mathrm{Cov}_t(\mathcal{M}_{t+1}, R_{j,t+1}). \tag{D.1}$$

Dividing by $\mathbb{E}_t[\mathcal{M}_{t+1}]$ gives the split of expected excess returns into a balance-sheet term and a covariance term, (37), and the portfolio condition gives the difference in expected returns between EM debt and U.S. capital, (38).

Decomposition of spreads. To split the EM spread into the components of Table 7, we compare the yield on EM debt with the yields on hypothetical bonds that differ from it in one respect at a time: whether they can default, and how they are priced. All of them pay the same coupons as EM debt (one unit next quarter, ξ the quarter after, and so on) in the same currency. They are not traded, so their prices are computed from the equilibrium but do not affect it. Let e_t be the dollar price of the unit of denomination ($e_t = \mathcal{S}_t$ with local-currency debt and $e_t = 1$ with dollar debt). A risk-neutral default-free bond Q^F, a risk-neutral defaultable bond $\tilde{Q}$, a default-free bond priced by GFIs without the balance-sheet term Q^r, and a default-free bond priced by GFIs with it, $\hat{Q}$, satisfy

$$Q^F_t = \frac{1}{R_t}\mathbb{E}_t\Big[\frac{e_{t+1}}{e_t}\big(1 + \xi Q^F_{t+1}\big)\Big], \qquad \tilde{Q}_t = \frac{1}{R_t}\mathbb{E}_t\Big[\frac{e_{t+1}}{e_t}(1 - hp_{t+1})\big(1 + \xi \tilde{Q}_{t+1}\big)\Big],$$

$$\mathbb{E}_t\Big[\mathcal{M}_{t+1}\Big(\frac{e_{t+1}}{e_t}\,\frac{1 + \xi Q^r_{t+1}}{Q^r_t} - R_t\Big)\Big] = 0, \qquad \mathbb{E}_t\Big[\mathcal{M}_{t+1}\Big(\frac{e_{t+1}}{e_t}\,\frac{1 + \xi \hat{Q}_{t+1}}{\hat{Q}_t} - R_t\Big)\Big] = \vartheta_E\,\mu_{H,t}.$$

$Q^{F\$}$ and $Q^{r\$}$ denote Q^F and Q^r with a dollar payoff ($e_{t+1}/e_t = 1$). A bond with price q has yield $y(q) = 1/q + \xi - 1$, and the EM spread is $y(Q_E) - y(Q^F)$. Each component is a difference between the yields of these bonds:

$$\begin{aligned}
\text{expected default losses} &= y(\tilde{Q}) - y(Q^F),\\
\text{balance-sheet wedge} &= y(\hat{Q}) - y(Q^r),\\
\text{currency risk} &= y(Q^r) - y(Q^F) - \big[y(Q^{r\$}) - y(Q^{F\$})\big],\\
\text{discount-rate risk} &= y(Q^{r\$}) - y(Q^{F\$}),\\
\text{default risk} &= y(Q_E) - y(\tilde{Q}) - y(\hat{Q}) + y(Q^F),
\end{aligned}$$

and they add up to the spread by construction. Section 6.3 and Appendix F also refer to the default premium, $y(\tilde{Q}) - y(Q^F)$, and the intermediation premium, $y(\hat{Q}) - y(Q^F)$, the sum of the balance-sheet wedge, currency risk and discount-rate risk. The order in which default, risk pricing and the balance-sheet term are added matters only for how interaction terms are assigned; the default-risk component collects those between default and the other two. In the deterministic steady state, where all covariances are zero, these interactions make up the whole default-risk component, 0.4 basis points a year.

E. Default costs: details

This appendix collects the details of the default-cost analysis of Section 5. Table E.1 reports the responses to the default-risk exercise in three cases. *No cost (B)*: zero recovery ($h = 1$) and no cost, so a default is a pure transfer from GFIs to the EM. *Haircut only*: $h = 0.37$, $c = 0$. *Baseline*: $h = 0.37$, $c = 0.035$. Figure E.1 plots the responses against the cost c.

