Global Risk Aversion and Sovereign Debt Denomination

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October 2025

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ABSTRACT

This paper studies how fluctuations in global risk aversion shape the currency composition of sovereign debt in emerging market economies. Using a multi-country panel, we document that periods of higher risk aversion are associated with a lower share of local currency debt held by foreign investors. To identify the mechanism through which risk aversion affects the share of local currency debt in equilibrium, we develop a small open-economy model with risk-averse foreign investors, discretionary monetary policy, and long-maturity sovereign debt. When risk aversion rises, the exchange rate risk premium and capital gains risk premium embedded in local currency bonds increase, constraining the government's ability to borrow in local currency.

1 Introduction

Local currency debt provides attractive hedging benefits to governments in emerging market economies, who can inflate away their local currency debt burden during economic downturns, thereby smoothing domestic consumption and avoiding outright default[1]. Despite these benefits, emerging economies have historically issued the majority of their external debt in foreign currency, struggling to sell local currency debt to foreign investors in a phenomenon known as "Original Sin" (Eichengreen and Hausmann 1999)[2]. This phenomenon has abated since the 2000s as shares of local currency debt in foreign portfolios (henceforth local currency shares) rose from 24% to 62% between 2005 and 2021. Although much scholarship has been devoted to evaluating the relationship between domestic policy and local currency shares in emerging economies, less is known about the relationship between global financial conditions and the willingness of foreign investors to hold emerging market local currency debt. Studying these relationships can improve our understanding of factors outside of these countries that contributed to the decline of Original Sin, and that may once again constrain emerging markets' ability to issue local currency debt in the future. Using a new dataset created by Onen et al. (2023), this paper finds a large and negative relationship between measures of investor risk aversion and local currency shares. This finding motivates the question: Why do episodes of high risk aversion reduce foreign investor demand for local currency debt relative to foreign currency debt in emerging market countries?

While the hedging properties of local currency debt are beneficial to an emerging market government, they can also be costly if the government's devaluation strategy causes the exchange rate to depreciate during the bad times of risk-averse foreign investors holding the government's debt. Risk-averse foreign investors value the foreign currency return on their local currency debt holdings, and prefer to receive a higher rate of return during their bad times in order to smooth consumption. If the government pursues a hedging strategy that causes local currency depreciation during foreign investors' bad times, then foreign investor demand for the country's local currency debt falls, and the government's ability to borrow in local currency is constrained. This is especially the case in emerging market economies where foreign investment has historically been an important source of financing.

To provide intuition for how foreign investor risk aversion affects emerging market governments' ability to borrow in local currency, consider a foreign investor that is indifferent between buying risk-free foreign currency debt and local currency debt from an emerging market country. Rearranging the no-arbitrage condition for this investor yields

$$i_t = i_t^* + \mathrm{E}_t[S_{t+1} - S_t] + \mathrm{cov}_t(m_{t+1}, S_{t+1} - S_t),$$

where i_t is the local currency interest rate, i_t^* is the risk-free foreign currency interest rate, S_t is the nominal exchange rate in terms of local currency per unit of foreign currency, $\mathrm{E}_t(S_{t+1} - S_t)$ is the expected change in the exchange rate, m_{t+1} is the foreign investor's stochastic discount factor, and

[1]This feature of local currency debt has been studied extensively in papers such as Fischer (1983) and Calvo (1988), as well as more recent literature such as Du et al. (2020). A benevolent government can use local currency debt to engineer state-contingent payoffs that lower the real debt obligation in bad times. Such a strategy smooths fluctuations in domestic consumption and improves welfare in the domestic economy. For example, Engel and Park (2022) construct a model with both local currency debt and foreign currency debt that exhibits both currency debasement and default. Investors in the model are willing to lend in local currency because it raises the probability of debasement but lowers the probability of more costly default.

[2]Onen et al. (2023) document that EMEs have historically relied on foreign participation in their bond markets because domestic markets were often too small to satisfy their financing needs.

$\text{cov}_t(m_{t+1}, S_{t+1} - S_t)$ is the exchange rate risk premium. The rate of return on local currency debt is determined by the risk-free foreign currency interest rate, the expected change in the exchange rate, and the exchange rate risk premium. According to the expectations term, the greater the expected currency depreciation tomorrow, the greater the required rate of return on local currency debt. The risk premium term indicates it is not just average depreciation that matters to the foreign investor, but the timing of this depreciation. The more the currency depreciates in the foreign investor's bad times, the greater the exchange rate risk premium, and the greater the required rate of return on local currency debt. The magnitude of the risk premium term is dictated by the foreign investor's level of risk aversion and is the focus of this paper. As long as the currency depreciates in the foreign investor's bad times, then when the foreign investor becomes more risk-averse their demand for local currency debt falls and the exchange rate risk premium rises. This raises the local currency interest rate i_t and constrains the government's ability to borrow in local currency.

To begin investigating this relationship, this paper uses data from Onen et al. (2023) to construct a panel of 15 emerging market countries. Evidence from this panel shows that there exists a negative and statistically significant relationship between the VIX and local currency shares in foreign portfolios. Considering that the VIX has historically been used as a proxy for risk aversion (Rey 2015), this suggests that during episodes of heightened risk aversion foreign investor demand for local currency debt falls.

To investigate the mechanism driving these results, the paper builds a general-equilibrium small-open-economy model with sovereign debt, monetary policy, and risk-averse foreign investors. In the model, the planner of the small open economy chooses to issue debt in local currency or foreign currency, in addition to choosing monetary policy without commitment. All debt is external, so the share of local currency debt in the foreign portfolio is identical to the share of debt denominated in local currency. The exchange rate in the model and the real payoff on debt to foreign investors are both determined endogenously as a result of the planner's choices of debt issuance and monetary policy. Foreign investors internalize the planner's decisions and price sovereign debt according to the expected future payoff given today's state.

The small open economy in the model is subject to a domestic tradable endowment shock only. All else equal, the planner prefers to issue local currency debt over foreign currency debt on account of its hedging properties. When the planner is faced with a negative domestic tradable endowment shock, it can reduce the real payoff on its local currency debt using two methods. The first method involves raising inflation to depreciate the local currency, thereby reducing the real value of local currency debt service. The second method involves manipulating the relative consumption of tradable and non-tradable goods to depreciate the real exchange rate and reduce debt service on local currency debt.

Foreign investors are risk-averse and incorporate expectations of the planner's future actions when pricing debt today. The tradable endowment shock proxies for global economic conditions, so foreign investors prefer payouts in states when the tradable endowment is low. Foreign investors demand a higher rate of return on local currency debt in the form of an exchange rate risk premium to compensate for the fact that the real payoff tends to fall in their bad times. In the model, when foreign investors become more risk-averse, their willingness to hold local currency debt falls and the exchange rate risk premium rises. This increase in borrowing costs constrains the planner's ability to issue local currency debt and reduces the equilibrium share of debt denominated in local currency.

The model is calibrated to moments generated using a panel of 15 emerging market countries. The calibrated model replicates the cyclical behavior of exchange rates and local currency shares in the data, and matches the response of these variables to an increase in foreign investor risk aversion.

In the model, the nominal exchange rate and real exchange rate depreciate in response to a negative tradable endowment shock. In addition, the yield on local currency debt rises and the share of local currency debt in the foreign investor's portfolio falls when foreign investor risk aversion rises. This is consistent with empirical evidence showing emerging market local currency shares falling in response to an increase in the VIX.

Literature Review.— This paper relates to the literature on optimal government debt management, the "Original Sin" literature, and the literature on the global financial cycle and capital flows.

This paper contributes to the literature on optimal government debt management by showing how global financial factors affect the composition of the government's optimal portfolio. This strand of literature studies the issuance of state-contingent debt to smooth consumption in economic downturns. Borrowing in local currency achieves this by letting inflation lower real payouts in bad times, as in Barro (1979), Lucas and Stokey (1983), Bohn (1988, 1990), and nominal-asset hedging in Lustig et al. (2008). In a recent paper, Du, Pflueger, and Schreger (2020) show that with risk-averse lenders, the risk premium induced by countercyclical inflation can make local currency debt costly for the issuer. Their mechanism frames the choice as a mean variance tradeoff between average consumption and its volatility. We primarily differ from this paper in that we examine how changes in foreign investor risk aversion affect local currency shares, while they focus on the relationship between the hedging benefit of local currency debt and local currency shares.

This paper also contributes to the "Original Sin" literature by demonstrating the relevance of global financial factors to local currency borrowing capacity. This literature has largely focused on the role that domestic policy has played in overcoming Original Sin in emerging markets. Ogrokhina and Rodriguez (2018) use a difference-in-differences estimator and find that inflation targeting reduces the foreign currency share of international debt by 3–6 percentage points, with the effect concentrated in foreign-held debt. Subsequent papers, including Ottonello and Perez (2019), Du et al. (2020), and Engel and Park (2022), study Original Sin in the context of monetary policy without commitment. In these papers, a sovereign prefers to issue local currency debt for its hedging properties but is constrained by foreign investors that internalize the sovereign's inability to commit. In these models, overcoming Original Sin depends on whether the sovereign can improve the credibility of its monetary policy through inflation targeting. Devereux and Wu (2022) document a positive relationship between foreign reserve holdings and local currency shares that is present only under inflation targeting. This paper contributes to this literature by asking how global financial conditions interact with these domestic channels to constrain a government's ability to issue debt in its own currency. The implication of this paper is that global and domestic factors jointly determine whether a country escapes Original Sin.

This paper also contributes to the literature on the global financial cycle and capital flows. Work by Rey (2015) and Miranda-Agrippino and Rey (2022) identifies a global financial cycle that affects international capital flows, asset prices, risk aversion, and liquidity, with a global factor that is highly correlated with the VIX. Additional research, such as Forbes and Warnock (2012), focuses on the interaction between global risk and emerging markets and finds that global risk is associated with extreme capital flows. Related work links sovereign and currency risk premia to priced global factors and investor bases, including Longstaff et al. (2011), Borri and Verdelhan (2015), and Maggiori, Neiman, and Schreger (2018). Recently, Chen and Zhou (2025) show that long positions in currency forwards amplify exchange rate risk on the balance sheets of funds investing in emerging market bonds, raising sensitivity to global conditions. This paper shows that changes in risk aversion not only affect flows but also affect the stock of local currency debt held by foreign investors. This

Table 1: Sample Countries

Asia	America	European Union	Europe, Middle East, Africa
China	Brazil	Hungary	Russia
India	Mexico	Poland	South Africa
Indonesia	Colombia		Turkey
Korea	Peru		
Malaysia			
Thailand			

Note: Countries are chosen from an original unbalanced panel of 21 countries. Only countries both in Onen et al. (2023) and Du et al. (2021) are selected into the final panel of 15 countries to achieve a balanced panel over local currency shares and local currency spreads.

paper also contributes to this literature by demonstrating that changes in risk aversion affect local currency shares through rising borrowing costs and an endogenous exchange rate depreciation channel.

Layout.— This paper is organized as follows. Section II presents empirical findings on the relationship between global risk aversion and emerging market local currency shares. Section III provides an overview of the model used to explore the mechanism governing this relationship. Section IV explores the quantitative results of the model and compares them to the data. Section V concludes the paper.

2 Empirical findings

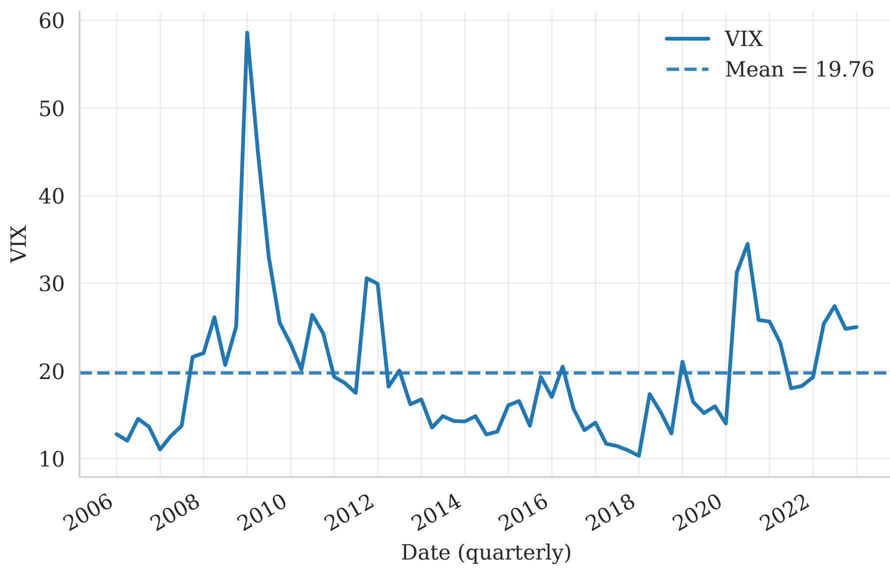
This section provides an overview of the data used for the empirical exercises (subsection 2.1), along with a discussion of why this new dataset offers insights not afforded by older datasets. Empirical findings then document that, on average, increases in the VIX are associated with lower local currency shares of emerging market debt in foreign investors' portfolios (subsection 2.2). Taken together, the evidence is consistent with the hypothesis that high-VIX episodes capture increases in foreign-investor risk aversion, which raise borrowing costs in local currency for emerging market governments and reduce the amount of local currency debt they can issue relative to foreign currency debt.

