Sovereign Debt Portfolios, Bond Risks, and the Credibility of Monetary Policy

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Abstract

Local currency (LC) debt provides consumption-smoothing benefits if it gets inflated away during recessions. However, we document that countries with more procyclical inflation and countercyclical LC bond returns, where consumption-smoothing benefits are lowest, issue the most LC debt. Monetary policy credibility explains this pattern through its effect on bond risk premia. In our model, low-credibility governments are more likely to inflate during recessions, generating excessively countercyclical inflation beyond the standard inflationary bias. In the model, and the data, low-credibility governments pay higher risk premia on LC debt, leading them to borrow in foreign currency.

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1 Introduction

Over the past decade, the market for emerging market government debt has undergone a remarkable transformation. In the 1980s and 1990s, most emerging market sovereigns and several developed country governments relied heavily on foreign currency (FC) in their foreign borrowing. This left borrowers vulnerable to currency fluctuations and financial crises (Eichengreen and Hausmann, 2005). Since the Asian Financial Crisis, local currency (LC) government bond issuance has grown rapidly. It now constitutes an important asset class for international investors and more than half of external debt issued by major emerging market sovereigns (Du and Schreger, 2016b). However, the shift toward LC government bonds has been highly uneven across markets.

This paper takes an asset-pricing perspective to understand cross-country differences in sovereign debt portfolio choice. The standard approach to optimal government finance implies that governments should smooth the costs of taxation across states of the world (Barro, 1979). If the costs of taxation rise during recessions, due to high marginal consumption utility or distortionary taxes, governments should issue debt that requires lower repayments in recessions than in expansions. Applying this argument to nominal LC debt, a key benefit of LC debt is that it can provide debt relief at just the right time, provided that inflation reduces the real debt burden in recessions (Bohn, 1990a,b; Barro, 1997; Lustig et al., 2008). However, we find empirically that countries where nominal LC debt provides little or no flexibility during adverse states of the world issue the most nominal debt.

Our primary proxy for the hedging properties of LC debt is the regression beta of LC bond returns with respect to stock market returns. A positive bond-stock beta indicates that LC bonds' expected real cash flows decline in stock market downturns and hence provide fiscal flexibility to the issuer. Figure 1 summarizes the key stylized fact that countries with the lowest LC bond betas have the highest LC debt shares. Even more puzzlingly, a substantial fraction of the most prolific LC debt issuers, including both developed and emerging markets, have negative bond-stock betas, so LC debt provides no hedging benefits or is even risky from these issuers' perspective.[2] This is the opposite of what we would expect if governments

[2]We show average LC debt shares in central government debt and the estimated slope coefficient of LC

issue LC debt to take advantage of its fiscal hedging properties.

We show that positive bond-stock betas coincide with countercyclical inflation, or negative inflation-output betas. This finding is important, because it indicates that inflation expectations are a key driver of the hedging properties of LC bonds, which depreciate when inflation expectations increase. We also show that local equity excess returns have betas with respect to U.S. equity excess returns that are statistically indistinguishable from 1, making it plausible that global investors require a risk premium for holding bonds that depreciate during periods of high local marginal utility.

The key finding that countries with more countercyclical LC bond returns rely more on nominal LC debt is robust to controlling for the exchange rate regime, GDP, and the commodity share of exports. Results look similar for the LC debt share in all central government debt, which is most closely related to a central government's active issuance decisions, or the LC debt share held by foreigners, which plausibly generates an especially strong ex post incentive to inflate. It is also robust to using the cyclicality of realized or expected inflation with respect to output and to using bond betas that control for default risk, control for real exchange rate cyclicality, or exclude the financial crisis.

What explains this apparently puzzling relation? We demonstrate that it is the equilibrium outcome when monetary policy credibility drives the cyclicality of inflation and risk-averse investors require a risk premium to hold LC bonds in countries with positive inflation cyclicality. In the model, the government communicates a contingent plan for future inflation, but with a given probability it may revert to a myopic policy (Kydland and Prescott, 1977; Barro and Gordon, 1983; Rogoff, 1985). When commitment fails, the government uses inflation to reduce the real burden of LC debt. The incentive to inflate is more pronounced during low-output states, when marginal utility is highest. Crucially, debt is priced by risk-averse lenders, whose stochastic discount factor (SDF) is correlated with domestic output.

The key insight of the model is that when governments with imperfect credibility borrow in nominal terms from risk-averse lenders, they not only have a classic inflationary bias but also lack the ability to commit to a degree of state contingency on the debt. With risk-averse lenders, a government's temptation to generate excessively countercyclical inflation

government bond returns against local stock market returns for the period 2005—2014 for a sample of 30 emerging and developed countries. For details, see Section 2.

leads lenders to charge an inflation risk premium. This lowers average borrower consumption. But a government with full commitment can lower the risk premium it pays on LC debt. It achieves this by committing to an inflation process that keeps LC bond payouts relatively stable during recessions, when investors' marginal utility is high, thereby increasing the insurance value of its LC debt to international investors. In contrast, a government lacking commitment cannot credibly promise to restrict itself to such a limited amount of state contingency and therefore pays a higher-than-optimal risk premium. In equilibrium, governments that obtain little or no consumption smoothing from issuing nominal debt (those with more procyclical inflation) issue the most nominal debt, and those that could obtain the most consumption smoothing from issuing nominal debt (those with more countercyclical inflation) issue the least.

Significantly, in our model limited commitment alone (without risk premia) cannot resolve the positive relationship between LC debt shares and inflation cyclicality. The intuition is that, without risk premia, high-credibility issuers optimally commit to using inflation only in bad states of the world, thereby smoothing tax distortions over states of the world and generating countercyclical inflation. As a result, the relation between LC debt shares and inflation cyclicality is flat or downward-sloping, in contrast to the data. In our model, it is only the interaction of imperfect commitment and risk-averse lenders that can explain the empirical patterns.

Finally, we present empirical evidence on the connection between LC bond risk premia and bond return cyclicality, monetary policy credibility, and LC debt issuance. First, we show that higher LC bond-stock betas are associated with significantly higher LC bond risk premia, supporting the model mechanism, whereby investors require a premium for holding LC bonds that tend to depreciate during downturns. Second, we provide direct evidence for the model mechanism by relating LC bond-stock betas and LC bond risk premia to two de facto measures of monetary policy credibility, based on official central bank inflation targets and newspaper text analysis. Third, we show empirical evidence that LC debt shares are strongly negatively correlated with LC bond risk premia. Decomposing LC bond risk premia into a world capital asset pricing model (CAPM) component and a residual or alpha, we find that the world CAPM component accounts for the majority of the downward-sloping relation between LC debt shares and risk premia. Finally, we show that changes in inflation forecast cyclicality, proxying for bond risks during periods when many issuers did not have

LC bond price data, from the 1990s to the 2000s, have a positive relation with changes in LC debt issuance, providing time series evidence that the bond risks channel of monetary policy credibility can also help us understand the substantial changes in LC debt issuance since the 1990s.

We contribute to the international asset pricing literature along two dimensions. First, we argue that risk premia matter for sovereign debt portfolio choice. Second, we provide a channel for why LC debt of low-credibility countries co-moves with international investors' stochastic discount factor and hence requires a risk premium. Similarly to Hassan (2016) and Hassan et al. (2016), we argue that international government bond yields reflect the insurance value for investors, even though the source of comovement that we focus on – monetary policy credibility – is different from the sources they emphasize. In our model, comovement with international fundamentals is priced, consistent with empirical evidence in Harvey (1991); Karolyi and Stulz (2003); Lewis (2011); Borri and Verdelhan (2011); Lustig et al. (2011); David et al. (2016); Della Corte et al. (2016) among others.