Table E.1. Default Costs: Responses to the Default-Risk Exercise

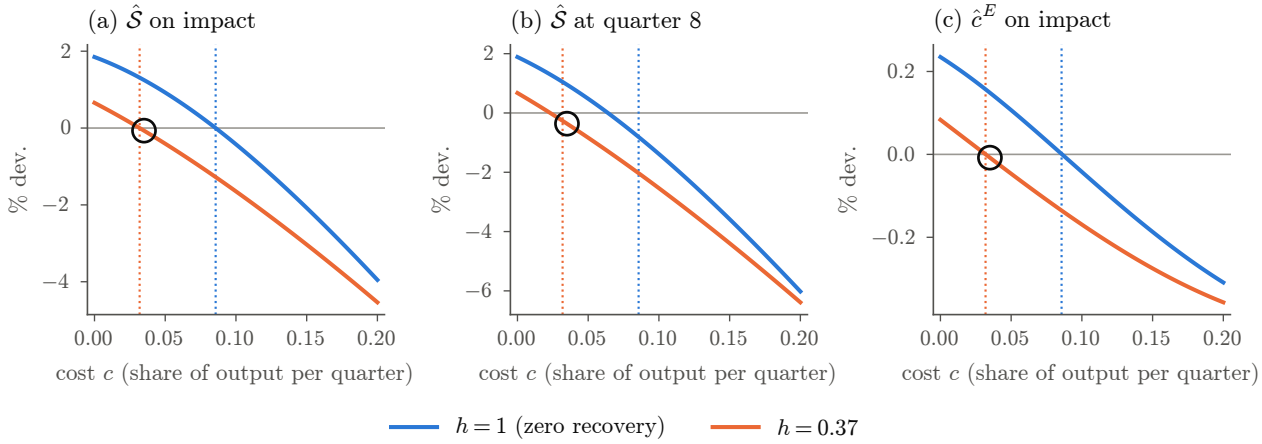
	No cost (B)		Haircut only		Baseline	
	Impact	Peak	Impact	Peak	Impact	Peak
Expected default rate (ann. pp)	3.42	3.42	3.01	3.01	3.00	3.00
Share in default status ζ (pp)	0.18	4.44	0.07	4.20	0.07	4.19
Contractual EM spread (bps)	139	139	48	48	75	75
EM debt price Q_E (%)	−4.89	−4.89	−1.81	−1.81	−1.74	−1.74
EM consumption C^E (%)	0.235	0.240	0.083	0.086	−0.008	−0.046
RER $\mathcal{S}$ (%)	1.85	1.89	0.66	0.67	−0.07	−0.47
U.S. consumption C (%)	−0.207	−0.212	−0.074	−0.076	0.005	−0.092
U.S. real rate (ann. bps)	−2.8	3.4	−1.0	1.0	−29.6	−29.6
U.S. capital price Q (%)	−0.83	−0.83	−0.28	−0.28	0.12	−0.29
GFI net worth N (%)	−4.97	−4.97	−1.72	−1.72	−0.30	−0.58

Notes: First-order responses, local-currency debt. Peak: largest deviation from steady state over 60 quarters.

No recovery and no cost. Only the EM-consumption term of (33) is active. The anticipated debt relief raises EM consumption by 0.24% on impact and the EM currency appreciates by 1.8%: a default is a transfer from GFIs to the EM, and with home bias it raises demand for the EM good. GFI net worth falls by 5.0% on impact. The fall in the price of EM debt, net of the EM appreciation, lowers it by 1.3%; GFIs then sell U.S. capital to households, its price falls by 0.8%, and with leverage of 4.5 on U.S. capital this lowers net worth by another 3.6%, so most of

the fall is fire-sale amplification. A haircut alone scales all these responses by about a third (Table E.1).

FIGURE E.1. Break-Even Default Cost



Notes: First-order responses to the default-risk exercise against the default cost c, with zero recovery ($h = 1$) and with $h = 0.37$. Dotted lines: the break-even costs c^* at which $\hat{\mathcal{S}}$ and $\hat{c}^E$ are zero on impact, 0.086 and 0.032. Circle: baseline.

Break-even cost. The responses are nearly linear in c (Figure E.1). The break-even cost c^* is 0.086 with zero recovery and 0.032 with $h = 0.37$, or 0.82 and 0.83 of c^{PV} in (35).

How large is the cost? The cost is a level loss: $c = 0.035$ means that a sovereign's output is worth 3.5% less in every quarter it spends in default status, 6.5 years on average. Its present value is $c/[1-\beta_E(1-\theta_d)] \approx 0.7$ quarters of output, or 17% of a year's output. At the break-even point this present value equals the debt relief, about $h\, d_y$ years of output in partial equilibrium. Table E.2 shows how c^{PV} varies with the haircut and the debt ratio.