2.1 Data Description

The empirical observations rely on a panel of 15 emerging market countries covering 2005Q4–2022Q4. Data on local currency shares come from Onen et al. (2023), who construct a dataset of emerging market long-term government bonds that distinguishes bonds by currency of denomination and investors' residency. The dataset is built from Bank for International Settlements (BIS) data on government bonds denominated in both local and foreign currency, matched to series on foreign bond holdings obtained from national sources. Unlike previous datasets of emerging market debt (e.g., Arslanalp and Tsuda 2014), Onen et al. exclude loans to emerging market governments, focusing only on sovereign bonds because bonds are tradable on international financial markets and better capture the effects of episodes of financial distress.

Daily data on the CBOE Volatility Index (VIX) are obtained from the Federal Reserve Economic Data (FRED) database. Quarterly and annual measures are computed as within-period means. The VIX is reported in percent units and represents the expected annualized standard deviation of the S&P 500 over the next 30 days. Over the sample period, the VIX is highly volatile, rising by more than 200% during the Global Financial Crisis and by around 75% during the COVID-19 pandemic. The sample mean of the VIX is 19.76% and the standard deviation is 8.17%. The quarterly VIX series is plotted in Figure 1.

Figure 1: The CBOE Volatility Index (VIX)



Note: Plotted series is the quarterly mean of daily closes of the VIX (2005Q4–2022Q4, not seasonally adjusted). Dashed line = sample mean (19.76); sample standard deviation = 8.17.

Data for control variables used in the regressions come from FRED, the World Bank World Development Indicators (WDI) database, and the International Monetary Fund International Financial Statistics (IFS) database. Additional information on the definitions of the controls and their sources can be found in Appendix B.1.

2.2 Local Currency Bonds and the VIX

To investigate the relationship between local currency shares in foreign portfolios and the VIX, a fixed-effects model is estimated with local currency shares as the dependent variable and $\ln(\text{VIX})_t$ as the regressor of interest. The variable used for local currency share, *LC share* in country i in time t is defined as

$$LC\ share_{i,t} = \frac{\text{foreign held local currency sovereign bonds}_{i,t}}{\text{total foreign held sovereign bonds}_{i,t}},$$

where both the numerator and denominator are expressed in US dollars. This definition follows Onen et al. (2023). All sovereign bonds in the sample are held by foreign investors and other debt instruments such as loans are excluded. The fixed-effects specification is

$$LC\ share_{i,t} = \alpha_i + \beta \ln(\text{VIX})_t + \gamma Domestic\,Controls_{i,t} + \delta Global\,Controls_t + \epsilon_{i,t},$$

where $Domestic\,Controls_{i,t}$ is a vector of domestic economic and political control variables (ln(Foreign Reserves/GDP), GDP growth, Government effectiveness, Political stability, ln(Domestic Credit/GDP), ln(Exchange rate)) and $Global\,Controls_t$ is a vector of global control variables (US GDP growth, US Treasury 5-year yield). The control variables used are similar to those in Engel and Park (2022). Because many controls are available only annually, the regression is run at annual frequency. The dependent variable is reported as a fraction (e.g., 10% is reported as 0.10).

Variables are detrended using the Quast and Wolters (2022) modification of the Hamilton filter. Cyclical components are obtained by taking an equally weighted average of the forecast errors from 1-3 year-ahead projections. This method mitigates the end-of-sample bias associated with purely statistical detrending methods such as the Hodrick-Prescott (HP) filter, and produces smoother coverage of business cycles than the standard Hamilton filter.

Estimates from the regression are shown in Table 2. Column (1) shows the results of the regression without controls. Column (2) includes domestic controls only, Column (3) includes global controls only, and Column (4) includes all controls. The estimated coefficient on the $\ln(\text{VIX})_t$ term in Column 4 indicates that a one-standard deviation increase in the VIX is associated with a 2.30 percentage point decline in local currency shares on average [3].

The reported effect size in Table 2 is slightly larger than what is typically found in the literature. This is likely due to the fact that Onen et al. (2023) exclude all forms of public debt other than sovereign bonds from their dataset. By focusing on sovereign bonds alone we can draw better inference on the effect of market forces on local currency share, because sovereign bonds are tradable claims subject to market pricing unlike other forms of debt.

To address concerns that the VIX is not a perfect proxy for risk aversion, regression results using the Bekaert-Engstrom-Xu Risk Aversion Index (BEX) are included in Appendix A.3. The BEX is a model-derived measure of risk aversion from Bekaert et al. (2022), who use the generalized method of moments (GMM) to identify risk aversion from an asset-pricing model with habit formation. The authors then parameterize the latent risk aversion process as a span of observable financial variables so that their measure of risk aversion can be measured at high frequencies. The results in Appendix A.3 report a coefficient of $\beta_{\text{BEX}} = -0.142$ on $\ln(\text{BEX})_t$ that is significant at the 1% level of significance, indicating an even stronger relationship between local currency shares and risk aversion than implied by the VIX.

[3] Since one standard deviation of the VIX is 8.17 percentage points, then one standard deviation relative to the mean is $\frac{8.17\%}{19.76\%} = 41\%$. The effect size of a one-standard deviation increase in the VIX on local currency shares would then approximately be $\ln(1.41)(-0.067)(100) = -2.30$pp

Table 2: Local Currency Shares and the VIX

	Dependent variable: Local Currency Share			
	no controls	domestic controls	global controls	all controls
	(1)	(2)	(3)	(4)
ln(VIX)	-0.069***	-0.081***	-0.060***	-0.067***
	(0.020)	(0.019)	(0.017)	(0.017)
ln(Reserves/GDP)		-0.088*		-0.151**
		(0.051)		(0.065)
Domestic GDP Growth		-0.000		-0.000
		(0.001)		(0.001)
Government Effectiveness		0.030		0.035
		(0.070)		(0.070)
Political Stability		0.010		0.010
		(0.019)		(0.020)
ln(Domestic Credit/GDP)		0.052		-0.001
		(0.073)		(0.097)
ln(Exchange Rate)		-0.095**		-0.080*
		(0.044)		(0.046)
US GDP Growth			0.000	-0.001
			(0.001)	(0.002)
US Treasury 5YR			-0.014*	-0.027**
			(0.008)	(0.012)
Observations	225	207	225	207
N. of groups	15	15	15	15
R^2	0.083	0.164	0.102	0.222
Residual Std. Error	0.020 (df=209)	0.030 (df=185)	0.023 (df=207)	0.035 (df=183)
F Statistic	18.797*** (df=16; 209)	5.166*** (df=22; 185)	7.842*** (df=18; 207)	5.808*** (df=24; 183)

*p<0.1; **p<0.05; ***p<0.01

Note: Coefficient estimates from OLS panel regressions. The dependent variable is the detrended local-currency share (entered as a fraction in $[0, 1]$). Standard errors are in parentheses. Asterisks denote statistical significance in two-sided tests of the null that the coefficient equals zero ($H_0 : \beta = 0$). $\ln(\cdot)$ denotes natural logs. "N. of groups" is the number of country panels. "df" indicates degrees of freedom for the residual standard error and the F-statistic.

3 A Model of Risk Aversion and Sovereign Borrowing

The previous section documented that increases in the VIX are associated with lower local currency shares of sovereign bonds in foreign investors' portfolios. The working hypothesis is that emerging market governments exploit the hedging property of local currency debt to smooth consumption in response to economic downturns, causing emerging market exchange rates to depreciate in investors' bad times. Consequently, when foreign investors become more risk-averse (proxied by high-VIX episodes), their demand for local currency debt falls, resulting in a fall in local currency shares in their portfolios. This fall in demand affects the yield on local currency debt through rising exchange rate risk premia, which increases the cost of borrowing in local currency debt and constrains the emerging market government's ability to borrow in local currency.

This section develops a small open-economy model to rationalize the empirical findings and assess the proposed mechanism. The environment features a representative household that consumes a tradable good and a non-tradable good. Both goods are received as endowments each period, but only the tradable endowment follows a stochastic process. The government makes savings decisions on behalf of the household by issuing debt denominated in either local currency or foreign currency. Monetary policy is set via the choice of inflation each period. The government lacks commitment with respect to both savings and monetary policy. A foreign investor prices debt taking into account the government's lack of commitment.

3.1 The Environment

Endowments.—Time in the model is discrete and is indexed by $t \in [0, 1, ...]$. The economy receives both a tradable and non-tradable endowment each period. The tradable endowment is denoted by $y_T \in \mathbb{R}_+$ and the non-tradable endowment is denoted by $y_N \in \mathbb{R}_+$. The non-tradable endowment is constant over time, and tradable endowment follows

$$\log(y_{T,t}) = \rho \log(y_{T,t-1}) + \epsilon_t, \tag{1}$$

where $|\rho| < 1$ and $\epsilon_t \sim N(0, \sigma_\epsilon^2)$.

Households.—The representative household has preferences over lifetime consumption and inflation given by

$$\mathrm{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left\{ \frac{c_t^{1-\sigma}}{1-\sigma} - \frac{\psi}{2}(\pi - \pi^*)^2 \right\} \right], \tag{2}$$

where $\beta \in (0, 1)$ denotes the household's discount factor and c_t denotes consumption in period t. Preferences over consumption conform to a standard constant relative risk aversion (CRRA) functional form that is differentiable, increasing, and concave. The CRRA coefficient σ governs the household's level of risk aversion. The gross inflation rate is given by $\pi_t = \frac{P_t}{P_{t-1}}$ where P_t is the aggregate price level in period t. The household is subject to a quadratic disutility cost over inflation that is differentiable and convex. The cost of inflation to the household is governed by ψ.

Consumption is a composite of the tradable and non-tradable goods,

$$c_t = c_{T,t}^{\alpha} c_{N,t}^{1-\alpha}, \tag{3}$$

where $c_{T,t}$ is the consumption of tradable goods in period t and $c_{N,t}$ is the consumption of non-tradable goods in period t. The share of tradable consumption in the household's utility function is determined by α.

Households are hand-to-mouth. Each period the government rebates a lump sum transfer to the household that results from its savings decisions. The household budget constraint is

$$p_{T,t}c_{T,t} + p_{N,t}c_{N,t} = p_{T,t}y_{T,t} + p_{N,t}y_{N,t} + T_t, \tag{4}$$

where $p_{T,t}$ is the price of tradable goods, $p_{N,t}$ is the price of non-tradable goods, and T_t is the lump sum transfer from the government. Each of these is in units of local currency. The household's problem is to maximize the present value of lifetime utility subject to its budget constraint. The solution to this problem yields the optimal relative consumption of tradable goods to non-tradable goods, expressed as

$$\frac{c_{T,t}}{c_{N,t}} = \frac{\alpha}{1-\alpha}\frac{p_{N,t}}{p_{T,t}}, \tag{5}$$

which reflects the flexible nature of prices in the model. For example, a tradable endowment shock will raise consumption of tradable goods and lower the price of tradable goods.

The aggregate price level P_t is derived by solving to the household's cost-minimization problem. The resulting expression for the aggregate price level

$$P_t = \frac{p_{T,t}}{\alpha}\left(\frac{c_{T,t}}{c_{N,t}}\right)^{1-\alpha}, \tag{6}$$

will prove useful for defining the model equilibrium[4].

Government.—Each period the government chooses inflation and a portfolio of local currency and foreign currency sovereign debt. Proceeds from borrowing are rebated to households as lump-sum transfers. As in Hatchondo and Martinez (2009), all bonds issued in period t promise an infinite stream of coupons that decay at deterministic rate δ. Local currency bonds and foreign currency bonds are assumed to have the same maturity. When the government issues a local (foreign) currency bond it receives q_t (q_t^*) units in local (foreign) currency in period t. In exchange, it repays δ^j units of local (foreign) currency for all periods $t+j$, $j \geq 0$. For $\delta = 0$ the bond is one-period; as δ rises, maturity increases. Debt dynamics are given by

$$b_{t+1} = \delta b_t + i_t, \tag{7}$$

$$b_{t+1}^* = \delta b_t^* + i_t^*, \tag{8}$$

where b_t and b_t^* are outstanding local currency and foreign currency debt in period t. Bond issuance in local currency and foreign currency in period t is represented by i_t and i_t^* respectively. Expressed in units of local currency, the government's budget constraint is given by

$$T_t = q_t\left(b_{t+1} - \delta b_t\right) + e_t q_t^*\left(b_{t+1}^* - \delta b_t^*\right) - b_t - e_t b_t^*, \tag{9}$$

[4]Formally, the aggregate price level P_t is the ideal price index which solves the cost minimization problem:

$$P_t \equiv \min_{c_{T,t},\, c_{N,t}} p_{T,t}\, c_{T,t} + p_{N,t}\, c_{N,t} \quad \text{s.t.} \quad C(c_{T,t}, c_{N,t}) = 1.$$

where e_t is the exchange rate in terms of local currency per unit of foreign currency.

Foreign Investors.—Sovereign bonds are priced by risk-averse foreign investors who also have access to a riskless foreign currency security with net return r [5]. The inclusion of risk-averse investors is motivated by the global financial cycle literature (Rey 2015), which links risk appetite and market liquidity, and by evidence that risk premia explain a substantial share of sovereign spread variation (Borri and Verdelhan 2015; Longstaff et al. 2011). By including risk aversion, the effect of exogenous shifts in investor risk aversion on equilibrium allocations and prices can be determined.