The notion that limited inflation commitment constrains nominal debt issuance has a long-standing tradition in economics, going back at least to Kydland and Prescott (1977) and Lucas and Stokey (1983). The continued relevance of this question is emphasized by Bolton (2016) and references therein, which analyzes sovereign debt finance within a corporate finance framework. By contrast, we study the asset pricing implications of limited monetary policy commitment, thereby contributing to the literature on optimal debt management with nominal and inflation-indexed debt (Bohn (1988); Calvo and Guidotti (1993); Barro (1997); Alfaro and Kanczuk (2010); Díaz-Giménez et al. (2008)), and to the contemporaneous and complementary work by Ottonello and Perez (2016) and Engel and Park (2016).[3] We contribute both empirically (by documenting the relation between inflation cyclicality and LC debt shares in a cross-section of countries) and theoretically (by proposing that investor risk aversion interacting with limited monetary policy credibility can explain this new stylized fact). Broner et al. (2013) consider a sovereign's optimal debt maturity choice for FC debt in the presence of risk-averse investors, but they take the correlation between bond returns and investors' stochastic discount factor to be exogenous. We add to that by

[3]Engel and Park (2016) study the currency composition of debt with optimal contracts and endogenous default when investors are risk-neutral. Ottonello and Perez (2016) present a quantitative model that generates predictions for the business cycle properties of LC debt issuance.

explaining bond return cyclicality and risks as an endogenous outcome of monetary policy credibility and matching cross-country evidence of bond return cyclicality. This paper is also related to a recent literature on inflation commitment and debt limits when the debt denomination is exogenous (Jeanne, 2005; Araujo et al., 2013; Aguiar et al., 2014; Chernov et al., 2015; Sunder-Plassmann, 2014; Bacchetta et al., 2015; Du and Schreger, 2016b; Corsetti and Dedola, 2015) and to the large literature on government debt and inflation (Sargent and Wallace, 1981; Leeper, 1991; Sims, 1994; Woodford, 1995; Cochrane, 2001; Davig et al., 2011; Niemann et al., 2013), but it differs in that it considers the optimal portfolio choice between LC and FC debt issuance.

Finally, we contribute to a recent literature on time-varying bond risks (Baele et al. (2010); David and Veronesi (2013); Campbell et al. (2014); Ermolov (2015); Campbell et al. (2015)) that is primarily focused on the U.S. and the UK.[4] In contrast to Campbell et al. (2015) and Guorio and Ngo (2016), we abstract from supply shocks as drivers of inflation and bond return cyclicality for two reasons. First, different from those papers, our main empirical fact is not just about understanding inflation cyclicality but about its relation with LC debt issuance in a cross-section of countries. Exogenously countercyclical inflation due to supply shocks should lead countries with the most countercyclical inflation to issue the most LC debt (Bohn (1988, 1990b)), whereas we see the opposite in the data. Second, we show that our empirical results are robust to controlling for the commodity share in exports as a proxy for countries' exposure to supply shocks.

The structure of the paper is as follows: In Section 2, we present new stylized facts on the relation between the cyclicality of LC bond risk and shares of LC debt in sovereign portfolios. In Sections 3 and 4, we lay out the model, provide analytical intuition for the key mechanisms, and calibrate the model to demonstrate that it can replicate the observed patterns of the currency composition of sovereign debt and inflation cyclicality. Section 5 tests additional model implications for LC debt issuance and risk premia. Section 6 concludes.

[4] Vegh and Vuletin (2012) also emphasize the evolution and cross-country heterogeneity in the cyclicality of monetary policy but do not study implications for sovereign debt portfolios. Poterba and Rotemberg (1990) examine the correlation between taxes and inflation under both commitment and no commitment in five major developed countries but do not consider the interaction with the currency composition of government debt.

2 Empirical Evidence

In this section, we demonstrate the robust empirical evidence that countries with more countercyclical inflation have lower LC debt shares. Our evidence is based on as large a cross-section of countries as permitted by the availability of LC debt data, including 11 developed markets (Australia, Canada, Denmark, Germany, Japan, New Zealand, Norway, Sweden, Switzerland, the United States, and the United Kingdom) and 19 emerging markets (Brazil, Chile, China, Colombia, the Czech Republic, Hungary, Indonesia, Israel, Malaysia, Mexico, Peru, Philippines, Poland, Russia, Singapore, South Africa, South Korea, Thailand, and Turkey).[5]

2.1 Nominal Bond Risks: Bond-Stock Beta

Asset markets incorporate investors' forward-looking information at much higher frequency than surveys and can therefore provide valuable proxies for inflation cyclicality that are potentially less subject to measurement error and more robust given the relatively short time series. LC bond-stock betas serve as an asset-market-based proxy of inflation cyclicality. We expect bond-stock betas to be inversely related to the cyclicality of inflation expectations.

We denote the log yield on a nominal LC n-year bond as y_{nt}^{LC}, where $y_{nt} = \log(1 + Y_{nt}^{LC})$. The log holding period return on the bond is given by

$$r_{n,t+\Delta t}^{LC} \approx \tau_n y_{nt}^{LC} - (\tau_n - \Delta t) y_{n-1,t+\Delta t}^{LC},$$

where $\tau_n = \frac{1-(1+Y_{nt}^{LC})^{-n}}{1-(1+Y_{nt}^{LC})^{-1}}$ is the duration of a bond selling at par (Campbell et al. (1997)).

[5] For LC bond yields, we use primarily Bloomberg fair value (BFV) curves. We focus on the five year tenor, which has the most consistent data availability across a wide range of countries. BFV curves are estimated using individual LC sovereign bond prices traded in secondary markets. Since sufficient numbers of bonds spanning different maturities are needed for yield curve estimation, the availability of the BFV curve is a good indicator for the overall development of the LC nominal bond market. Countries such as Argentina, Uruguay, and Venezuela have only a handful of fixed-rate bonds and hence do not have a BFV curve. Because for most emerging markets in our sample BFV curves are available starting in the mid-2000s, we focus on the period 2005—2014 to maintain a balanced panel. To measure inflation risk and the perceived cyclicality of inflation, we use realized inflation from Haver and inflation forecasts from Consensus Economics, respectively. Finally, we measure the share of LC debt in total sovereign debt portfolios with data from BIS Debt Securities Statistics, OECD Central Government Debt Statistics, and several individual central banks. All results winsorize the highest and lowest observation to ensure that results are not driven by outliers.

We approximate $y^{LC}_{n-\Delta t,t+\Delta t}$ by $y^{LC}_{n,t+\Delta t}$ for the quarterly holding period. We let y^{LC}_{1t} denote the three-month T-bill yield and then the excess return on LC bonds over the short rate is given by

$$xr^{LC} = r^{LC}_{n,t+\Delta t} - y^{LC}_{1t}.$$

From a dollar investor's perspective, we can rewrite the excess return as

$$xr^{LC} = [r^{LC}_{n,t+\Delta t} - (y^{LC}_{1t} - y^{US}_{1t})] - y^{US}_{1t}.$$

The dollar investor can hedge away the currency risk of the holding period Δt by going long a U.S. T-bill and shorting an LC T-bill with the same market value as the LC bond. By doing so, any movement in the spot exchange rate of the LC has the same offsetting first-order impact on the bond position and the local T-bill position and hence cancels out. After hedging currency risk for the holding period, the dollar investor bears duration risk of the LC bond.

We define the local equity excess returns as the log return on local benchmark equity over the three-month LC T-bill:

$$xr^{m}_{t+\Delta t} = (p^{m}_{t+\Delta} - p^{m}_{t}) - y^{LC}_{1t},$$

where p^m_t denotes the log benchmark equity return index at time t. Country subscripts are suppressed to keep the notation concise. We then compute the local bond-stock beta $b(bond, stock)$ by regressing LC bond excess returns $xr^{LC}_{t+\Delta t}$ on local equity excess returns $xr^{m}_{t+\Delta t}$:

$$xr^{LC}_{t+\Delta t} = b_0 + b(bond, stock) \times xr^{m}_{t+\Delta t} + \epsilon_t. \quad (1)$$

Bond-stock betas measure the risk exposure of LC bond returns on local equity returns.

2.2 Cyclicality of Inflation Expectations: Inflation-Output Forecast Beta

We construct a new measure for the procyclicality of inflation expectations by regressing the change in the consumer price index (CPI) inflation rate predicted by forecasters on the change in their predicted real GDP growth rate. Each month, professional forecasters surveyed by Consensus Economics forecast inflation and GDP growth for the current and next calendar year. We pool all revisions for 2006 through 2013 (so that the forecasts were all made post-2005) and run the country-by-country regression:

$$\Delta\tilde{\pi}_t = b_0 + b(\tilde{\pi},\widetilde{gdp_t}) \times \Delta\widetilde{gdp_t} + \epsilon_t, \tag{2}$$

where t indicates the date of the forecast revision. The revisions to inflation forecasts ($\Delta\tilde{\pi}_t$) and GDP growth forecasts ($\Delta\widetilde{gdp_t}$) are percentage changes of mean forecasts made three months before and proxy for shocks to investors' inflation and output expectations. The coefficient $b(\tilde{\pi},\widetilde{gdp_t})$ measures the cyclicality of inflation expectations and is the coefficient of interest.

Because forecasts are made for calendar years, the forecast horizon can potentially vary. Consensus Economics has forecasts for the annual inflation rate up to two years in advance. This means that in January 2008, the forecast of calendar year 2008 inflation is effectively 11 months ahead and the forecast of calendar year 2009 is 23 months ahead. We focus on revisions to the two-year forecast (13—23 months ahead) to minimize variation in the forecast horizon.