- The required cost scales with the debt the EM defaults on. In the model GFIs hold all EM debt, so d_y should be the external debt held by foreign intermediaries (Section 4). At $d_y = 0.15$ and $h = 0.37$, c^{PV} is 1.2% of output a quarter.
- The exit rate θ_d spreads the cost over time without changing its present value. If default status lasts one year ($\theta_d = 1/4$), the quarterly cost is 5.1 times as large; if it lasts three years ($\theta_d = 1/12$), it is 1.9 times as large.
- For comparison, debt crises are followed by output losses of about 10% after eight years (Furceri and Zdzienicka, 2011), and hard defaults by GDP drops of up to 10% (Trebesch and Zabel, 2017). A level loss of 3.5% for 6.5 years is within that range. Those estimates

refer to total GDP, while the model needs the cost to fall on traded goods; measured relative to tradable output alone, the same cost would be larger.

TABLE E.2. Partial-Equilibrium Break-Even Default Cost

	Haircut h			
Debt/GDP d_y	0.25	0.37	0.50	1
0.15	0.8 (3.8)	1.2 (5.6)	1.6 (7.6)	3.1 (15.3)
0.25	1.3 (6.3)	1.9 (9.4)	2.6 (12.7)	5.2 (25.5)
0.50	2.6 (12.7)	3.8 (18.8)	5.2 (25.4)	10.4 (51.0)

Notes: Break-even cost c^{PV} from (35), in percent of output a quarter while in default status ($\theta_d = 0.0385$). In parentheses: its present value, equal to the debt relief, in percent of a year's output. The model's break-even cost c^* is 0.82 and 0.83 of c^{PV} in the two cases computed ($d_y = 0.5$; $h = 1$ and $h = 0.37$), and $c^* = 0.017$ and 0.011 at $d_y = 0.25$ and 0.15 with $h = 0.37$. Baseline: $d_y = 0.5$, $h = 0.37$.

F. DEFAULT RISK WITHOUT THE BORROWING-COST FEEDBACK

In the baseline, default risk rises when the price of EM debt falls, through the term in a_q in (22), with a_q set under dollar debt so that the standard deviation of spreads matches the data. This appendix sets $a_q = 0$, so that default risk depends on the debt burden and output only, keeping all other parameters, including σ_N, at their baseline values. Table F.1 compares the two.

The feedback matters for the volatility and composition of spreads. Without it, the standard deviation of dollar-bond spreads falls from 173 to 106 basis points, the default premium accounts for 37% of it rather than 58%, and the mean default rate in the simulation falls from 4.5% to 3.4%. It barely matters for the exchange rate. The Lehman elasticity changes little at first order (-0.151 instead of -0.156 with dollar debt), amplification of U.S. and EM shocks by GFIs changes in the third decimal, and the share of the extra depreciation under dollar debt that runs through defaults falls from 9% to 7% on impact.

TABLE F.1. Default Risk With and Without the Borrowing-Cost Feedback

	Baseline		$a_q = 0$	
	Dollar	Local currency	Dollar	Local currency
Spreads, third-order simulation				
Mean spread (bps)	310	317	261	281
Standard deviation (bps)	173	119	106	93
Intermediation premium, share of s.d.	0.40	0.68	0.66	0.86
Default premium, share of s.d.	0.58	0.57	0.37	0.43
Default rate, mean (% a year)	4.5	4.1	3.4	3.2
GFI net-worth shock				
Lehman elasticity γ^{model}, impact	−0.156	−0.105	−0.151	−0.104
third order	−0.137	−0.091	−0.125	−0.091
Expected default rate, impact (ann. pp)	0.18	0.02	0.07	0.00
Defaults through the exchange rate, share of				
extra dollar-debt depreciation, impact	9.3%		7.2%	
extra dollar-debt depreciation, quarters 1–8	10.4%		8.4%	

Notes: $d_y = 0.5$. Simulations include the U.S. endowment, EM output and GFI net-worth shocks. Data: mean spread 410 basis points, standard deviation 173; intermediation and default premia 39% and 76% of the standard deviation in the estimated model of Morelli et al. (2022).