Foreign investors price sovereign bonds using a log-normal stochastic discount factor

$$m_{t,t+1} = e^{-r-\left(\kappa\epsilon_{t+1}+\frac{1}{2}\kappa^2\sigma_\epsilon^2\right)}, \tag{10}$$

where $\kappa \geq 0$ is the price of risk parameter which governs the foreign investor's level of risk aversion and is the object that maps to the VIX in the empirical section. Additionally, ϵ_{t+1} is the shock to the tradable endowment process. This specification implies a preference for payoffs in states with negative tradable endowment shocks and can be viewed as a special case of Vasicek (1977), used in Arellano and Ramanarayanan (2012) and Bianchi et al. (2018). It has the attractive feature that $\mathrm{E}[m_{t,t+1}] = e^{-r}$, so the stochastic discount factor affects bond prices only through covariance terms.

Foreign investors price foreign currency sovereign bonds and local currency sovereign bonds using the pricing equations

$$q_t^* = \frac{1}{R-\delta}, \tag{11}$$

$$q_t = \mathrm{E}\left[m_{t,t+1}\frac{e_t}{e_{t+1}}(1+\delta q_{t+1})\right]. \tag{12}$$

The foreign currency bond is risk free due to the absence of default. The local currency bond price depends on current and future exchange rates and on the future bond price. These pricing equations arise from a representative foreign investor that maximizes discounted utility from tradable consumption; see Appendix C.2 for a derivation.

Equilibrium.—In the model economy the market for non-tradable goods clears each period, so that

$$c_{N,t} = y_{N,t}. \tag{13}$$

Assume that the law of one price holds for tradable goods so that $p_{T,t} = e_t p_{T,t}^f$, where $p_{T,t}^f$ is the price of tradable goods in foreign currency. By normalizing the international price of tradable goods to one, the expression becomes $p_{T,t} = e_t$. Plugging in to the expression for the aggregate price level P_t yields an expression for the exchange rate e_t. For notational convenience, we introduce expression $r(P_t, c_{T,t}/y_{N,t})$ which is equivalent to the inverse nominal exchange rate e_t^{-1}:

$$r\left(P_t, \frac{c_{T,t}}{y_{N,t}}\right) = \frac{1}{\alpha}\frac{1}{P_t}\left(\frac{c_{T,t}}{c_{N,t}}\right)^{1-\alpha} \tag{14}$$

This functional form suggests the nominal exchange rate is determined by a price index factor $1/P_t$ and a real exchange rate factor $(c_{T,t}/y_{N,t})^{1-\alpha}$. Intuitively, a higher aggregate price level

[5] Let r denote the continuously compounded (log) return over one model period. Continuous compounding implies value grows as $\exp(rt)$; with period length normalized to $t = 1$, the discrete gross rate is $R = \exp(r)$.

depreciates the domestic currency, while a higher relative consumption of tradables (and thus a lower relative price of tradables) appreciates it. This is supported by empirical evidence showing that movements in the real exchange rate are closely related to movements in the relative price of tradable goods to non-tradable goods (Burstein et al. 2005). Because prices in the model are fully flexible, the relative consumption of tradable goods to non-tradable goods determines their relative price.

Combining the household budget constraint (4) and the government budget constraint (9), the non-tradable goods market clearing condition (13), and dividing by e_t yields the resource constraint

$$c_{T,t} = y_{T,t} - b_t^* - r\left(P_t, \frac{c_{T,t}}{y_{N,t}}\right) b_t + q_t^*(b_{t+1}^* - \delta b_t^*) + r\left(P_t, \frac{c_{T,t}}{y_{N,t}}\right) q_t(b_{t+1} - \delta b_t). \tag{15}$$

The competitive equilibrium of this economy satisfies the following definition.

DEFINITION 1 (Competitive Equilibrium): *Given initial debt positions b_0^* and b_0, initial price level P_0, a state-contingent sequence of endowments $\{y_{T,t}, y_{N,t}\}_{t=0}^{\infty}$, and government policies $\{\pi_t, b_{t+1}^*, b_{t+1}\}_{t=0}^{\infty}$, a competitive equilibrium is a set of prices $\{q_t^*, q_t, e_t, P_t\}_{t=0}^{\infty}$ and quantities $\{c_{T,t}, c_{N,t}, T_t\}_{t=0}^{\infty}$, such that:*

(i) households solve their optimization problem given equilibrium prices,

(ii) lump-sum transfers satisfy the government's budget constraint,

(iii) sovereign bond prices satisfy (11) and (12),

(iv) the market for non-tradable goods clears.

3.2 Optimal Government Policies

This subsection presents a recursive formulation of the benevolent government's problem. Each period the government chooses inflation and the stocks of foreign and local currency bonds to maximize the representative household's lifetime utility. The government lacks commitment to future bond issuance and monetary policy. Attention is restricted to a Markov perfect equilibrium in which policies depend only on payoff-relevant state variables.

Let $s = \{b^*, b, y_T, P_{-1}\}$ represent the aggregate state. Because the planner lacks commitment, it takes as given the optimal policies of future planners. Let $\mathcal{R}(s)$ represent the perceived inverse nominal exchange rate policy of future planners. The planner's problem can then be expressed in recursive form as

$$V(s) = \max_{b^{*\prime}, b', \pi, c_T} \frac{c^{1-\sigma}}{1-\sigma} - \frac{\psi}{2}(\pi - \pi^*)^2 + \beta \, \mathrm{E}\left[V(s')\right],$$

subject to

$$c_T = y_T - b^* - r\left(P, \frac{c_T}{y_N}\right) b + \frac{1}{R-\delta}(b^{*\prime} - \delta b^*) + \tilde{q}(b' - \delta b),$$

$$\tilde{q} = \mathrm{E}\left[m(s', s)\mathcal{R}(s') + \delta \tilde{q}(s')\right],$$

$$P = \pi P_{-1},$$

where $\tilde{q} = qe^{-1}$ is the price of the local currency sovereign bond expressed in units of foreign currency. The recursive formulation shows the planner maximizing the present discounted value of the representative household's lifetime utility, subject to the economy's resource constraint, the recursive definition of the price of local currency sovereign bonds, and the definition of inflation. A no-Ponzi condition is imposed to prevent the planner from engaging in Ponzi schemes.

Assuming non-zero inflation in equilibrium, the price level and the nominal value of local currency sovereign bonds will follow a stochastic trend. Detrending all nominal variables by the previous period's aggregate price level P_{-1} renders these variables stationary. In this stationary formulation of the planner's problem, non-stationary state variables b and P_{-1} are combined into a new stationary state variable $\hat{b} = b/P_{-1}$. This process also removes the non-stationary endogenous state variable P_{-1}, and replaces it with the stationary choice variable π, the planner's choice of inflation. This stationary formulation of the planner's problem permits a solution using standard solution methods. The derivation of the stationary formulation of the planner's problem is included in Appendix D.1.

Given the recursive formulation of the planner's problem, the Markov perfect equilibrium satisfies the following definition.

DEFINITION 2 (Markov Perfect Equilibrium): *A Markov perfect equilibrium consists of the value function V(s), a set of policy rules* $\{c_T(s), b^{*'}(s), b'(s), \pi(s)\}$*, perceived policies* $\mathcal{R}(s)$*, and prices* $\{q^*(s), q(s)\}$ *such that:*

(i) the set of policy rules $\{c_T(s), b^{*'}(s), b'(s), \pi(s)\}$ *solves the planner's problem,*

(ii) sovereign bond prices $\{q^*(s), q(s)\}$ *solve (11) and (12),*

(iii) the perceived policies correspond to the actual policies, so that $\mathcal{R}(s) = r\left(P(s), \frac{c_T(s)}{y_N}\right)$.

3.3 Discussion of Assumptions and Model Choices

The model features an endogenous nominal exchange rate that depends on the planner's choice of inflation and on a real-exchange rate factor. Fluctuations in the real exchange rate factor respond to movements in the relative price of tradables to non-tradables, a relationship documented empirically across emerging markets (Burstein et al. 2005). Including this real-exchange rate channel is essential for realistic exchange rate dynamics that generate the hedging properties of local currency debt and motivates the presence of both tradable and non-tradable goods. Without the real exchange rate factor, the exchange rate would simply move one-to-one with inflation in the model.

All debt is public and issued to foreign investors. Because households are hand-to-mouth and do not purchase government bonds, all public debt in the model is external. An important implication of this assumption is that the foreign investor's bond holdings are equivalent to all outstanding bonds issued by the planner. Thus, a decline in the local currency share of debt in the foreign investor's portfolio is identical to a decline in the share of local currency issued by the planner.

The investor is assumed to have a log-normal stochastic discount factor with a price of risk parameter κ. A consequence of this functional form is that the standard deviation of the log stochastic discount factor is scaled linearly by κ, so that

$$\sigma(log(m_{t,t+1})) = \kappa\sigma_\epsilon,$$

where the left hand side of this equation $\kappa\sigma_\epsilon$ is the foreign investor's price of risk. This relationship permits a neat comparison to a micro-founded stochastic discount factor constructed using constant absolute risk aversion (CARA) utility. With CARA preferences, the standard deviation of the log stochastic discount factor scales linearly with the Arrow-Pratt coefficient. As the Arrow-Pratt coefficient rises, the agent becomes more risk-averse and their stochastic discount factor becomes more volatile. This behavior is identical to the way our reduced form log-normal stochastic discount factor responds to a change in κ, permitting a clean interpretation of an increase in κ as an increase in foreign investor risk aversion. For further discussion of this interpretation see Appendix C.2.

3.4 Hedging Incentive and Risk Premia

This subsection examines the planner's hedging incentive and its implications for the price of local currency debt, specifically through the exchange rate risk premium. It will then examine how changes in the exchange rate risk premium affect the planner's local currency debt issuance decision. Time subscripts are used below for clarity. For simplicity, we will consider a special case of the model where all debt is one-period, short-term debt $\delta = 0$, and there is no depreciation through the real-exchange rate factor $r_{c_{T,t}}\left(P_t, c_{T,t}/y_N\right) = 0$, so all depreciation is delivered through inflation. In the full model, the nominal exchange rate is affected by the planner's choice of debt and its impact on the relative consumption of tradable goods to non-tradable goods.[6]

Because the planner can manipulate the nominal exchange rate through its policy choices, it will use local currency bonds to hedge against unfavorable tradable endowment shocks. Consider the planner's first order condition for its choice of inflation

$$\psi(\pi - \pi^*) = \underbrace{u'(c_t)C_{c_T,t}}_{\text{MU}(c_{T,t})}\ \underbrace{r_\pi\left(P_t, \frac{c_{T,t}}{y_N}\right) b_t}_{\text{Dilution Value}}. \tag{16}$$

The planner's choice of inflation, and in this case depreciation, is determined by the marginal utility of consumption and a dilution value which corresponds to the amount of resources that can be saved through depreciation. The higher the marginal utility of consumption, the greater the marginal benefit of raising inflation, depreciating the currency, and reducing the real value of outstanding local currency debt. This channel is amplified by a dilution value that grows with the quantity of outstanding local currency bonds. The more outstanding bonds there are, the more resources can be saved through a currency depreciation, and the higher the marginal benefit of depreciation. Putting these facts together, in response to a negative tradable endowment shock that raises marginal utility of consumption, the planner depreciates the domestic currency, reduces the real debt burden, and smooths consumption.[7] This behavior generates an endogenous countercyclical nominal exchange rate, such that $\text{cov}(y_{T,t}, e_t) < 0$.

To analyze the implications for local currency bond prices, decompose the foreign investor's pricing equation for local currency sovereign bonds (12) into

$$q_t = \underbrace{\text{E}_t\left[m_{t,t+1}\right]\text{E}_t\left[\frac{e_t}{e_{t+1}}\right]}_{(i)} + \underbrace{\text{cov}\left(m_{t,t+1}, \frac{e_t}{e_{t+1}}\right)}_{(ii)}. \tag{17}$$

Component (i) shows that expected depreciation tomorrow lowers today's price. The greater the expected depreciation, the greater the return demanded by investors today. Component (ii) is the exchange rate risk premium. Mechanically, foreign investors prefer payoffs in states with a negative

[6] Reducing issuance today postpones tradable consumption, depreciates the real exchange rate, and lowers the real value of outstanding local currency debt.

[7] Ottonello and Perez (2019) show that if the tradable endowment is perfectly negatively correlated with the nominal exchange rate, consumption can be perfectly smoothed.

tradable endowment shock by virtue of the fact that their stochastic discount factor (10) moves negatively with this shock $\text{cov}(m_{t,t+1}, \epsilon_{t+1}) < 0$. Since the nominal exchange rate is countercyclical, this will yield a negative exchange rate risk premium $\text{cov}\Big(m_{t,t+1}, \frac{e_t}{e_{t+1}}\Big) < 0$. Intuitively, foreign investors demand a higher rate of return to compensate them for the fact that the exchange rate depreciates in their bad times, lowering the price of local currency debt today[8].

The size of the exchange rate risk premium is determined by two factors: the planner's hedging strategy and the risk aversion of the foreign investor. The more the planner exploits the hedging properties of local currency debt, the more countercyclical the nominal exchange rate will become and the larger the risk premium will be. Additionally, the higher the foreign investor's market price of risk parameter κ, the more volatile the stochastic discount factor $m_{t,t+1}$ and the larger the exchange rate risk premium. The focus of this paper is the second factor.