2.3 Cyclicality of Realized Inflation: Realized Inflation-Output Beta

While investors' beliefs about inflation cyclicality enter into government debt prices and hence sovereign debt portfolio choice, it is useful to verify that the composition of debt portfolios also lines up with the cyclicality of realized inflation and output. We compute the realized inflation-output beta by regressing the change in the inflation rate on the change in the industrial production growth rate:

$$\Delta\pi_t = b_0 + b(\pi, IP)\Delta IP_t + \epsilon_t, \tag{3}$$

where $\Delta\pi_t$ is the 12-month change in the year-over-year inflation rate and ΔIP_t is the 12-month change in the year-over-year industrial production growth rate. The coefficient $b(\pi, IP)$ measures the realized inflation cyclicality with respect to output. We obtain the seasonally adjusted CPI and the industrial production index from Haver between 2005 and

2014.

2.4 Local Currency Debt Shares

For developed countries, we construct the share of LC debt based on the OECD Central Government Debt Statistics and supplement this data with hand-collected statistics from individual central banks.[6] Central banks typically directly report the instrument composition of debt securities outstanding issued by the central government.

For emerging markets, we measure the share of LC debt in sovereign debt portfolios using the BIS Debt Securities Statistics, supplemented with statistics from individual central banks. Table 16C of the BIS Debt Securities Statistics reports the instrument composition for outstanding domestic bonds and notes issued by the central government (D_t^{dom}) starting in 1995. Table 12E of the BIS Debt Securities Statistics reports total international debt securities outstanding issued by the general government (D_t^{int}). For emerging markets, as the vast majority of international sovereign debt is denominated in foreign currency, and local governments rarely tap international debt markets, D_t^{int} offers a good proxy for central government FC debt outstanding. Data for developed countries are from individual central banks or the OECD. The share of LC debt is computed as the ratio of the fixed-coupon domestic sovereign debt outstanding (D_t^{int}) over the sum of domestic and international government debt:

$$s_t = \frac{D_t^{dom,fix}}{D_t^{dom} + D_t^{int}}.$$

Inflation-linked debt, floating-coupon debt, and FC debt are all treated as real liabilities. In our baseline results, we do not distinguish between foreign-owned and domestically owned debt, but we provide evidence in Appendix B that empirical results are similar for foreign-owned debt.

2.5 Summary Statistics

Table 1 reports summary statistics for inflation, inflation expectations, LC bond yields, bond-stock betas, inflation-output forecast betas, realized inflation-output betas, local eq-

[6] The OECD Central Bank Debt Statistics database was discontinued in 2010. We collected the statistics between 2010 and 2014 from individual central banks.

uity—S&P betas, and LC debt shares. Emerging market realized inflation is 2.4 percentage points higher, and survey-based expected inflation is 2.0 percentage points higher than in developed markets. In addition, expected inflation and realized inflation are less procyclical in emerging markets than in developed countries.

For LC bonds, five-year LC yields are 3.4 percentage points higher in emerging markets than in developed markets. Nominal bond returns are countercyclical in developed markets, as is evident from negative bond-stock betas. By contrast, LC bond returns are procyclical in emerging markets. Finally, developed markets borrow almost entirely with LC debt, while the LC debt share in emerging market averages only 60%.

Importantly, column (7) shows that the beta of local stock returns with respect to U.S. S&P 500 stock returns, estimated as the slope coefficient of regressing local log excess equity returns onto U.S. log equity excess returns, is 1 on average for both developed and emerging economies in our sample. If local stock return variation proxies for variation in the local stochastic discount factor (SDF) and U.S. equity returns reflect variation in international investors' SDF, a local-U.S. stock beta close to 1 implies that assets that co-move with the local SDF also co-move with the international investor's SDF and hence are risky for international investors. This evidence is also consistent with the evidence in David et al. (2016), who argue that emerging market stock returns have large betas with respect to the world equity portfolio and consequently comovement with local stock markets carries a risk premium in international markets. In particular, this implies that if the domestic government inflates away its LC debt in states of high local marginal utility of consumption, LC debt tends to depreciate in real terms in bad states of the world for international investors, making it a risky investment.

2.6 Relation between Nominal Risk Betas and Sovereign Debt Portfolios

Figure 2 adds to the evidence in Figure 1, showing that patterns are similar if we measure bond return cyclicality with respect to U.S. instead of local stock returns and if we replace bond return cyclicality with inflation cyclicality. The inverse of LC bond betas should proxy for the cyclicality of inflation expectations, if higher inflation expectations depress LC bond prices and stock returns fall during recessions. Panels A and B of Figure 2 confirm this intuition. Emerging markets tend to have lower LC debt shares and more negative realized and expected inflation betas, as would be the case if they inflate during recessions. This finding is important, because it indicates that inflation and output dynamics are key to understanding the cross-country patterns of LC bond risks.

Panel C of Figure 2 shows LC bond betas with respect to U.S. S&P returns, which is constructed analogously using LC bond betas with respect to S&P excess returns. For instance, the Brazilian bond-stock beta is estimated as the slope coefficient of LC bond excess returns with respect to Brazilian stock excess returns as in (1), while the Brazilian bond-S&P beta is the estimated slope coefficient of LC bond excess returns with respect to U.S. S&P excess returns. Panel C shows a striking correlation between bond-stock betas and bond-S&P betas across countries. Given this result, it is unsurprising that the relation between LC debt shares and bond-S&P betas in panel D is downward sloping, similar to the results for bond-stock betas in Figure 1. Taken together, panels C and D indicate that LC bonds that provide the best hedge for the issuer are also riskiest for an international investor. This finding is important, because it gives us further indication that it is reasonable to think of international investors as risk-averse over LC bonds that lose value in real terms during bad states of the world for local consumers, consistent with our modeling assumption that domestic and international investors price bonds with correlated SDFs.

Table 2 shows cross-sectional regressions of LC debt shares on measures of inflation cyclicality. The first three columns show that all nominal risk betas are significantly correlated with LC debt shares. A 0.16 increase in the bond-stock beta, corresponding to the average difference between emerging and developed markets, is associated with an 18 percentage point reduction in the LC debt share. Column (4) shows that the relation is robust to controlling for mean log GDP per capita, the exchange rate regime, and the share of commodities in total exports.[7]

The relationship between the LC debt share and nominal risk betas is robust to using long-term debt, excluding the financial crisis, adjusting for default risk, and using only externally held government debt. The robust result for the LC debt share in long-term debt is important, because Missale and Blanchard (1994) argue that shorter debt maturity reduces

[7] We use the exchange rate regime developed by Reinhart and Rogoff (2004) and the "Commodity Share" is defined as the sum of "Ores and Metals" and "Fuel" exports as a percentage of total merchandise exports from World Bank World Development Indicators.

the incentive to inflate away debt. The recent increase in emerging market LC debt issuance has been accompanied by a surge in importance of this asset class among international investors. Consistent with this, our findings are also robust to using a proxy of the LC debt share held in foreigners' portfolios instead of the LC debt share in all government debt, thereby ruling out the possibility that high LC debt shares simply reflect high LC debt shares held domestically, which might lead to less inflationary incentives than LC debt held by foreigners. The finding that cross-sectional variation in LC debt shares is driven by LC debt held by foreigners is important, because it corresponds most closely to our modeling assumption that debt is held by foreign investors. It also further strengthens the puzzle, because a high LC debt share held by foreigners should be especially useful for smoothing domestic consumption with state-contingent inflation. Detailed results are available in Appendix A.

3 Model

This section describes the model and presents analytic solutions for optimal debt portfolio and inflation policies. The model has two periods, periods 1 and 2. The timing within periods is as follows. In period 1, the government chooses simultaneously the optimal share of LC government debt s_1 and the optimal commitment inflation policy. We require the commitment inflation policy to be a function of only the local period 2 output x_2, consistent with the notion that complex monetary policy rules may be hard to verify and enforce. The LC debt share and the commitment inflation policy are chosen to minimize a loss function that reflects expected inflation distortions and domestic agents' consumption utility, while taking into account that the government may deviate in period 2 from the ex-ante optimal inflation policy. At the end of period 1, international investors with rational expectations determine asset prices and buy the debt. At the beginning of period 2, agents learn the exogenous level of second period output and whether the government maintains or loses its commitment. If the commitment state holds, which occurs with probability p, the government implements the previously announced commitment inflation policy. Otherwise (with probability $1-p$), the government re-optimizes myopically while taking the LC debt share s_1 and bond prices as given, thereby generating an incentive to inflate away LC debt in bad states of the world. Finally, the real exchange rate shock is realized, the government repays all of the debt, consumption occurs and inflation costs are realized. The government and investors are assumed to have complete information at all times.

The government objective is standard, combining domestic agents' power utility over consumption and a quadratic inflation cost. We assume that investor marginal utility is correlated with domestic marginal utility, consistent with the empirical evidence of high local-U.S. stock betas in Table 1 and the close correspondence between bond-stock and bond-S&P betas in Figure 2, panel C, generating risk premia on nominal bonds.

We solve the model both using an approximate analytical solution method following Campbell and Viceira (2002) and using numerical global projection methods. For the analytic solution, we first characterize the commitment and no-commitment inflation policy functions conditional on the LC debt share s_1 and then solve for s_1 by taking the first-order condition of the government's expected loss. The analytic solution for the ex-ante optimal commitment inflation policy and LC debt share relies on a second-order expansion of the government loss function. We keep the analytic solution tractable by solving for the no-commitment inflation policy in period 2 using a first-order log-linear expansion of the relation between real debt values and inflation, similarly to the use of a first-order intertemporal budget constraint in the analytic portfolio choice solutions of Campbell and Viceira (2002) and Devereux and Sutherland (2011). Throughout the analytic solution, we keep only first- and second-order terms of $\bar{D}$ in the loss function to clarify the intuition of our results. This approximation is justified if the debt-to-GDP ratio is small and state-contingent debt does not eliminate consumption volatility completely, an empirically plausible assumption. Similar approximation methodologies have been found to be highly accurate in many standard portfolio choice applications, and we verify the numerical accuracy by comparing the analytic solution with a numerical global solution method in Appendix B.3.

3.1 Government Objective

We use lowercase letters to denote logs. The government's loss function combines quadratic loss in log inflation π_2 and power utility over consumption:

$$L_2 = \alpha\pi_2^2 - \frac{C_2^{1-\gamma}}{1-\gamma}. \tag{4}$$

We do not take a stand on the source of inflation costs. A quadratic inflation cost of the form (4) may arise from price-setting frictions leading to production misallocation, as in New Keynesian models (see Woodford (2003)). Period 2 output is log-normally distributed:

$$X_2 = \bar{X} \exp(x_2/\bar{X}),\ x_2 \sim N\left(0, \sigma_x^2\right). \tag{5}$$

Domestic consumption equals output minus real debt repayments to foreign bond holders D_2, generating an incentive for the government to reduce real debt repayments:

$$C_2 = X_2 - D_2. \tag{6}$$

One interpretation of (6) is that the government only cares about the consumption of non-bondholders, who could be either foreigners or domestic agents to whom the government attaches little weight for political economy reasons. We normalize steady-state period 2 consumption to 1, so α captures the cost of inflation distortions in units of period 2 consumption.[8] Formally, we require that $\bar{X} = 1 + \bar{D}$.

3.2 Investors

Financial markets are integrated in the sense that all assets are priced by the same international investor. However, markets are segmented from the point of view of the domestic borrower, who has access only to LC and FC debt borrowing and cannot go long bonds. Inflation in the investor's home currency is assumed to be zero for simplicity. International consumption and domestic consumption can differ if international agents prefer a different consumption bundle from domestic agents.

The international investor is risk-averse over world output x_2^*, which is log-normally distributed with standard deviation σ^*. We model the international investor's SDF in reduced form with risk-aversion coefficient θ, similarly to Arellano and Ramanarayanan (2012), with local output x_2 loading onto world output:

[8] Allowing period 2 steady-state consumption different from 1 would scale the loss function (6) by a constant, leaving the analysis unchanged.

$$
\begin{aligned}
m_2^* &= \log\beta - \theta x_2^* - \frac{1}{2}\theta^2\left(\sigma^*\right)^2, && (7)\\
x_2 &= \lambda x_2^* + \eta_2. && (8)
\end{aligned}
$$

Here, $\eta_2 \sim N(0, \sigma_\eta^2)$ is an idiosyncratic shock uncorrelated with world output. The SDF (7) captures risk-neutral investors as a special case when $\theta = 0$. If investor risk aversion θ is greater than zero and global and local output are positively correlated ($\lambda > 0$), the SDF (7) implies that investors' and the domestic consumer's marginal utility of consumption are positively correlated, or that bad states of the world for the domestic consumer also tend to be bad states of the world for the investor.

We interpret the SDF (7) and (8) broadly, potentially reflecting several channels. First, if international investors are risk-averse over international consumption and output, and international output is correlated with domestic output, this may give rise to a correlation between international and domestic marginal utility. We document a high correlation in output growth across countries, lending credence to this channel. In our sample, the average correlation between emerging market output growth and U.S. output growth is equal to 58%. Second, it is crucial for the government's trade-off that domestic and international stochastic discount factors are correlated, but it is not essential for our channel that stochastic discount factor correlations arise entirely from output correlations. It is plausible that output correlations are a lower bound for the degree of international comovement in SDFs (Brandt et al., 2006). We find that the average correlation between emerging market stock returns and U.S. stock returns is even higher, at 70%, as would be the case if SDFs co-vary more than output. Interpreting (7) more broadly, highly correlated consumption growth (Colacito and Croce, 2011; Lewis and Liu, 2015), correlated discount rate news (Borri and Verdelhan, 2011; Viceira et al., 2016), correlated risk premia (Longstaff et al., 2011), or increasing correlations during downturns (Ang and Bekaert, 2002) may further drive up the cross-country correlations between SDFs and hence the role of risk premia in the government's debt portfolio choice. A different way to motivate an SDF of the form (7) and to generate the main channel in our model would be if bond investors are domestic and hence risk-averse over domestic output, but the government has an incentive to expropriate bondholders, because ex post it is more efficient to use the inflation tax rather than taxes that distort incentives and lead to deadweight costs, such as income or sales taxes.[9]

The role of real exchange rate shocks in the model is to capture a principal cost of FC borrowing of Eichengreen and Hausmann (2005), namely that FC debt exposes issuers to sudden increases in the real cost of debt service. This cost incentivizes otherwise unconstrained borrowers, such as the U.S., to borrow in LC. We normalize the real exchange rate in period 1 to 1. The period 2 real exchange rate (in units of international goods per domestic goods) is given by

$$exp\left(\varepsilon_2 - \frac{1}{2}\sigma_\varepsilon^2\right), \, \varepsilon_2 \sim N\left(0, \sigma_\varepsilon^2\right), \tag{9}$$

where ε_2 is uncorrelated with all other shocks and realized after the government has chosen inflation, so monetary policy takes effect more slowly than exchange rate shocks. In modeling the real exchange rate, we face a tension arising from the well-known Backus-Smith puzzle. While under complete international financial markets the real exchange rate of a country is predicted to depreciate when consumption is high, empirically real exchange rates are close to uncorrelated with real economic fundamentals or even depreciate when consumption is low (Backus and Smith (1993)). We choose the reduced-form specification (9) to be consistent with the empirical evidence, so as to generate empirically relevant bond risk predictions. We keep the specification of exchange rates quite general, but one possible driver of exchange rates could be shocks to the risk-bearing capacity of financial intermediaries, as in Maggiori and Gabaix (2015). One important implication of (9) is that domestic inflation tends to devalue LC bonds for international agents and drives LC bond risks, consistent with the empirical evidence in panels A and B of Figure 2.[10]

We can now price three different bonds: (a) an FC bond, which pays one unit of real international consumption; (b) a nominal LC bond, which delivers $exp(-\pi_2)$ units of real domestic consumption; and (c) a real LC bond, which delivers one unit of real domestic

[9]Appendix B.6 develops such a model extension, shows that the analytic solutions are of the same form as in our benchmark model, and illustrates that our channel remains quantitatively important.