The planner's hedging incentive and consequently the foreign investor's exchange rate risk premium have important implications for the planner's local currency debt issuance decision. In the sequential formulation, the first-order condition for local currency issuance is

$$u'(c_t)C_{c_T,t}\left(q_t + \frac{\partial q_t}{\partial b_t} b_{t+1}\right) = \beta \, \text{E}_t\left[u'(c_{t+1})C_{c_T,t+1}\frac{e_t}{e_{t+1}}\right]. \tag{18}$$

The marginal benefit of issuing debt today depends on the current local currency bond price q_t and the price impact $\partial q_t/\partial b_t < 0$. A higher price charged to the foreign investor increases the amount earned from debt issuance and raises the marginal benefit of an additional unit of local currency debt. This benefit is attenuated by the adverse price impact $\partial q_t/\partial b_t < 0$, which is amplified by the volume of new issuance b_{t+1}. More debt issuance reduces the price the planner can charge the foreign investor, and this impact grows with the quantity of already-issued bonds that are revalued.

Substituting the foreign investor's local currency bond pricing equation (17) into (18) and rearranging yields

$$\begin{aligned}
&\underbrace{u'(c_t)C_{c_T,t}(1}_{\text{MBFC}} + \underbrace{R\frac{\text{cov}(m_{t,t+1}, \frac{e_t}{e_{t+1}})}{\text{E}_t\left[\frac{e_t}{e_{t+1}}\right]})(1 + \frac{\partial q_t}{\partial b_t}\frac{b_{t+1}}{q_t})}_{\text{local currency risk premium}} = \\
&\underbrace{\beta R \, \text{E}_t\left[u'(c_{t+1})C_{c_T,t+1}\right]}_{\text{MCFC}} + \underbrace{\beta R\frac{\text{cov}(u'(c_{t+1})C_{c_T,t+1}, \frac{e_t}{e_{t+1}})}{\text{E}_t\left[\frac{e_t}{e_{t+1}}\right]}}_{\text{local currency hedging benefit}}.
\end{aligned} \tag{19}$$

The planner trades off the hedging benefit of an additional unit of local currency debt against the higher risk premium charged by foreign investors. In equation (19), the MBFC represents the marginal benefit of issuing an additional unit of one-period foreign currency debt, and MCFC represents the expected marginal cost of issuing an additional unit of one-period foreign currency debt. Looking at the right-hand side of (19), local currency debt offers an additional benefit over foreign currency debt through its hedging properties. The more willing the planner is to exploit

[8] In the full model where $\delta > 0$, the price of local currency debt will also contain a capital gains risk premium $\text{cov}(m_{t,t+1}, q_{t+1})$ and the covariance between the future exchange rate and bond price $\text{cov}(\frac{e_t}{e_{t+1}}, q_{t+1})$. The capital gains risk premium will be negative, indicating that the price of local currency debt falls in foreign investors' bad times. The covariance between exchange rates and bond price is quantitatively insignificant across all parameterizations of the model.

these opportunities, the greater the marginal benefit of an additional unit of local currency debt, and the more local currency debt will be issued in equilibrium all else equal.

The left-hand side of the equation reveals the additional cost of local currency debt over foreign currency debt. The magnitude of this additional cost is governed by the exchange rate risk premium. The greater the exchange rate risk premium, the greater the marginal cost of an additional unit of local currency debt and the less local currency debt is issued in equilibrium. Since a larger market price of risk parameter κ increases the risk aversion of the foreign investor and therefore the magnitude of the exchange rate risk premium, we would expect that an increase in κ would lower the quantity of local currency debt issued in equilibrium. This relationship is explored quantitatively below.

Table 3: Model Calibration

Parameter	Values	Source/target
Preferences		
CRRA coefficient σ	5.0	Ottonello and Perez (2019)
Tradable share in utility α	0.50	Akinci (2017)
Discount factor β	0.9	
Target of inflation π^*	1.048	Avg. inflation (4.8%)
Cost of inflation ψ	7.08	Lucas (2000), Burstein and Hellwig (2008)
Price of risk κ	40.0	Avg. LC spread (4.3%)
Endowments and interest rate		
Risk free interest rate r	0.04	
Decay rate of bonds δ	0.76	Cruces and Trebesch (2013)
Non-tradable endowment y_N	1.00	Normalization
Autocorrelation of y_T ρ_{y_T}	0.81	Estimation, data tradable output
Standard deviation of y_T σ_{y_T}	0.04	Estimation, data tradable output

4 Quantitative Results

This section calibrates the model from Section 3 to match key moments from the sample of 15 emerging market countries from Section 2. The calibrated model is compared to the data, and then used to study the relationship between foreign investor risk aversion and local currency shares.

4.1 Calibration

The model is calibrated to a sample of 15 emerging market countries. The sample period is from 2005 to 2022. The model's frequency is annual so that one period t corresponds to one year in the data.

The CRRA coefficient σ is set to a value of 5.0, which sits at the upper end of the range used in quantitative macroeconomic models. A higher risk aversion coefficient is important for the results, as the planner must be sufficiently risk-averse to exploit the hedging properties of local currency debt, thereby generating risk premia in equilibrium. The share of tradable goods to non-tradable goods α is set to 0.5, in line with estimates by Schmitt-Grohe and Uribe (2020) and Akinci (2017). The discount factor β is taken to be 0.9, which delivers a realistic average debt-to-GDP ratio in the model, and is in line with values used in the sovereign-debt literature (e.g., Bianchi et al., 2018).

The following parameters govern the planner's willingness to use inflation to devalue local currency bonds. The first parameter is the inflation target rate π^* which is calibrated to target an average inflation rate of 4.8% during the sample period. The calibrated value is then set to 1.048. The second parameter is the cost of inflation ψ. The value of ψ is calibrated to 7.08, which delivers a 1% drop in permanent consumption for a 1% permanent increase in inflation. This is the size of the welfare loss quantified in Lucas (2000) and Burstein and Hellwig (2008).

The price of risk parameter κ governs the level of risk aversion in foreign investors. The price of risk is calibrated to target the average spread between the yield on local currency sovereign bonds and the yield on a US treasury of an equivalent maturity, which is estimated to be 4.3%. In the model, the average local currency spread is calculated using the difference between the yield on the local currency bond and the risk-free rate r. The net risk-free rate is set to 0.04, which as discussed yields a gross rate R of approximately 1.04[9]. This value is widely used in the sovereign debt literature (e.g., Hatchondo et al. 2016; Arellano and Ramanarayanan 2012). The decay rate δ is set to 0.76, so that bonds in the model have a duration of 4 years. This corresponds to the average duration of emerging market bonds as estimated by Cruces and Trebesch (2013).

Non-tradable goods y_N in the model are normalized to one. The persistence coefficient ρ_{yT} and standard deviation coefficient σ_{yT} of the tradable endowment process are estimated using the detrended logarithm of tradable output. Estimates are obtained using OLS with country fixed effects. Because of the size of the sample period, there is concern for small-T bias in these estimates, as identified by Nickell (1981). To address these concerns, parameter values estimated using the dynamic panel are compared to parameter values estimated for each individual country in the sample. The estimated values of both ρ_{yT} and σ_{yT} are close to the average value of the country-specific regressions, as shown in Appendix B.2.

4.2 Model Predictions

Moments generated from the model's ergodic set are compared to moments computed from the data to assess the performance of the model. Moments are computed from a simulation of 50,000 periods of the tradable endowment process, discarding the first 5,000 observations as burn-in before calculating statistics.

Average levels of inflation and local currency bond spreads match their moments in the data, as a consequence of the fact that these are chosen as targets in the calibration. The model's predictions of the average debt-to-GDP ratio and local currency share are slightly overestimated, likely reflecting lower simulated variance in the model.

The model modestly understates standard deviations. A key driver is that inflation is less volatile than in the data, which dampens foreign-investor reactions to negative endowment shocks because the sovereign is unlikely to deviate far from its inflation target. Consequently, local currency bond prices are less volatile than in the data, yielding lower volatility of debt and of the local currency share.

The simulated variables mostly correspond to the same cyclicality observed in their counterparts in the data. Debt is countercyclical, as observed empirically, with a stronger negative correlation with

[9]The risk free rate is set so that $\beta < \frac{1}{R}$ so that the planner has an incentive to issue positive amounts of debt in the model.

Table 4: Data and Model Moments

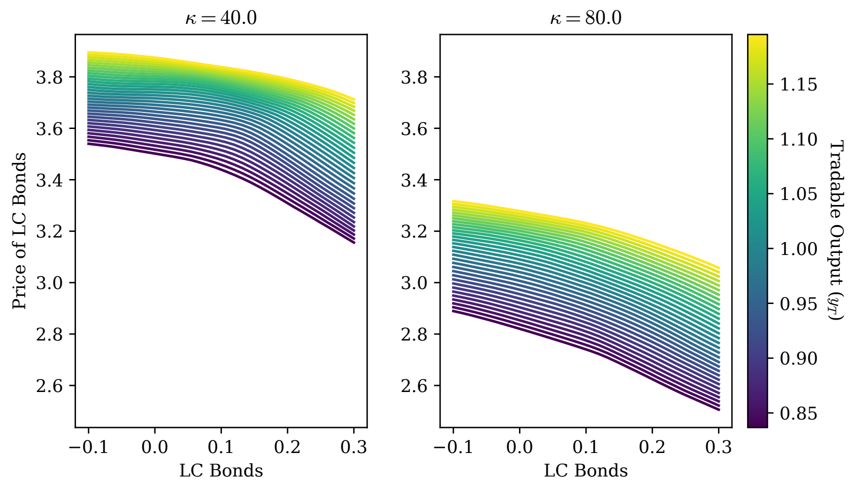
Moments	Data	Model
Average levels		
Debt	34.3%	43.5%
Share of debt in LC	60.0%	75.2%
Inflation (matched)	4.8%	4.8%
LC spread (matched)	4.3%	4.4%
Standard deviation		
Debt	2.9%	1.5%
Share of debt in LC	3.5%	0.6%
Inflation	2.3%	0.1%
Exchange rate	5.4%	2.4%
GDP	3.4%	3.0%
LC spread	0.9%	0.4%
Correlations with GDP		
Debt	-44.4%	-90.3%
Share of debt in LC	15.8%	6.1%
Inflation	64.3%	6.7%
Exchange rate	-5.0%	-5.5%
LC spread	1.7%	-6.7%

Note: The data column refers to moments computed from the 15 country panel outlined in Section 2.1. The sample period for this panel is from 2005Q4 to 2022Q4. The moments are computed at an annual frequency. Debt refers to external public debt over GDP. Share of debt in LC refers to the fraction of outstanding external debt in local currency. LC spread is computed by differencing the yield on local currency debt less the yield on foreign currency debt. In the model, the yield on local currency debt is computed using $y = \log(\delta + 1/q)$ and the yield on the foreign currency debt is the risk free rate r. Moments from the model are computed from simulated data. Standard deviations and correlations are computed using the cyclical component of each variable, where the cycle is obtained using an HP filter with a smoothing parameter of 6.25.

output, indicating heavier reliance on debt issuance to smooth consumption in low-endowment states. The nominal exchange rate is countercyclical, consistent with the data. This countercyclicality is central to the model's predictions. It provides a hedging benefit from issuing local currency debt and creates an exchange rate risk premium for foreign investors, who internalize that the exchange rate tends to depreciate in their bad times and therefore offer lower prices for local currency bonds.

The local currency share is procyclical, as in the data. The countercyclicality of local currency spreads is counterfactual, but consistent with the mechanism discussed in Section 3.4. The planner raises issuance of local currency debt in response to a negative endowment shock, increasing local currency spreads during bad economic states. Notably, this means that while local currency shares are procyclical, the level of local currency debt is countercyclical.

Figure 2: Price of LC Bonds



Note: Both panels plot the detrended local currency bond price $\tilde{q}$ against detrended local currency debt $\hat{b}$ for different values of κ. Variables are detrended by P_{-1} to eliminate the non-stationary state variable P_{-1} and to render non-stationary nominal variables stationary. The color bar indicates the level of tradable endowment.

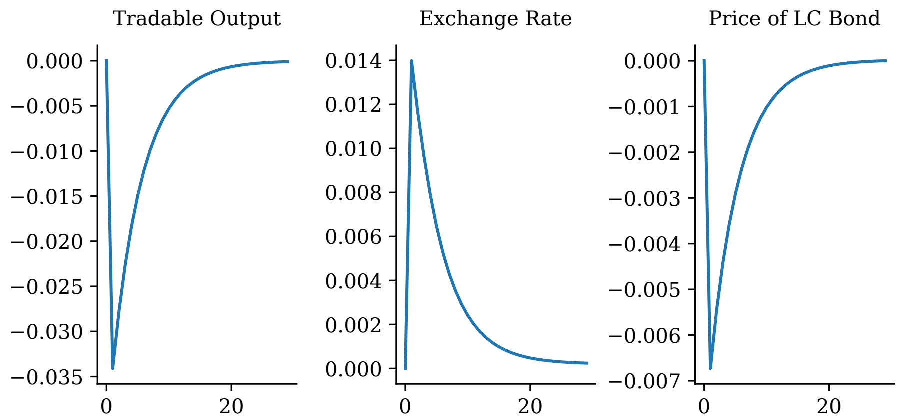
4.3 Pricing Mechanics

In the quantitative exercises in subsections 4.3 and 4.4, the price of risk parameter κ is exogenously adjusted to simulate increases in foreign investor risk aversion. While this technically represents a permanent increase in risk aversion in the model, it is effectively a four-year increase in risk aversion from the perspective of the planner and the foreign investor, because bonds in the model mature in four years on average. Thus, the impact from a permanent change in risk aversion is approximately equivalent to a change in risk aversion over a four-year horizon, not unlike the Great Financial Crisis where the VIX remained above its mean for nearly four years (see Figure 1). We thus interpret this exercise as equivalent to modeling a crisis that produces a protracted period of elevated risk aversion, like the Great Financial Crisis.