[10]Given that there is some evidence that real exchange rates tend to depreciate in recessions, particularly in EMs, Appendix B.5 solves an extended model with this feature and finds that model implications are unchanged.

consumption. Bond prices are given by the following equations (see Appendix B for details):

$$q_1^{FC} = \beta, \tag{10}$$

$$q_1^{LC,real} = \beta. \tag{11}$$

$$q_1^{LC} = E_1\left[exp\left(\log\beta - \phi x_2 - \frac{1}{2}\phi^2\sigma_x^2\right)exp(-\pi_2)\right],\ \phi = \theta\lambda\frac{(\sigma^*)^2}{\sigma_x^2}. \tag{12}$$

LC bonds are priced as if the international investor had *effective risk aversion* ϕ over local output x_2. Expression (12) shows that the international investor is effectively more risk-averse over local output if risk aversion θ is high or if the local output loading onto world output λ is high. The ratio of the variances enters, because if local output is more volatile than world output, world output moves less than one-for-one with local output, so international investors appear less risk-averse over local output variation. The real exchange rate does not enter into the pricing of real and nominal LC bonds, because in expectation one unit of real domestic consumption buys one unit of real international consumption and exchange rate shocks are uncorrelated with all other shocks. Finally, we denote one-period log bond yields by

$$y_1^{LC} = -\log q_1^{LC},\ y_1^{FC} = -\log q_1^{FC}. \tag{13}$$

We assume that domestic equity is a claim on domestic output and is priced by the same international investor, giving the equity risk premium faced by the international investor as

$$E_1\left(r_2^e\right) + \frac{1}{2}Var_1\left(r_2^e\right) - y_1^{FC} = \theta Cov_1\left(x_2^*, x_2\right) = \phi\sigma_x^2. \tag{14}$$

Equity is in zero supply to financial investors, thereby not entering into domestic consumption. The expression for the equity premium will be useful in Section 4 to calibrate the magnitude of risk premia.

We abstract from the risk of outright sovereign default. Under the assumption of simultaneous default, which Du and Schreger (2016a) and Jeanneret and Souissi (2016) show is empirically plausible, LC debt and FC debt by the same issuer bear the same default risk premium. Even then, issuing FC debt may be costly if it precludes the option to use inflation to avoid outright default. In the current framework, exchange rate volatility is the main driver making FC debt issuance costly, so adding such an additional cost of FC debt would act similarly to increasing the exchange rate volatility. For an analysis of the choice of the currency denomination of sovereign debt with strategic default, see Engel and Park (2016).

3.3 Budget Constraint

To focus on the portfolio choice component of the government's decision, we assume that the government must raise a fixed amount V. The government chooses face values D^{FC} and D^{LC} to satisfy the period 1 budget constraint:[11]

$$D_1^{FC} q_1^{FC} + D_1^{LC} q_1^{LC} \quad = \quad V. \tag{15}$$

Let s_1 denote the share of nominal LC bonds in the government's portfolio:

$$s_1 \quad = \quad \frac{q_1^{LC} D_1^{LC}}{V}. \tag{16}$$

We define the debt portfolio log return from period 1 to period 2 in excess of the domestic consumption risk-free bond:[12]

$$xr_2^d \quad = \quad \log \left(\frac{D_1^{FC} exp\left(-\varepsilon_2 + \frac{1}{2}\sigma_\varepsilon^2\right) + D_1^{LC} exp\left(-\pi_2\right)}{\beta^{-1} V} \right). \tag{17}$$

[11]Here, we do not explicitly allow the government to issue inflation-indexed LC debt. In contrast to the hypothetical real LC bond considered in the previous section, in practice inflation-indexed bond issuance appears to be costly. Inflation-indexed bond issuance can be costly for reasons analogous to those for FC debt, if indexation is imperfect, either because the inflation index does not correspond perfectly to the domestic borrower's consumption basket or because indexation occurs with lags. In addition, empirical evidence from the U.S. suggests that inflation-indexed debt requires a substantial liquidity premium (Pflueger and Viceira (2016)). For this reason, in our empirical analysis we combine inflation-indexed and FC debt to capture inflation-insulated debt issuance.

[12]Taking the expectation over ε_2, the average cost in terms of domestic consumption of repaying a unit face value FC bond is greater than 1. While the mean exchange rate is 1, the mean inverse exchange rate is not equal to 1 due to Jensen's inequality. To purchase one unit of international consumption, the domestic borrower expects to give up more than one unit of real domestic consumption, because he has to average over states with different exchange rates. This divergence between the expected return on risk-free real FC and LC bonds is also known as Siegel's paradox (Siegel (1972), Karolyi and Stulz (2003)).

3.4 Log-Quadratic Expansion for Loss Function

This section derives a log-quadratic expansion of the government loss function, which provides intuition and is used for the log-linear analytic solution. In contrast, the numerical solutions do not rely on the log-quadratic expansion, instead using the exact expressions in Sections 3.1 through 3.3. We obtain the following second-order expressions for LC bond prices and risk premia:

$$q_1^{LC} \approx \beta \exp\left(-E_1\pi_2 + \frac{1}{2}Var_1\pi_2 + \phi Cov_1\left(x_2, \pi_2\right)\right), \tag{18}$$

$$y_1^{LC} - E_1\pi_2 + \frac{1}{2}Var_1\pi_2 - y_1^{FC} = -\phi Cov_1(x_2, \pi_2). \tag{19}$$

The output-inflation covariance $Cov_1\left(x_2, \pi_2\right)$ enters as a risk premium term. Intuitively, a positive output-inflation covariance means that the issuer does not inflate during bad times, making LC bonds safe from investors' point of view and increasing the value to investors. Provided that π_2 is a function of local output x_2 and the commitment state, as is the case in equilibrium, (19) also equals the possibly more familiar expression in terms of global output $-\theta Cov_1\left(x_2^*, \pi_2\right)$. We expand bond portfolio excess returns log-quadratically following Campbell and Viceira (2002):

$$\begin{aligned} xr_2^d + \frac{1}{2}\left(xr_d\right)^2 \quad \approx \quad & (1-s_1)\left(\varepsilon_2 + \frac{1}{2}\left(\varepsilon_2^2 + \sigma_\varepsilon^2\right)\right) \\ & + s_1\left(-(\pi_2 - E_1\pi_2) + \frac{1}{2}\left((\pi_2 - E_1\pi_2)^2 - Var_1\pi_2\right) - \phi Cov_1(x_2, \pi_2)\right) \end{aligned} \tag{20}$$

Substituting back into a log-quadratic expansion of the loss function, taking expectations, and ignoring policy-independent terms gives the expected loss:

$$\begin{aligned} E_1 L_2 \quad = \quad & \underbrace{\alpha E_1 \pi_2^2}_{\text{Inflation Cost}} + \underbrace{s_1 \bar{D}\left(\gamma - \phi\right) Cov_1(x_2, \pi_2)}_{\text{Hedging - Nominal Risk Premium}} + \underbrace{\frac{\gamma}{2} s_1^2 \bar{D}^2 Var_1 \pi_2}_{\text{Volatility LC Debt}} \\ & \underbrace{+\frac{\gamma}{2}\bar{D}^2(1-s_1)^2\sigma_\varepsilon^2 + \bar{D}\left(1-s_1\right)\sigma_\varepsilon^2}_{\text{Volatility + Convexity FC Debt}}. \end{aligned} \tag{21}$$

Here, we define $\bar{D} = \beta^{-1}V$. We divide the expected loss into four terms. The first term, Inflation Cost, is simply the expected welfare cost of inflation. The second term, Hedging − Nominal Risk Premium, is new and is the focus of our analysis. This term captures the welfare benefits and costs of the state contingency of LC debt. Since this term depends on the comovement of expected inflation and output, it corresponds most closely to the expected inflation-output beta and the bond-stock beta, which are our key empirical proxies, rather than the noisier realized inflation-output beta. There are two opposing forces: the welfare benefit of domestic consumption smoothing from a positive inflation-output covariance is counteracted by the risk premium that can be earned by selling insurance to risk-averse investors. If $\gamma > \phi$, the model formalizes the intuition from the introduction, where a government inflates in bad times in order smooth consumption, and the benefits of doing so outweigh the risk premium that needs to be paid for this insurance. In contrast, if $\phi > \gamma$, the benefit to the government from selling insurance to foreign investors outweighs the desire to smooth domestic consumption. In this case, the loss function decreases with the inflation-output covariance, because a government that inflates during good times and deflates during bad times earns a risk premium from risk-averse investors, thereby raising average domestic consumption. To preview our results, one of the most important considerations in solving this problem is to understand when the government can credibly promise a less negative or even positive inflation-output covariance. As long as the investor has non-zero risk aversion ($\phi > 0$), the government wants to limit the tendency to inflate during bad states of the world ex ante, but may deviate ex post.

The final two terms capture losses from consumption volatility induced by the volatility in debt repayments. The volatility of debt repayments enters into expected domestic consumption utility, because domestic consumers have a non-diversified, non-zero debt position, and consumption utility is concave. The third term, Volatility LC Debt, captures the utility losses from consumption volatility caused by the fact that inflation volatility induces movements in the real amount repaid on LC debt. If the country has no LC debt ($s_1 = 0$), this effect disappears. The final term, Volatility + Convexity FC Debt, captures losses from borrowing in foreign currency induced by fluctuations in the exchange rate and disappears if the country has no FC debt ($s_1 = 1$). Exchange rate volatility lowers expected consumption through a convexity effect and induces variation in domestic real consumption, which is costly due to utility curvature. In the same way that inflation volatility induces fluctuations in consumption by inducing volatility in LC debt repayments, so do exchange rate fluctuations through their effect on real debt repayments on FC debt. In addition, FC debt is costly because the expected inverse exchange rate is greater than 1 over the expected exchange rate.

3.5 Analytic Solution

This section presents the analytic model solution. For solution details, see Appendix B.

3.5.1 Inflation Policy Functions

We first solve for the inflation policy function as a function of local output and the LC debt share. There will be two inflation policy functions: one for the commitment state and one for the no-commitment state. We first characterize inflation policy functions conditional on the LC debt share s_1 and then solve for the optimal s_1. If the no-commitment state is realized, which occurs with probability $1 - p$, the government re-optimizes the ex post loss function (4), taking as given any quantities that were determined in period 1. Combining a log-linear expansion of the relation between real debt repayments and inflation with a log-quadratic expansion for the government loss function (4) gives the ex post optimal inflation policy that the government will implement when it loses commitment:[13]

$$\pi_2^{nc} = \frac{s_1 \bar{D}}{2\alpha} - \gamma \frac{s_1 \bar{D}}{2\alpha} x_2. \tag{22}$$

The first term in (22) captures the standard inflation bias of a myopic government. The bias increases with the amount of LC debt $s_1 \bar{D}$ and decreases in the real marginal cost of inflation α. The second term captures inflation cyclicality, showing that the incentive to inflate is greatest during recessions, when output is low and the marginal utility of consumption is high for domestic consumers. The degree of countercyclicality depends on $\gamma \frac{s_1 \bar{D}}{2\alpha}$. This term is intuitive, because γ is the curvature of the domestic agents' consumption utility and determines how much the marginal utility of consumption increases in low-consumption

[13]The log-linear expansion simplifies the effect that inflation has on the real value of debt. It effectively approximates that a one percentage point of extra inflation provides the same real debt relief at any level of inflation. This approximation is reasonable for low to moderate inflation regimes, as in our empirical sample. It greatly enhances tractability of the analytic solution, because it allows us to solve separately for the optimal inflation policies across the commitment and no-commitment states.

states. The amount of LC debt $s_1\bar{D}$ and the cost of generating inflation α enter similarly as for the inflation level. Risk premia do not enter the no-commitment inflation policy function, because from the perspective of a reoptimizing government they are predetermined.

In period 1, the government chooses the commitment inflation rule to minimize (21), while internalizing that with probability $1-p$ its future self will deviate and choose inflation according to (22). This gives the commitment policy function:

$$\pi_2^c = (\phi - \gamma)\frac{s_1\bar{D}}{2\alpha}x_2. \tag{23}$$

The commitment inflation rule (23) exhibits no inflationary bias on average. Inflation-cyclicality, as captured by the inflation-output slope coefficient also changes and has a new non-negative term ϕ. The slope coefficient in (23) is positive, and the government wants to commit to procyclical inflation if and only if investors have higher effective risk aversion than the government, because government debt has hedging value to investors and sells at a premium.

3.5.2 Inflation Moments and LC Debt Share

Analogously to our empirical analysis, we define the inflation-output beta as the slope from regressing period 2 log inflation π_2 onto period 2 log output x_2. The mean, variance, and inflation-output beta for period 2 inflation then equal:

$$E_1(\pi_2) = (1-p)\frac{s_1\bar{D}}{2\alpha}, \tag{24}$$

$$Var_1(\pi_2) = \left(\frac{s_1\bar{D}}{2\alpha}\right)^2\left(p(1-p) + \left(\gamma^2 - p\phi\left(2\gamma - \phi\right)\right)\sigma_x^2\right), \tag{25}$$

$$Beta(\pi_2, x_2) = \frac{(p\phi - \gamma)\, s_1\bar{D}}{2\alpha}. \tag{26}$$

We can gain intuition by considering two special cases with zero credibility ($p = 0$) and full credibility ($p = 1$). With $p = 0$, the government has no ability to commit and the inflation-output beta reduces to $Beta(\pi_2, x_2) = -\frac{\gamma s_1\bar{D}}{2\alpha}$. A government without commitment is always tempted to inflate during recessions, leading to countercyclical inflation and a negative inflation-output beta.

With full credibility ($p = 1$), the inflation-output beta becomes $Beta\left(\pi_2, x_2\right) = \frac{(\phi-\gamma)s_1\bar{D}}{2\alpha}$, which is greater than the inflation-output beta with zero commitment as long as effective investor risk aversion ϕ is positive. In particular, when $\phi = \gamma$ the full credibility government's inflation-output beta is zero and inflation is constant. More generally, provided that $\phi > 0$, (26) increases with credibility p. While it is well understood that a lack of credibility can lead to an inflationary bias, our contribution is to show that a lack of credibility also affects sovereign debt portfolio choice through an inflation cyclicality channel.

In the model, LC bond payoff surprises are perfectly negatively correlated with inflation and equity payoff surprises are perfectly positively correlated with output, so the bond-stock beta is exactly the negative inflation-output beta. This links back to our empirical evidence, where we proxy for inflation cyclicality both directly and with the negative beta of LC bond returns with respect to the local stock market, which can be measured more precisely using higher-frequency financial data.

Substituting (24) through (26) into the expected loss function (21) and taking the first-order condition with respect to the LC debt share s_1 gives an intuitive expression for this debt share (assuming an interior solution):

$$s_1 = \frac{2\alpha\left[\gamma + 1/\bar{D}\right]\sigma_\varepsilon^2}{(1-p)\left(1+\phi^2\sigma_x^2\right) - (\phi-\gamma)^2\sigma_x^2 + 2\alpha\gamma\sigma_\varepsilon^2}. \tag{27}$$

The model provides guidance regarding how we should think about measuring the LC debt share in the data. The LC debt share s_1 plays two different roles in the model, each of which is more accurately represented by different measures in the data. The optimal inflation policy functions (22) and (23) depend on how many resources one percentage point of inflation transfers from foreigners to domestic agents. On the other hand, the equilibrium LC debt share (27) reflects the government's choice of a debt portfolio. Since a central government arguably controls how much LC debt it issues, but not necessarily how much of that debt is held by foreigners, we use as the main variable in our empirical analysis the LC debt share in all central government debt. All our empirical results are robust to using the LC debt share of externally-held debt and the LC debt share of long-term debt – two types of debt that provide a domestic borrower with particularly strong real debt relief for each percentage point of inflation.

3.5.3 Comparative Statics

From (27), we derive the comparative static for the LC debt share with respect to credibility:

$$\frac{ds_1}{dp} = s_1^2 \frac{1+\phi^2\sigma_x^2}{2\alpha\left[\gamma+1/\bar{D}\right]\sigma_\varepsilon^2} > 0. \tag{28}$$

Provided that the LC debt share s_1 is at an interior solution, it increases with credibility. As credibility increases, the government faces smaller risk premia for issuing LC debt. Moreover, the probability of inefficiently high inflation for a government with LC debt declines. Both of these factors reinforce each other to increase the LC debt share for high-credibility governments.

Next we explore the model implications for the relation between inflation cyclicality and LC debt shares. Combining (26) and (28) gives the total derivative:

$$\begin{aligned}\frac{dBeta(\pi_2,x_2)}{ds_1} &= \frac{\partial Beta(\pi_2,x_2)}{\partial s_1} + \frac{\partial Beta(\pi_2,x_2)}{\partial p}\frac{1}{\frac{ds_1}{dp}} \\ &= \underbrace{\frac{(p\phi-\gamma)\,D}{2\alpha}}_{\text{Direct Effect}} + \underbrace{\frac{\phi\bar{D}}{s_1}\frac{\left[\gamma+1/\bar{D}\right]\sigma_\varepsilon^2}{(1+\phi^2\sigma_x^2)}}_{\text{Equilibrium Effect}}.\end{aligned} \tag{29}$$

Our main stylized empirical fact, which finds that LC debt shares are positively related to inflation-output betas, predicts $\frac{dBeta(\pi_2,x_2)}{ds_1} > 0$. The model inflation-output beta varies with the LC debt share s_1 through two channels. First, the direct effect of a higher LC debt share is to increase both the consumption-smoothing benefits of countercyclical inflation and the amount of real consumption that can be gained from making LC debt safe for investors. Through this channel, the effect of increasing the LC debt share s_1 is proportional to the inflation-output beta (26). The first term in (29) is negative if the government is more risk-averse with respect to domestic output than investors are ($\gamma > \phi$), or if credibility p is low. In this case, to generate a positive relation between inflation-output betas and LC debt shares as in the data, the second term would have to be sufficiently positive to outweigh the direct effect.