One way to understand the change in risk represented by a change in κ is through the local currency spreads reported in the results in Table 6. Local currency spreads embed a time-varying risk premium and are known to widen in 'risk-off' episodes when global risk aversion rises. In our quantitative exercises, a doubling of κ causes the average local currency spread to double. A tripling of κ causes the average local currency spread to triple. Such large movements in local currency spreads are not uncommon in the data, having been observed during the Great Financial Crisis, the Taper Tantrum in 2013, and the COVID-19 crisis (see Figure A1). Model-produced spreads are all well within the range found in our sample of 15 emerging market countries.

Figure 2 shows that increasing κ lowers the price of local currency bonds across income levels. The mechanism linking investor risk aversion to local currency bond prices is investigated using simulations from the numerical solution. Two components are central: the exchange rate risk premium and the capital gains premium. Evidence from impulse responses and model-generated moments indicates that movements in exchange rates and local currency bond prices generate

Figure 3: Impulse Response Functions



Note: Each panel plots a variable's response to a one-standard deviation income shock over 30 periods. The vertical axis represents the percent deviation from the initial value.

negative risk premia that lower the price of local currency debt. Because debt is long-term, these premia are amplified by feedback from expected future prices, since lower expected prices tomorrow depress prices today.

Figure 3 reports impulse responses to a negative one-standard deviation tradable endowment shock. The second panel shows that following a negative endowment shock $\epsilon_{t+1} < 0$ the nominal exchange rates rises ($e_{t+1} \uparrow$) (a depreciation), implying the change in the exchange rate falls $\left(\frac{e_t}{e_{t+1}} \downarrow\right)$. This same shock causes the foreign investor's stochastic discount factor to rise ($m_{t,t+1} \uparrow$) producing a negative exchange rate risk premium, $\text{cov}\left(m_{t,t+1}, \frac{e_t}{e_{t+1}}\right) < 0$, which lowers the price of local currency debt q_t. The third panel of Figure 2 shows that the local currency bond price falls in response to a negative shock. Hence prices are lower in the foreign investor's bad times, yielding a negative capital gains risk premium $\text{cov}\left(m_{t,t+1}, q_t\right) < 0$. Taken together, these facts indicate that the foreign investor's risk aversion should raise local currency borrowing costs for the planner.

While the results from the impulse response functions are consistent with the existence of an exchange rate risk premium and capital gains risk premium, it remains to be seen how large the risk premia are and how they vary with the level of risk aversion in the model. To quantify the relationship between the risk premia terms and κ, moments from the decomposition of the local currency bond price q_t are computed every period for a 50,000-period simulation, with a burn-in of 5,000 periods. The average of each moment is then taken and reported in Table 5. The exercise is repeated for three values of the price of risk parameter κ.

In Table 5, column (1) corresponds to the price of risk parameter, column (2) is the average price of a local currency bond across over all simulated periods, column (3) is the average expected exchange rate times the expected future local currency bond price, column (4) is the average exchange rate risk premium, and column (5) is the average capital gains risk premium.

The first row corresponds to the calibrated level of risk aversion ($\kappa = 40.0$), which produces relatively small exchange rate and capital gains risk premia. As the foreign investor becomes highly

Table 5: Price of LC Bond Decomposition

κ	q_t	$\mathrm{E}[m_{t,t+1}]\ \mathrm{E}\left[\frac{e_t}{e_{t+1}}\right]\mathrm{E}[1+\delta q_{t+1}]$	$\mathrm{E}[1+\delta q_{t+1}]\,\mathrm{cov}\left(m_{t,t+1}, \frac{e_t}{e_{t+1}}\right)$	$\delta\ \mathrm{E}\left[\frac{e_t}{e_{t+1}}\right]\mathrm{cov}(m_{t,t+1}, q_{t+1})$
40.0	2.95	3.02	-0.05	-0.02
80.0	2.54	2.72	-0.14	-0.04
120.0	2.23	2.50	-0.21	-0.06

Note: The price of debt is decomposed into an expectation term, an exchange rate risk premium, and a capital-gains risk premium. All expectations and covariances are computed from a simulation of 50,000 periods of the tradable endowment process. Any residual interaction, including the covariance of the change in the exchange rate and the future price $\mathrm{cov}(\frac{e_t}{e_{t+1}}, q_{t+1})$, are numerically negligible in simulations and not shown.

risk-averse, as in the second row ($\kappa = 80.0$), both the exchange rate risk premium and the capital gains risk premium rise, leading to a reduction in the local currency bond price. This trend continues in the third row ($\kappa = 120.0$), with a very high level of risk aversion driving down prices even more. In total, the price of local currency sovereign bonds drops 13.9% from the calibrated case to the high risk aversion case, and 12.2% from the calibrated case to the very high risk aversion case.

Importantly, the large decline in q_t is a consequence of the long-term nature of debt. Higher premia depress today's price directly and also lower expected future prices, which feeds back into today's valuation. This feedback mechanism amplifies the effect of the risk premia on the price of debt today. This is confirmed by the fact that $\mathrm{E}[m_{t,t+1}]$ and $\mathrm{E}\left[\frac{e_t}{e_{t+1}}\right]$ are constant across all values of κ, and that $\mathrm{E}[q_{t+1}]$ is the only expected value that drops as foreign investors become more risk-averse. This has important implications for the maturity structure of debt in emerging market economies. The longer the average maturity of debt, the greater the impact on borrowing costs from a rise in foreign investor risk aversion.

These quantitative results reinforce the proposed mechanism. Heightened risk aversion induces larger premia that reduce the price investors are willing to pay for local currency bonds, tightening the sovereign's local currency borrowing capacity. Subsection 4.4 uses the model to assess the implied effects on local currency debt shares.

4.4 Local Currency Shares

The quantitative solution to the model shows that higher foreign-investor risk aversion lowers local currency debt prices via a higher exchange rate premium, a higher capital gains premium, and a lower expected future local currency price. The next step is to quantify how these price changes affect local currency share of debt in equilibrium.

Consistent with the proposed mechanism, Table 6 reports that an increase in risk aversion from ($\kappa = 40.0$) to ($\kappa = 80.0$) causes a 16 percentage point decline in local currency shares, and a 5.1 percentage point increase in the local currency spread. An increase in risk aversion from ($\kappa = 80.0$) to ($\kappa = 120.0$) causes a 15.7 percentage point decline in local currency shares, and a 4.4 percentage point increase in local currency spreads. This evidence is consistent with our story that an increase in foreign investor risk aversion reduces demand for local currency debt, raises local currency borrowing costs, and constrains the ability of the planner to issue local currency debt.

Using some back-of-the-envelope math, we can tie our model results to our empirical results in Section 2. Using a local linear approximation, from ($\kappa = 40.0$) to ($\kappa = 80.0$) a 1-percentage point

Table 6: Model Moments and Risk Aversion

Moments	Calibrated Risk Aversion ($\kappa = 40.0$)	High Risk Aversion ($\kappa = 80.0$)	Higher Risk Aversion ($\kappa = 120.0$)
Average levels			
Debt	43.5%	44.8%	45.9%
Share of debt in LC	75.2%	59.2%	43.5%
Inflation	4.8%	4.8%	4.8%
LC spread	4.4%	9.5%	13.9%
Standard deviation			
Debt	1.5%	1.6%	1.9%
Share of debt in LC	0.6%	0.9%	0.7%
Inflation	0.1%	0.1%	0.1%
Exchange rate	2.4%	2.8%	3.1%
Real Exchange rate	2.4%	2.8%	3.1%
GDP	3.0%	3.1%	3.1%
LC spread	0.4%	0.6%	0.6%
Correlations with GDP			
Debt	-90.3%	-87.2%	-92.1%
Share of debt in LC	6.1%	7.7%	9.5%
Inflation	6.7%	5.9%	5.2%
Exchange rate	-5.5%	-8.2%	-8.4%
Real Exchange rate	-5.5%	-8.2%	-8.4%
LC spread	-6.7%	-5.4%	-5.7%

Note: The data column refers to moments computed from the 15 country panel outlined in Section 2.1. The sample period for this panel is from 2005Q4 to 2022Q4. The moments are computed at an annual frequency. Debt refers to external public debt over GDP. Share of debt in LC refers to the fraction of outstanding external debt in local currency. LC spread is computed by differencing the yield on local currency debt less the yield on foreign currency debt. In the model, the yield on local currency debt is computed using $y = \log(\delta + 1/q)$ and the yield on the foreign currency debt is the risk free rate r. Moments from the model are computed from simulated data. Standard deviations and correlations are computed using the cyclical component of each variable, where the cycle is obtained using an HP filter with a smoothing parameter of 6.25.

Table 7: ΔLC Share Decomposition

$\Delta\kappa$	$\mathrm{d}\bar{\ell}$	$\frac{\partial \bar{\ell}}{\partial \bar{e}}\mathrm{d}\bar{e}$	$\frac{\partial \bar{\ell}}{\partial \bar{b}}\mathrm{d}\bar{b}$	$\frac{\partial \bar{\ell}}{\partial \bar{b}^*}\mathrm{d}\bar{b}^*$
$\Delta\kappa = 40.0 \to 80.0$	-16.00pp	-1.29pp	-5.65pp	-8.52pp
$\Delta\kappa = 80.0 \to 120.0$	-15.68pp	-0.09pp	-7.18pp	-7.57pp

Note: Decomposition is of the change in average LC share computed for a change in κ. Components of the LC share include: b the average LC debt (LC units), b^* the average FC debt (FC units), and e the average nominal exchange rate (higher e = LC depreciation). The change in the share is decomposed using the total differential with analytic derivatives evaluated at the baseline in each row for different changes in κ. Entries in the last three columns report these first-order contributions, expressed in percentage points (pp).

increase in the local currency spread corresponds approximately to a 3.13 percentage point decline in the local currency share[10]. Using the local currency spread–VIX semi-elasticity in Table A1, this model implies that a one-standard deviation increase in the VIX corresponds to a decline in the local currency share of 2.21 percentage points. [11]. This estimate is slightly smaller than the -2.30 coefficient relating the VIX to local currency shares in Table 2. It is, however, not statistically distinguishable from this coefficient, failing to reject the null of $H_0 : \beta = -2.30$ for a two-sided test at the 85% level of significance.

To illustrate the consistency of these results, from ($\kappa = 80.0$) to ($\kappa = 120.0$) a 1 percentage point increase in the local currency spread corresponds to roughly a -3.57 decline in local currency shares. Using the same method as before, for this change in κ the model implies that a one-standard deviation in the VIX corresponds to a -2.52 percentage point decline in local currency shares. This implies a slightly larger relationship between the VIX and local currency shares than is estimated, indicating that the relationship between local currency shares and local currency spreads in the model is not fixed, but rather changes with risk aversion.