Second, the equilibrium relation between inflation-output betas and LC debt shares reflects the effect of credibility on both variables. Expression (26) shows that the inflation-output beta increases with credibility (strictly, if $\phi > 0$), because with higher credibility we need to put a higher weight on the stable inflation policy. Since the LC debt share also increases with credibility, variation in credibility induces a non-negative relation between LC debt shares and inflation-output betas. This second channel is larger if effective investor risk aversion ϕ is high. The reason is that a high-credibility government has a stronger incentive to limit inflation state contingency when risk premia are large.

The case $\phi = 0$ illustrates that limited commitment alone cannot plausibly generate the upward-sloping relation between inflation-output betas and LC debt shares in the data. Risk-averse investors are therefore essential to matching the downward-sloping empirical relation between inflation-output betas and LC debt shares. In the absence of risk premia, a high-credibility government optimally follows a countercylical inflation policy that generates inflation only in bad states of the world to smooth consumption, generating a negative inflation-output beta (26) in contrast with the empirical evidence that countries with high LC bond shares have zero or even positive inflation-output betas and zero or negative bond-stock betas. Moreover, (29) is negative, so the model predicts a downward-sloping relation between LC debt shares and inflation-output betas. Intuitively, because domestic consumption is far from perfectly hedged, as appears plausible empirically, the marginal benefit from further consumption hedging to the government is high. Consequently, a higher LC debt share increases the benefit of each additional percentage point of inflation, increasing the incentive to vary inflation countercyclically over the business cycle.[14]

4 Calibrating the Model

In this section, we calibrate the model to examine whether the forces discussed in Section 3 can quantitatively replicate the empirical patterns and to assess the numerical accuracy of the analytic solution. The analytic solution helps us select parameter values without an expensive grid search. We use global solution methods to solve for the full nonlinear

[14] Only if domestic consumption is close to perfectly hedged, which appears less empirically plausible, can the model generate an upward-sloping relation between LC debt shares and inflation-output betas, because then the marginal benefit of inflation variation decreases with the amount of LC debt outstanding. However, with close to perfect domestic consumption hedging, the model counterfactually predicts negative inflation-output betas and positive bond-stock betas for LC debt issuers. Formally, we capture limited consumption smoothing in the analytic solution by taking an expansion with $\bar{D}^3$ small. For a solution that keeps third-order terms in $\bar{D}$, see Appendix B.

solution (i.e., not the analytic solution).[15] Table 3 reports calibration parameters, and Table 4 compares empirical and model moments.

We solve the model for two calibrations that differ only in terms of credibility p. The high-credibility calibration uses $p_H = 1$, corresponding to full credibility, while the low-credibility calibration has $p_L < 1$. We choose the low-credibility calibration to target the difference in empirical moments between emerging markets and developed markets, reported in the leftmost column of Table 4.

We set the government's borrowing need to 13% of GDP, corresponding to the average share of external sovereign debt in emerging markets. We set exchange rate volatility to $\sigma_\varepsilon = 14\%$ to match the median annual volatility of emerging market exchange rate returns since 1990. A substantial cost of borrowing in FC implies that the share of LC debt falls relatively slowly with respect to p in equilibrium, ensuring that even low-credibility countries have some LC debt.

With (22) and (24), we have that $E_1\pi_{2,L} = (1 - p_L)E_1\pi_{2,L}^{nc}$. Identifying $E_1\pi_{2,L}$ with average emerging market survey inflation in excess of developed market survey inflation and $E_1\pi_{2,L}$ with maximum emerging market survey inflation in excess of average developed market survey inflation pins down $p_L = 1 - \frac{2.00\%}{6.07\%} = 0.67$. We calibrate the inflation cost to match average emerging market survey inflation in excess of developed market survey inflation of 2.0%. With (24) we obtain:

$$\alpha = \frac{(1-p_L)s_{1,L}\bar{D}}{2E_1\pi_{2,L}} = \frac{0.33 \times 0.5 \times 0.13}{2 \times 0.02} = 0.5. \tag{30}$$

We explore model implications for a wide range of values for ϕ. We set $\phi = \gamma$ for our benchmark calibration. The benchmark case of equal government and effective investor risk aversion has appealing implications. It implies that a full-credibility issuer chooses an all LC debt portfolio and perfect inflation targeting, with no inflation variability, similarly to developed countries in our sample.[16] We choose government and effective investor risk

[15] We minimize the Euler equation error for the inflation policy function in the no-commitment state over the no-commitment policy function. We then minimize the loss function over the commitment policy function and the LC debt share. Both commitment and no-commitment policy functions for log inflation are quadratic in log output. For details and a sensitivity analysis of model moments to individual parameters, see Appendix B.

[16] In our sample, the mean beta of local equity returns on U.S. equity returns is 0.97 and the mean beta of local GDP growth on U.S. GDP growth 0.86. Therefore, assuming equal risk aversion ($\gamma = \theta$) between the

aversion (γ and ϕ) to match the empirical difference in inflation-output betas of -0.21. We substitute into (26):

$$Beta_L(\pi_2, x_2) - Beta_H(\pi_2, x_2) \quad = \quad -\frac{\gamma \bar{D} s_{1,L}}{2\alpha}(1 - p_L) = -\gamma \times \left[\frac{0.13 \times 0.5}{2 \times 0.5} \times 0.33\right], \quad (31)$$

indicating that we need risk aversion on the order of $\gamma = 10$ to match the empirical difference in inflation-output betas across emerging and developed markets. While a risk-aversion parameter of 10 is high, it is at the upper end of values considered plausible by Mehra and Prescott (1985).

Finally, high output volatility $\sigma_y = 8\%$ is needed to generate a plausible level for the equity premium. While this volatility is higher than emerging market output volatility in our sample, a higher volatility may be priced into asset markets if emerging markets are subject to crashes and crises. We do not attempt to explain the equity volatility puzzle (Shiller, 1981; LeRoy and Porter, 1981), which can be resolved if consumption and dividend growth contain a time-varying long-run component (e.g., Bansal and Yaron (2004)) or if preferences induce persistent fluctuations in risk premia (e.g., Campbell and Cochrane (1999)).

Table 4 shows that the calibration matches the empirical moments quite well. We obtain average low-commitment inflation of around 3% and maximum no-commitment inflation of 8%. The inflation-output beta for the low-credibility calibration is -0.27 compared to a high-credibility beta of 0, matching the difference in betas in the data. The small difference between the global and analytic solutions reassures us that our approximations capture the main forces at play.

4.1 Policy Functions

Figure 3 contrasts government policy functions for inflation and real debt repayments as functions of log output. The top two panels show log inflation (left) and the conditional expected real debt portfolio excess excess return (right), averaged across commitment and no-commitment states. Blue solid lines correspond to low credibility and red dashed lines correspond to high credibility. All policy functions in Figure 3 use numerical solution methods.

government and investors, the benchmark of $\gamma \approx \phi$ is natural.

The left panels of Figure 3 illustrate the inflation policy function features discussed in Section 3.5. The top left panel shows that the low-credibility government implements a state-contingent inflation policy function that is higher on average than for the high-credibility government, and especially so during low-output states. The middle and lower panels of Figure 3 decompose the differences between high- and low-credibility governments across commitment and no-commitment states. In the commitment state, the low-credibility government sets inflation to zero, similarly to the high-credibility government. In the no-commitment state, the low-credibility government inflates away its LC debt and chooses especially high inflation in low-output states. The low-credibility government reaches the no-commitment state with positive probability $1-p_L > 0$, while the high-credibility government reaches it with probability 0, so the average inflation profile for the low-credibility government is higher and more countercyclical.

The right panels of Figure 3 show real debt portfolio excess returns, which are related to inflation by taking the expectation of (17) with respect to ε_2. The top right panel shows that countercyclical inflation translates into procyclical real debt repayments for the low-credibility country. Moreover, the low credibility country faces real debt repayments that are higher on average because of LC bond risk premia.