The question remains: what mechanisms in the model account for the decline in average local currency shares following an increase in foreign investor risk aversion? Recall the definition for local currency shares is the foreign currency value of local currency debt over the foreign currency value of total debt. Define a new variable representing the average local currency share $\bar{\ell}$, so that

$$\bar{\ell} = \frac{\bar{b}/\bar{e}}{\bar{b}/\bar{e} + \bar{b}^*}. \tag{20}$$

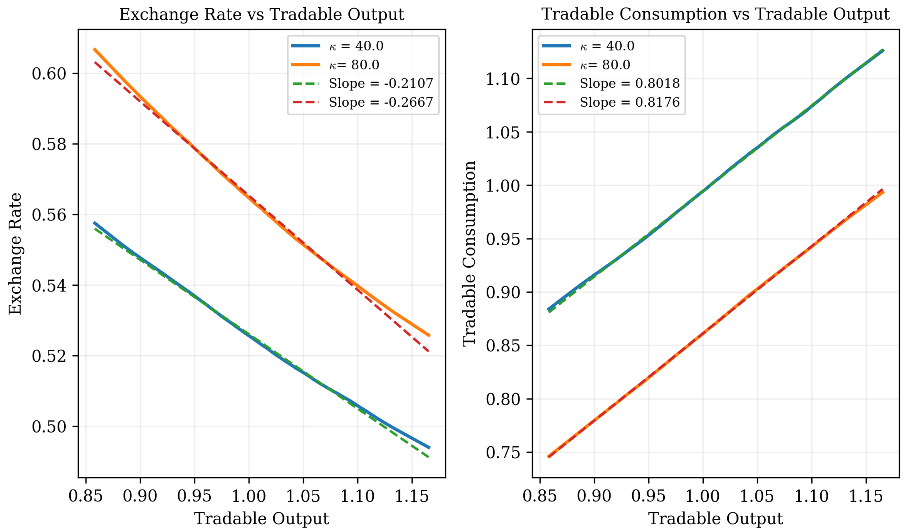
In this equation, $\bar{e}$ represents the average exchange rate, $\bar{b}$ is average local currency debt, and $\bar{b}^*$ is average foreign currency debt. Taking the total differential of equation (20) yields the following equation:

$$\mathrm{d}\bar{\ell} = \frac{\partial \bar{\ell}}{\partial \bar{e}}\mathrm{d}\bar{e} + \frac{\partial \bar{\ell}}{\partial \bar{b}}\mathrm{d}\bar{b} + \frac{\partial \bar{\ell}}{\partial \bar{b}^*}\mathrm{d}\bar{b}^* \tag{21}$$

[10] This back-of-the-envelope estimate assumes local linearity in the relationship between local currency shares and local currency spreads implied by the model

[11] Table A1 gives a semi-elasticity of local currency spreads with respect to $\ln(\mathrm{VIX})_t$ of $\hat{\beta} = 0.017$ percentage points. A one-standard deviation increase in the VIX is an approximately 40% increase, implying a change in local currency spreads of $\ln(1.4)(0.021\text{pp}) * (100) = 0.72pp$. Assuming a linear relationship between local currency shares and local currency spreads, such that a 1 percentage point increase in local currency spreads decreases local currency shares by 3.13 percentage points, the approximate change in local currency shares for a one-standard deviation in the VIX is $(-0.313\text{pp})(0.72) = -2.21\text{pp}$

Figure 4: Exchange Rate and Tradable Consumption vs Output, by κ



Note: Each curve shows a binned conditional–mean relation with y_T on the horizontal axis. For each $\kappa \in \{40, 80\}$ the model is simulated for 55,000 periods with a burn-in of 5,000. We partition y_T into up to 80 equal-mass (quantile) bins and, for each retained bin compute the average value of y_T and the conditional mean of the vertical variable. Bins with fewer than 100 observations are dropped. Dashed lines are OLS fits of the binned conditional means on y_t^T; the legend reports the slope.

Using the total differential of $\bar{\ell}$, the total change in the average local currency share can be decomposed into changes in each component in equation (21). Table 7 reports the results of this decomposition.

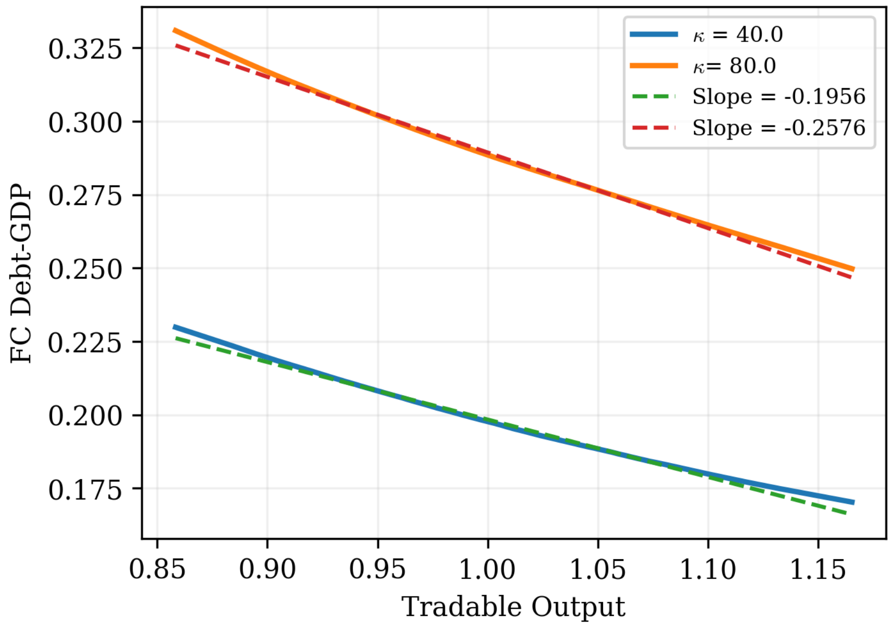
From the first row in Table 7, when κ increases from 40.0 to 80.0, the average local currency share of debt falls by 16.00 percentage points. Of that total decline, 1.29 percentage points can be explained by local currency depreciation (a higher $\bar{e}$), 5.65 percentage points can be explained by a decrease in average outstanding local currency debt, and 8.52 percentage points can be explained by an increase in average foreign currency debt. With a further increase in κ in row 2, a larger fraction of the change is accounted for by falling local currency debt issuance, and a smaller fraction by depreciation and rising foreign currency debt issuance.

These findings point to three channels through which higher risk aversion lowers local currency shares. First, the currency depreciates, reducing the foreign currency value of local currency debt. Second, the local currency bond price falls, so the planner scales back local currency issuance, consistent with the higher local currency spreads in Table 6. Third, the planner issues more foreign currency debt, raising the denominator in $\bar{\ell}$ and mechanically lowering the local currency share. The second mechanism has been discussed extensively in this paper. The first and third mechanisms are explored in more detail below.

Why does the currency depreciate when risk aversion rises? In the stationary problem, the exchange rate takes the form

$$e = \alpha\pi(c_T)^{(\alpha-1)}, \tag{22}$$

Figure 5: FC Debt-GDP vs Tradable Output by κ



Note: Each curve shows a binned conditional–mean relation with y_T on the horizontal axis. For each $\kappa \in \{40, 80\}$ the model is simulated for 55,000 periods with a burn-in of 5,000. We partition y_T into up to 80 equal-mass (quantile) bins and, for each retained bin compute the average value of y_T and the conditional mean of the vertical variable. Bins with fewer than 100 observations are dropped. Dashed lines are OLS fits of the binned conditional means on y_t^T; the legend reports the slope.

where π is a domestic inflation term and $(c_T)^{(\alpha-1)}$ is a real exchange rate factor. Thus, average depreciation requires either higher average inflation or lower average tradable consumption. Table 6 shows that inflation is essentially unchanged across κ, suggesting the latter mechanism. Figure 4 corroborates this. In the left panel, as κ rises from 40.0 to 80.0, the average exchange rate rises (depreciates) across the support of the tradable endowment y_T. In the right panel average tradable consumption declines across the same support in response to the increase in risk aversion.

Interpreting the evidence from Figure 4, as risk aversion rises and the price of local currency debt falls, the value of total debt falls and consumption declines across all states. As consumption declines, the real exchange rate factor in equation (22) rises, pushing up the nominal exchange rate and depreciating the currency.

The third channel operates through substitution toward foreign currency issuance. As local currency bond prices fall, the total value of debt and, hence, consumption decline across states, prompting the planner to issue more foreign currency debt to raise average consumption. Figure 5 shows the conditional mean of the foreign currency debt-to-GDP ratio rising across the domain of tradable output as κ increases from 40.0 to 80.0. The additional foreign currency debt issuance does not fully offset the loss of local currency debt value, as evidenced by the drop in average consumption and depreciation in Figure 4. This is because obligations on foreign currency debt, unlike local currency debt, are not state contingent. From the perspective of the risk-averse planner, a unit of foreign currency debt is riskier than a unit of local currency debt, and is therefore not a one-to-one substitution. The precautionary savings motive of the planner thus limits the extent of substitution away from local currency debt into foreign currency debt.

Finally, as local currency debt becomes more expensive and local currency debt issuance declines, the planner loses access to an asset that it can use to hedge against low income shocks. In response, the planner chooses to issue relatively more foreign currency debt in low income states to smooth consumption. Evidence for this hypothesis is found in Figure 5, where the slope of foreign currency debt against tradable output rises from -0.1956 to -25.576 as κ increases.

5 Conclusion

This paper provides new evidence and a coherent mechanism linking global risk aversion to the currency composition of sovereign borrowing in emerging markets. Empirically, higher risk aversion coincides with a systematic fall in the local currency share of foreign holdings, a relationship that is robust to alternative measures of risk aversion and sample definitions.

The mechanism is investigated using a small open economy model with risk-averse foreign investors, discretionary monetary policy, and long-term debt. Risk-averse foreign investors demand compensation when local currency payoffs are weakest in their bad times. With long-term debt and discretionary monetary policy, the local currency price loads on both exchange rate and capital gains premia, and expected future price movements feed back into today's valuation. The result is that episodes of high risk aversion raise local currency borrowing costs, constraining the ability of the government to borrow in local currency and reducing the share of local currency debt in equilibrium. This outcome is mainly driven by issuance decisions, with resulting depreciation effects playing a secondary role.

Two implications follow. First, "Original Sin" is state contingent. In tranquil times, hedging benefits sustain local currency borrowing, but in episodes of high risk aversion, risk premia dominate and local currency borrowing capacity shrinks. Second, the maturity structure is not innocuous. Long duration bonds strengthen the premium feedback from expected future prices, amplifying the impact of an increase in risk aversion and constraining local currency borrowing capacity further.

The analysis abstracts from default and treats global risk aversion as exogenous. These choices isolate the premium channel and make the mapping from states to prices transparent. Extending the framework to admit persistent or endogenous global risk, a richer domestic investor base, and reserve management would sharpen the policy trade offs and further align the model with the persistence of risk-off episodes.

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APPENDIX

A Additional Tables and Robustness

A.1 Additional Figures

Figure A1: 3-Year Local Currency Spreads by Country

Note: The "3Y LC spread" is the yield on 3-year local-currency sovereign debt in country i minus the yield on 3-year U.S. Treasuries of the same maturity. The dashed line shows the country-specific time-series mean. Spread series are constructed from Du et al. (2021).

A.2 Additional Tables

Data on sovereign spreads are from Du et al. (2021), who define local currency sovereign spreads as the difference between the yield on an emerging market local currency bond and the yield on a U.S. Treasury of the same maturity. We use the three-year spread because it is closest to our sovereign debt duration of four years in the model.

Using annual data and the same panel of 15 emerging market countries, the following fixed effects

Table A1: Local Currency Spreads and the VIX

	Dependent variable: 3YR Local Currency Spread
ln(VIX)	0.021^{***}
	(0.005)
ln(Reserves/GDP)	-0.015
	(0.029)
ln(External Debt/GDP)	0.018^{**}
	(0.007)
ln(Private Debt/GDP)	0.090^{**}
	(0.035)
GDP Growth	0.000
	(0.000)
Observations	182
N. of groups	13
R^2	0.196
Residual Std. Error	0.009 (df=164)
F Statistic	7.995^{***} (df=18; 164)

*p<0.1; **p<0.05; ***p<0.01

Note: Coefficient estimates from OLS panel regressions. The dependent variable is the detrended local-currency spread (entered as a fraction in $[0, 1]$). Standard errors are in parentheses. Asterisks denote statistical significance in two-sided tests of the null that the coefficient equals zero ($H_0 : \beta = 0$). $\ln(\cdot)$ denotes natural logs. "N. of groups" is the number of country panels. "df" indicates degrees of freedom for the residual standard error and the F-statistic.

model for country i in time t is estimated

$$y_{i,t} = \alpha_i + \beta_1 \ln(\text{VIX})_t + \beta_2 \ln\Big(\frac{Foreign\ Reserves}{GDP}\Big)_{i,t} + \beta_3 \ln\Big(\frac{External\ Debt}{GDP}\Big)_{i,t} + \beta_4 \ln\Big(\frac{Priate\ Debt}{GDP}\Big)_{i,t} + \beta_5 GDP\ growth_{i,t} + \epsilon_{i,t},$$

where $y_{i,t} = \{\text{local currency sovereign spread}\}$ and controls match those used in Devereux and Wu (2022).

Results for spreads are reported in Table A1. The results show that a one–standard deviation increase in the VIX is associated with a 0.72 percentage-point increase in three-year local currency sovereign spreads on average. This result is used to compute our back-of-the-envelope effect of the VIX on local currency spreads using our model results.

A.3 Robustness

In this subsection several robustness checks are included to substantiate the findings reported in Section 2. These checks are included to confirm that what is being captured in Table 2 is indeed a relationship between risk aversion and local currency shares, and to confirm that this relationship holds at other frequencies.

Table A2: Local Currency Shares and the BEX Risk Aversion Index

	Dependent variable: Local Currency Shares			
	no controls	domestic controls	global controls	all controls
	(1)	(2)	(3)	(4)
ln(BEX)	-0.125***	-0.153***	-0.123***	-0.142***
	(0.036)	(0.039)	(0.036)	(0.039)
ln(Reserves/GDP)		-0.083*		-0.148**
		(0.049)		(0.065)
Domestic GDP Growth		-0.001		0.000
		(0.001)		(0.001)
Government Effectiveness		0.027		0.034
		(0.076)		(0.073)
Political Stability		0.009		0.007
		(0.018)		(0.018)
ln(Domestic Credit/GDP)		0.054		0.000
		(0.071)		(0.099)
ln(Exchange Rate)		-0.096**		-0.082*
		(0.044)		(0.047)
US GDP Growth			-0.001	-0.002
			(0.001)	(0.002)
US Treasury 5YR			-0.013	-0.026**
			(0.008)	(0.012)
Observations	225	207	225	207
N. of groups	15	15	15	15
R^2	0.081	0.161	0.102	0.223
Residual Std. Error	0.020 (df=209)	0.030 (df=185)	0.023 (df=207)	0.035 (df=183)
F Statistic	18.383*** (df=16; 209)	5.072*** (df=22; 185)	7.854*** (df=18; 207)	5.847*** (df=24; 183)

*p<0.1; **p<0.05; ***p<0.01

Note: Coefficient estimates from OLS panel regressions. The dependent variable is the detrended local-currency share (entered as a fraction in $[0, 1]$). Standard errors are in parentheses. Asterisks denote statistical significance in two-sided tests of the null that the coefficient equals zero ($H_0 : \beta = 0$). $\ln(\cdot)$ denotes natural logs. "N. of groups" is the number of country panels. "df" indicates degrees of freedom for the residual standard error and the F-statistic.

For our first check, we substitute the Bekaert-Engstrom-Xu Risk Aversion Index (BEX) for the VIX as our independent variable of interest in our regression analysis. The BEX is a model-derived estimate of risk aversion from Bekaert et al. (2022). The authors use an asset-pricing model with habit formation to distinguish between risk-aversion and uncertainty. Uncertainty is disciplined using data from macroeconomic fundamentals. The latent risk aversion state variable is then identified via generalized method of moments (GMM) using moments from equity and credit spreads, as well as the difference between options-implied and realized variance. The latent risk aversion process is then parameterized as a span of observable financial variables to achieve a measure of risk aversion at high frequency. The advantage of using the BEX is that, unlike the VIX, which measures both risk aversion and uncertainty, the BEX measures risk aversion alone given the model assumptions.

Results are reported in Table A2, which reports a larger coefficient on $\ln(\text{BEX})_t$ than on $\ln(\text{VIX})_t$ in Table 2. The estimated coefficient indicates that a one-standard deviation increase in the BEX corresponds to a 2.79 percentage point decrease in local currency shares on average, a consequence of the fact that the BEX is less volatile than the VIX. This evidence suggests that the relationship between local currency shares and the VIX is largely driven by changes in risk aversion, and substantiates our hypothesis that rising investor risk aversion lowers local currency shares on average.

Table A3: Local Currency Share and the VIX (Quarterly)

	Dependent variable: Local Currency Shares	
	no controls	all controls
	(1)	(2)
ln(VIX)	-0.045***	-0.043***
	(0.012)	(0.016)
ln(Reserves/GDP)		-0.096
		(0.060)
Domestic GDP Growth		0.000
		(0.000)
ln(Exchange Rate)		-0.090*
		(0.047)
US GDP Growth		-0.003***
		(0.001)
US Treasury 5YR		-0.017**
		(0.007)
Observations	810	805
N. of groups	15	15
R^2	0.040	0.135
Residual Std. Error	0.013 (df=794)	0.023 (df=784)
F Statistic	32.840*** (df=16; 794)	20.464*** (df=21; 784)

*p<0.1; **p<0.05; ***p<0.01

Note: Coefficient estimates from OLS panel regressions. The dependent variable is the detrended local-currency share (entered as a fraction in $[0, 1]$). Standard errors are in parentheses. Asterisks denote statistical significance in two-sided tests of the null that the coefficient equals zero ($H_0 : \beta = 0$). $\ln(\cdot)$ denotes natural logs. "N. of groups" is the number of country panels. "df" indicates degrees of freedom for the residual standard error and the F-statistic.

The next robustness check uses data from a quarterly panel to confirm that the relationship between the VIX and local currency shares holds at a quarterly frequency as well as an annual frequency. To run these regressions, variables representing government effectiveness and political stability must be dropped, because they are only available at an annual frequency. Regressions are run using country-level fixed effects, and results are reported in Table A3.

The findings reported in Table A3 indicate that a one-standard deviation increase in the VIX is associated with a 1.47 percentage point decrease in local currency shares at a quarterly frequency. While this effect size is slightly smaller than what is reported in Table 2, the relationship remains negative and statistically significant. It could be that episodes of heightened risk aversion have cumulative effects on local currency shares, so that quarterly estimates understate the relationship between the VIX and local currency shares relative to annual estimates.

B Data Appendix

B.1 Data Description

Table B1: Data Sources

Variable	Source
Local Currency Share	Onen et al. (2023)
Total External Debt	Onen et al. (2023)
CBOE Volatility Index (VIX)	FRED
Foreign Reserves	IMF IFS
Domestic GDP	IMF IFS
Exchange Rate	IMF IFS
Government Effectiveness	World Bank WDI
Political Stability	World Bank WDI
Domestic Credit-to-GDP	World Bank WDI
Agriculture Vaue Added	World Bank WDI
Industry Value Added	World Bank WDI
US GDP	FRED
US Treasury 5 Year Yield	FRED
Private Debt-to-GDP	FRED
3YR Local Currency Spread	Du et al. (2021)

Note: All variables cover a sample period from 2005Q4 to 2022Q4.

Data for local currency shares and total external debt comes from Onen et al. (2023). The authors construct a measure of local currency share of sovereign bonds held by foreign investors using a combination of data from the Bank of International Statistics (BIS) and series on foreign holdings of sovereign debt from central banks, national statistical offices, and ministries of finance. The result is a quarterly dataset of sovereign bond holdings that distinguishes between local and foreign currency as well as domestic or foreign ownership. Compared to other common datasets, such as Arslanalp and Tsuda (2014), this dataset included only long-term general government debt securities. Total external debt is defined as the dollar value of local currency debt and foreign currency debt held by foreign investors.

Data for the VIX, US GDP, the market yield on US treasury securities at a five year constant maturity, and private debt all come from Federal Reserve Economic Data published by the Federal Reserve Bank of St. Louis. Data on US GDP is reported in billions of US dollars, is available at a quarterly frequency, and is seasonally adjusted. Data on the VIX and US treasury five year yield are available at daily frequencies and are reported as their end-of-day closing values. Private debt-to-GDP is defined as outstanding international private debt securities as a share of GDP. This includes long-term bonds, notes, and money-market instruments placed in international markets.

Data for official reserve assets and other foreign currency assets (foreign reserves), domestic GDP, and the exchange rate all come from the International Monetary Fund's (IMF) International Financial Statistics (IFS) dataset. Foreign reserves are defined as external assets available to a monetary authority for balance of payments financing needs and for exchange market intervention, as well as liquid foreign currency assets that are not included in reserve assets. This definition also includes central government foreign currency assets excluding social security funds. Domestic GDP is available at a quarterly frequency and is seasonally adjusted. This is true for all countries except Malaysia, where quarterly GDP data were obtained from the Central Bank of Malaysia and seasonally adjusted. Exchange rate data is reported in units of national currency per unit US dollar, and is reported as the per-period average at a quarterly frequency.

Data for Government effectiveness, political stability, and the domestic credit-to-GDP ratio all come from the World Bank World Development Indicators (WDI) dataset. Government effectiveness measures the perception of the quality of public services, the quality of the civil service, and the quality of policy formulation and its implementation. Countries are fitted to a standard normal distribution, and the score for each country corresponds to its deviation from the mean in units of a standard normal distribution, from -2.5 to 2.5. Political stability measures the perception of the likelihood of political instability and political violence, including terrorism. Country scores are also reported in units of the standard normal distribution, from -2.5 to 2.5. The domestic credit-to-GDP ratio measures financial resources provided to the private sector by financial corporations, including loans, trade credit, and purchase of non-equity securities, as a fraction of GDP. Data for all three variables is available only at an annual frequency.

Agriculture valued added and industry valued added both come from the World Bank WDI dataset. Both series are available at an annual frequency, and are measured in 2015 US dollars. The sum of agricultural value added and industry value added is used to measure tradable output for our estimation of the tradable endowment process in the model.

To aggregate higher frequency series to the regression frequency, I take within-period averages so every variable is reported at a common frequency. For quarterly regressions, I use the within-quarter average of daily data; for annual regressions, I use the within-year average of quarterly data.

Data is detrended using the Quast and Wolters (2022) modification of the Hamilton filter. Cyclical components of variables are constructed by first taking 4-12 quarter ahead forecasts using an AR(4) and lags of the variable of interest. So the first forecast will be

$$y_t = \hat{\beta}_{0,4} + \hat{\beta}_{1,4} y_{t-1} + \hat{\beta}_{2,4} y_{t-2} + \hat{\beta}_{3,4} y_{t-3} + \hat{\beta}_{4,4} y_{t-4} + \hat{v}_{t,4},$$

and the last forecast will be

$$y_t = \hat{\beta}_{0,12} + \hat{\beta}_{1,12} y_{t-12} + \hat{\beta}_{2,12} y_{t-13} + \hat{\beta}_{3,12} y_{t-14} + \hat{\beta}_{4,12} y_{t-15} + \hat{v}_{t,12}.$$

The cyclical components of the variables are then set equal to a weighted average of the forecast errors by

$$\tilde{y}_t = \frac{1}{9} \sum_{i=4}^{12} \hat{v}_{t,i}.$$

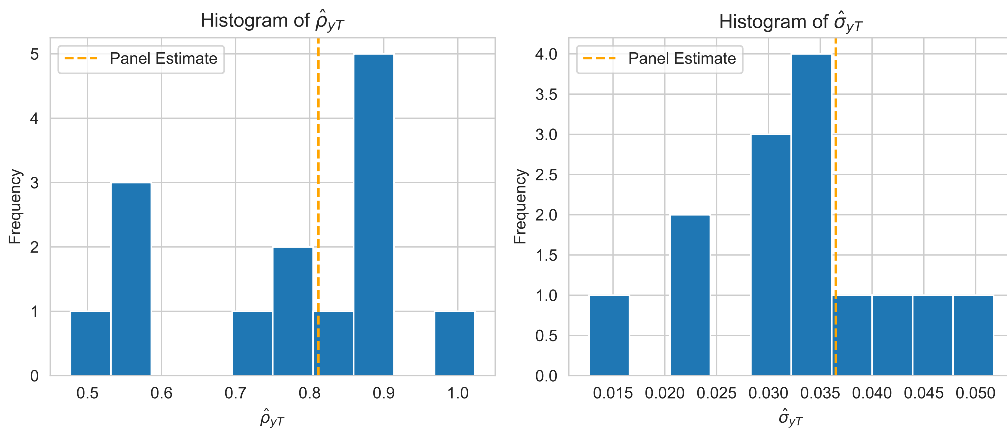
For annual data the filter instead uses 1-3 year ahead forecast errors and uses an AR(1) specification.

The authors show that the Quast and Wolters (2022) modification provides more even coverage of business cycles between 6-32 quarters by smoothing out high-frequency variation in the trend estimation. Additionally, the filter avoids the problem of eliminating business cycles less than two years in length.

B.2 Estimation of Exogenous Process

In the model, the log tradable endowment is assumed to follow an AR(1) process. This process is estimated using the cyclical component of annual tradable output from 2005 to 2022. We use OLS to estimate a dynamic panel of 15 countries with country fixed effects. Since these estimates may be subject to bias as identified in Nickell (1981), we compare the estimates using the dynamic panel to a histogram of estimates from each individual country. The dynamic panel estimates lie close to the average for both histograms, allaying bias concerns. The plotted results for the Nickell bias test are shown in figure B1.

Figure B1: Histogram of Country-Specific Estimates



Note: This graph shows a histogram of country-specific estimated coefficients from the AR(1). The orange dashed line represents the estimate from a dynamic panel of 15 emerging market countries. All estimates are obtained using OLS.

C Additional Derivations

C.1 Nominal Exchange Rate

The expression for the nominal exchange rate e_t can be derived from the household's cost minimization problem

$$P_t \equiv \min_{c_{T,t},\, c_{N,t}} p_{T,t}\, c_{T,t} + p_{N,t}\, c_{N,t} \quad \text{s.t.} \quad c_{T,t}^{\alpha} c_{N,t}^{1-\alpha} = 1,$$

where the household minimizes the cost of consuming a single unit of the composite consumption good. Combining the first order conditions from this problem yields an expression which determines the relative consumption of tradable goods to non-tradables goods

$$\frac{c_{N,t}}{c_{T,t}} = \left(\frac{1-\alpha}{\alpha}\right) \frac{p_{T,t}}{p_{N,t}}. \tag{23}$$

This expression reflects the flexible nature of prices in the model. A larger tradable endowment shock increases the supply of tradable goods, driving down the relative price of tradable goods to non-tradable goods and increasing the relative consumption of tradable goods to non-tradable goods. Plugging this condition into the composite consumption good allows us to pin down consumption of tradable goods and non-tradable goods as functions of the relative prices only

$$c_{T,t} = \left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha}\left(\frac{p_{N,t}}{p_{T,t}}\right)^{1-\alpha}, \tag{24}$$

$$c_{N,t} = \left(\frac{1-\alpha}{\alpha}\right)^{\alpha}\left(\frac{p_{T,t}}{p_{N,t}}\right)^{\alpha}. \tag{25}$$

Take these two expressions and plug into the aggregate price level equation to yield an expression for the aggregate price level in terms of the price of tradable goods and price of non-tradable goods only

$$P_t = p_T^{\alpha} p_N^{1-\alpha}\left[\left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha} + \left(\frac{1-\alpha}{\alpha}\right)^{\alpha}\right]. \tag{26}$$

Now that we have an expression for the aggregate price level P_t, we want to exploit the fact that the price of tradable goods is equal to the exchange rate $p_{T,t} = e_t$, and derive an expression for the exchange only in terms of the aggregate price level and relative consumption of tradable goods to non-tradable goods. To achieve this, plug in expression (23) into (25) on the price of non-tradable goods $p_{N,t}$ and substitute $c_{N,t} = y_N$ to reflect the fact that the non-tradable good is constant and market-clearing in the non-tradable goods market. Rearrange to yield

$$e_t = \alpha P_t \left(\frac{y_N}{c_{T,t}}\right)^{1-\alpha}, \tag{27}$$

which is exactly the expression used in the paper. The interpretation of this expression is consistent with empirical evidence. An increase in the aggregate price level depreciates the nominal exchange rate. An fall in tradable consumption corresponds to a rise in the price o tradable goods, which will also correspond to a nominal exchange rate depreciation.

C.2 Foreign Investor Pricing Equations

Below the pricing equations for the foreign investor will micro-founded using a model economy in which the foreign investor chooses an optimal portfolio to maximize it's consumption of the international traded good.

$$\max_{c^f_{T,t}, b^*_t, b_t} \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^{f,t} U(c^f_{T,t}) \quad \text{s.t.} \quad p^f_{T,t} c^f_{T,t} + \frac{q_t b_{t+1}}{e_t} + q^*_t b^*_{t+1} = (1-\delta q_t)\frac{b_t}{e_t} + (1-\delta q^*_t) b^*_t$$

Taking the first order conditions yields

$$[c^f_{T,t}] : \beta^{f,t} u'(c^f_{T,t}) = \lambda_t p^f_{T,t},$$

$$[b^*_t] : \lambda_t q^*_t = \mathrm{E}_t[\lambda_{t+1}(1-\delta q^*_{t+1})],$$

$$[b_t] : \lambda_t \frac{q_t}{e_t} = \mathrm{E}_t\left[\lambda_{t+1}(1-\delta q^*_{t+1})\frac{1}{e_{t+1}}\right].$$

Now combine the first order conditions to derive the pricing equations for foreign currency debt and local currency debt.

$$q_t^* = \mathrm{E}_t \left[\beta \frac{u'(c^f_{T,t+1})}{u'(c^f_{T,t})} \frac{p^f_t}{p^f_{t+1}} (1 - \delta q^*_{t+1}) \right], \tag{28}$$

$$q_t = \mathrm{E}_t \left[\beta \frac{u'(c^f_{T,t+1})}{u'(c^f_{T,t})} \frac{p^f_t}{p^f_{t+1}} \frac{e_t}{e_{t+1}} (1 - \delta q^*_{t+1}) \right]. \tag{29}$$

Let the foreign investor have CARA utility such that $u(c^f_{T,t}) = e^{-\gamma c^f_{T,t}}$, and assume that the change in international tradable consumption moves one-to-one with the tradable endowment shock ϵ_t. The micro-founded foreign investor stochastic discount factor will then move one-to-one with the reduced form log-normal stochastic discount factor $m_{t,t+1}$ in response to the tradable endowment shock. Without loss of generality, replace the micro-founded stochastic discount actor with the reduced form log-normal stochastic discount factor and normalize the price of the international traded good to 1 to yield

$$q_t^* = \mathrm{E}_t \left[m_{t,t+1} (1 - \delta q^*_{t+1}) \right],$$

$$q_t = \mathrm{E}_t \left[m_{t,t+1} \frac{e_t}{e_{t+1}} (1 - \delta q^*_{t+1}) \right],$$

where the first expression corresponds to the price of foreign currency debt in the model and the second expression corresponds to the price of local currency debt in the model.

Next we will derive the risk-free form of the foreign currency debt pricing equation. Use the fact that in the absence of default foreign currency debt is risk free, so that $q_t = q_{t+1}\ \forall t$. Because q_t is constant across time, then $\mathrm{cov}(m_{t,t+1}, q_{t+1}) = 0$. Additionally, recall that $\mathrm{E}_t[m_{t,t+1}] = e^{-r} \approx \frac{1}{R}$. Using this information we can derive

$$q_t = \frac{1}{R}(1 + \delta q_t).$$

Finally rearrange this expression to yield

$$q_t = \frac{1}{R - \delta}.$$

D Stationary Problem and Solution Method

D.1 Stationary Problem

Below it will be helpful to know the following transformations

$$\hat{b} = \frac{b}{P_{-1}}, \tag{30}$$

$$q e^{-1} = \mathrm{E} \left[m' r \left(P', \frac{c'_T}{y_N} \right) (1 + \delta q') \right], \tag{31}$$

$$r \left(\pi, \frac{c_T}{y_N} \right) = \frac{P_{-1}}{e} = \frac{1}{\alpha} \frac{1}{\pi} \left(\frac{c_T}{y_N} \right)^{1-\alpha}, \tag{32}$$

$$r\left(1, \frac{c_T}{y_N}\right) = \frac{P}{e} = \frac{1}{\alpha}\left(\frac{c_T}{y_N}\right)^{1-\alpha}. \tag{33}$$

To derive the stationary problem, first start with the timeless form of the non-stationary resource constraint (15). Re-express the constraint using

$$c_T = y_T - b^* - \frac{b}{e}\frac{P_{-1}}{P_{-1}} + q^*(b^{*'} - \delta b^*) + \frac{q}{e}(b'\frac{P}{P} - \delta b\frac{P_{-1}}{P_{-1}}\frac{P}{P}). \tag{34}$$

Some simple re-arranging and plugging in expression (30) for $\frac{q}{e}$ yields

$$c_T = y_T - b^* - r\left(\pi, \frac{c_T}{y_N}\right)\hat{b} + q^*(b^{*'} - \delta b^*) + \mathrm{E}\left[m'r\left(P', \frac{c_T'}{y_N}\right)(1+\delta q')\right](\hat{b}' - \delta\frac{\hat{b}}{\pi})P. \tag{35}$$

Finally, multiply the expression for $\frac{q}{e}$ by the aggregate price level P on the outside of the parentheses in the last term in the expression to yield the stationary resource constraint

$$c_T = y_T - b^* - r\left(\pi, \frac{c_T}{y_N}\right)\hat{b} + q^*(b^{*'} - \delta b^*) + \mathrm{E}\left[m'r\left(\pi', \frac{c_T'}{y_N}\right)(1+\delta q')\right](\hat{b}' - \delta\frac{\hat{b}}{\pi}). \tag{36}$$

Define the detrended state as $\hat{s} = \{y_T, b^*, \hat{b}\}$. The stationary formulation of the Planner's problem is

$$V(\hat{s}) = \max_{b^{*\prime}, b', \pi, c_T} \frac{c^{1-\sigma}}{1-\sigma} - \frac{\psi}{2}(\pi - \pi^*)^2 + \beta\,\mathrm{E}\left[V(\hat{s}')\right],$$

subject to

$$c_T = y_T - b^* - r\left(\pi, \frac{c_T}{y_N}\right)\hat{b} + q^*(b^{*'} - \delta b^*) + \mathrm{E}\left[m'r\left(\pi', \frac{c_T'}{y_N}\right)(1+\delta q')\right](\hat{b}' - \delta\frac{\hat{b}}{\pi}).$$

Let $\chi(\hat{s})$ represent the expression in the expectation operator for the detrended price of local currency debt in units of foreign currency, so that

$$\chi(\hat{s}) = m\,r\left(\pi, \frac{c_T}{y_N}\right)(1 + \delta q(\hat{s})). \tag{37}$$

In the model equilibrium for the stationary planner's problem this object will solve the fixed point problem where the price of local currency debt is determined by the following equation.

$$q(\hat{s}) = r\left(1, \frac{c_T}{y_N}\right)\mathrm{E}\left[\chi(\hat{s}')\right]. \tag{38}$$

D.2 Solution Method

The model equilibrium is solved using deep neural networks to approximate the value function and policy functions, adopting methods pioneered in Fernández-Villaverde et al. (2020) and Azinovic et al. (2022). Equilibrium is enforced by a loss function constructed using residual error terms from the first order conditions, Bellman equation, bond pricing equations, and feasibility penalties. Solving the model yields policy functions $\{b^{*'}(\hat{s}), \hat{b}'(\hat{s}), \pi(\hat{s})\}$ that solve the planner's problem. The solution algorithm proceeds as follows

1. Define a domain over the stationary state $\{y_T, b^*, \hat{b}\}$. Set the batch size to 128, so that each epoch 128 points are randomly sampled from the domain of each state variable. These points will be used to train the neural networks.

2. Define a Gauss-Hermite quadrature grid of 19 nodes to build expectations.

3. Specify six feed-forward neural networks $\{\mathcal{N}_\pi, \mathcal{N}_{b^*}, \mathcal{N}_{\hat{b}}, \mathcal{N}_V, \mathcal{N}_{\tilde{q}}, \mathcal{N}_q\}$ to approximate the following model objects $\{\pi, b^*, \hat{b}, V, \tilde{q}, q\}$. Each network contains 3 hidden layers and 50 neurons per layer. Hidden layers use a LeakyReLU activation function, and weights are initialized using Kaiming initialization. Activation functions for the output layer vary per network based on the approximated object. Neural networks $\{\mathcal{N}_{b^*}, \mathcal{N}_{\hat{b}}, \mathcal{N}_V\}$ use the Identity activation function with range $(-\infty, \infty)$ on the output layer. Neural networks $\{\mathcal{N}_\pi, \mathcal{N}_{\tilde{q}}\}$ use the Sigmoid activation function on the output layer. Neural network $\{\mathcal{N}_q\}$ uses the Softplus activation function on the output layer.

4. Solve for consumption c_T using the resource constraint.

5. Solve the fixed point problem for bond prices $\{\tilde{q}, q\}$. Construct $\tilde{q} = \mathrm{E}[m' e(\pi', c_T/y_N)(1+\delta\mathcal{N}_q)]$ from next period states $\hat{s}$ using Gauss-Hermite quadrature nodes. Compute q using equation (37), and form the error term $err_q = q - \mathcal{N}_q$. Use the constructed $\tilde{q}$ and its neural network to construct the error term $err_{\tilde{q}} = \tilde{q} - \mathcal{N}_{\tilde{q}}$.

6. Build additional error terms using the residual from the Bellman equation err_V, the FOCs for consumption and inflation $err_{c,\pi}$, the foreign currency bond Euler equation err_{b^*}, and the local currency bond Euler equation $err_{\hat{b}}$.

7. Construct a quadratic loss term $\mathcal{L}$ using the sum of the squared error terms, so that

$$\mathcal{L} = \theta_{Val}(err_V)^2 + \theta_{REE}(err_{c,\pi})^2 + \theta_{REE}(err_{b^*})^2 + \theta_{REE}(err_{\hat{b}})^2 + \theta_{REE}(err_q)^2 + \theta_{REE}(err_{\tilde{q}})^2.$$

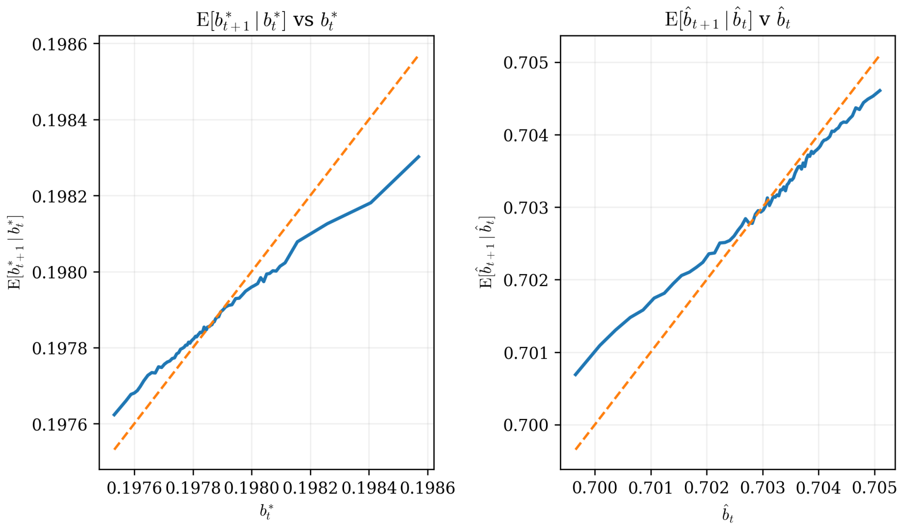
8. Minimize the quadratic loss using backpropagation with AdamW optimizer over 70k epochs until $\mathcal{L} < 10^{-5}$, in accordance with recommendations made in Fernández-Villaverde (2025).

D.3 Stationarity of Solution

For $b = \{b^*, \hat{b}\}$, the stationarity of the solution is confirmed by plotting the conditional mean of next period's choice of debt $E[b'|b]$ against today's inherited value of debt b. The conditional mean is plotted against a 45° line to ensure the choice of debt is mean-reverting and does not explode.

Data for the plots is generated using simulations of 50,000 periods of the tradable endowment. Conditional means are computed using 80 bins over the domain of b with at least 100 observations per bin. Bins are built using NumPy's quantile binning function. Results are shown in Table C1.

Figure C1: Conditional Means of Issued Debt



Note: Each curve shows a binned conditional–mean relation. The model is simulated for 55,000 periods with a burn-in of 5,000. We partition inherited debt $\{b^*, \hat{b}\}$ into 80 equal-mass (quantile) bins and, for each retained bin compute the average value of $\{b^*, \hat{b}\}$ and the conditional mean of the vertical variable. Bins with fewer than 100 observations are dropped. Dashed line = 45° line. Crossing the line indicates mean reversion.