Even in the commitment state, credibility affects real excess returns of the sovereign bond portfolio, even though inflation in this state is close to zero. Credibility enters because ex ante LC bond prices reflect non-zero inflation expectations and inflation risk premia, which can raise the cost of repaying LC debt ex post. The low-credibility government's real debt repayments are highest in the commitment state, because this is a state of surprisingly low inflation relative to ex ante investor expectations. With high average inflation expectations, the low-credibility government has to issue a large face value of LC debt to raise a given amount of real resources, so in a state of low realized inflation, real debt repayments are high. In the no-commitment state, real debt portfolio excess returns are close to zero on average, reflecting higher average inflation, and lowest in recessions, when inflation is high.

4.2 Comparative Statics

In this section, we analyze how LC debt issuance, inflation, inflation-output betas, and LC risk premia vary with credibility and investor risk aversion.

4.2.1 Credibility

Figure 4 shows that changes in credibility, or the probability of honoring the previously announced inflation plan, can explain substantial differences along key dimensions. An increase in credibility makes it less likely that the government will be tempted to inflate away the debt, leading to lower inflation expectations. A low-credibility government is especially tempted to inflate away the debt during recessions, generating an upward-sloping relation between inflation-output betas and credibility. Risk-averse international investors require a return premium for holding LC bonds that lose value precisely when marginal utility is high, driving up LC risk premia for low-credibility governments. Finally, low-credibility governments issue a smaller share of LC debt, to constrain themselves from inflating in low-output states, thereby reducing the real costs of inflation and risk premia.

4.2.2 Investor Risk Aversion

Figure 5 shows that model predictions vary substantially with investor risk aversion. In the case with risk-neutral investors ($\phi = 0$), investors charge no risk premium for inflation-output covariances. In this case, the low-credibility government has a high LC debt share, generates high inflation, and generates a strongly negative inflation-output beta. In fact, both low- and high-credibility governments generate almost identical inflation-output betas, indicating clearly that this case cannot explain the cross-country variation in inflation cyclicality in the data.

While the benchmark calibration in Tables 3 and 4 replicates the empirical fact that inflation-output betas are greater in developed markets than in emerging markets and generates zero inflation-output betas for high-credibility issuers, the model can easily generate even positive inflation-output betas if investors are effectively more risk-averse than the government ($\phi = 12$). With highly risk-averse investors, it is the government that sells insurance to the global investor by issuing LC debt, similarly to the setting considered in Farhi and Maggiori (2016), rather than the risk-neutral investor insuring the government by buying it. Higher investor risk aversion than government risk aversion could be due to political economy reasons that induce the government not to fully adjust for risk. For instance, the risk of losing elections may lead to a divergence between private and government incentives, especially during low-output states, much as in Aguiar and Amador (2011), where a lower discount factor driven by political economy forces can engender a bias toward more debt.

5 Testing Additional Empirical Implications

The model presented in the previous two sections highlights the importance of monetary policy credibility for the level and cyclicality of LC risk and sovereign debt portfolios. This section tests additional model predictions and provides direct evidence for our proposed mechanism. We provide evidence for the following three predictions: First, we predict that countries with positive bond-stock betas have higher LC bond risk premia. Second, we predict that low-credibility countries have higher LC bond risk premia. Third, we predict an inverse relation between LC debt shares and LC bond risk premia.

5.1 Empirical Drivers of Risk Premia

In the model, bond risk premia act as an important channel linking monetary policy credibility, bond return cyclicality, and sovereign debt portfolios. We measure ex ante risk premia for our cross-section of countries to correspond to the left-hand side of (19):

$$\overline{RP} = \overline{y^{LC}} - \bar{\pi} + \frac{1}{2} Var\pi - \left(\overline{y^{US}} - \overline{\pi^{US}} + \frac{1}{2} Var\pi^{US} \right). \tag{32}$$

A bar indicates the mean from 2005 to 2014. Intuitively, (32) removes average local inflation from LC bond yields to isolate the risk premium component. Unlike in the model, we correct for the fact that U.S. inflation is non-zero. In Appendix A, we show that results are quantitatively and qualitatively robust to adjusting LC bond yields for default risk using synthetic default-free LC bonds as in Du and Schreger (2016a).[17]

In the model, bond risk premia are driven by return comovements with the international SDF (7). In our empirical analysis, we proxy for this with the beta of LC bond log excess returns with respect to log excess returns on the U.S. S&P 500 (bond-S&P betas). For instance, for Brazil the bond-S&P beta would represent the slope coefficient of Brazilian LC bond log excess returns with respect to U.S. stock log excess returns. Here, U.S. stock

[17]Due to our short sample, ex post bond risk premia, measured as realized excess returns, are extremely noisy. We therefore prefer ex ante measures, corresponding to those that governments see when making issuance decisions.

returns proxy for world stock returns if the U.S. equity market is well integrated with the rest of the world. While bond-S&P betas are unlikely to explain all cross-sectional variation in LC bond risk premia, showing a qualitatively and quantitatively significant relation will provide important evidence for our proposed channel. We decompose each country's risk premium into two components by estimating the following regression:

$$\overline{RP_i} = \mu + \kappa b(bond, S\&P)_i + \varepsilon_i. \tag{33}$$

Column (2) of Table 5 estimates regression (33) and finds a statistically significant and quantitatively meaningful estimate for κ. A one-unit increase in the bond-S&P beta is associated with an increase in the risk premium of 10 percentage points in annualized units, which is the same order of magnitude as the U.S. equity premium. The bond-S&P beta not only carries an economically and statistically significant price of risk but also explains a substantial portion of cross-sectional variation in LC bond risk premia, with an R-squared of 30%. The estimated slope coefficient is similar in column (1), where we use the beta with respect to the local stock market instead of the S&P, supporting the notion that LC bonds that are the best hedges for the issuer tend to require the highest risk premia. In Appendix A.6, we show that the key risk premium relation in Table 5, column (2), remains highly statistically significant when using generalized method of moments to account for the fact that bond-S&P betas are estimated.

Next we interact the bond-stock beta with the local-S&P beta, as a proxy for the comovement between local and global SDFs. Column (3) shows that results are unchanged, indicating that the comovement between local and global SDFs is sufficiently large and consistent across countries that local inflation cyclicality indeed drives the cross-section of LC bond risk premia, as in the model. Column (4) further addresses concerns that cross-country differences in the local-global loadings might directly drive differences in LC bond risk premia. We regress risk premia onto the local-global beta $b(stock, S\&P)$ directly, which does not enter significantly and has no explanatory power for LC bond risk premia.

Table 5 also provides evidence on the link between bond risk premia and monetary policy credibility using two de facto measures that we construct. We prefer de facto measures of central bank credibility to de jure ones because recent measures of de jure central bank independence have been found to be uncorrelated with average inflation (Crowe and Meade, 2007). Using *Financial Times* articles over the period 1995—2015, we construct the correlation between the keywords "debt" and "inflation" for each country as a proxy for inverse inflation credibility. The intuition is that if inflation is solely determined by the central bank and debt is determined by the fiscal authority, these topics should be discussed separately, and the correlation should be low. On the other hand, if inflation and debt are determined by the same central government, we would expect newspaper articles to discuss both jointly, and the correlation should be high. We count the number of articles containing both keywords and the country name and divide them by the geometric average of the articles that contain one of the keywords combined with the country name. Consistent with the model, column (5) of Table 5 shows that this de facto monetary policy credibility measure is strongly correlated with risk premia, with an R^2 of 47.2%.

Column (6) uses the gap between announced inflation targets and survey expectations to measure inverse inflation credibility. If credibility is low, we expect survey inflation to exceed announced inflation targets. We define the "credibility gap" as the greater of the average difference between the central bank inflation target and survey inflation expectations and zero. Over the past decade, on average, the emerging markets in the sample have a mean credibility gap of 0.6 percent, whereas the developed markets in the sample have a mean credibility gap of 0.1 percent. Column (6) suggests that a 0.5 percentage point increase in the credibility gap, corresponding to the average difference between emerging and developed countries, is associated with a 2 percentage point increase in LC bond risk premia, which is economically large and in line with model predictions.

5.2 Evidence on Bond Risk Premia and Debt Portfolio Choice

Next we turn to the model prediction that LC debt shares are negatively related to LC bond risk premia, and in particular to the component of LC bond risk premia that derives from bond return comovements with the international investor's SDF. Consistent with this prediction, Table 6 shows a negative and statistically significant relation between LC debt shares on the left-hand side and LC bond risk premia on the right-hand side. LC bond risk premia explain a substantial 45% of variation in LC debt shares. A 2.4 percentage point increase in LC bond risk premia, roughly the average difference between emerging and developed countries, is associated with a $2.4 \times 6.6 = 16$ percentage point decrease in the LC debt share. Next we decompose the risk premium into a world CAPM component—the component explained by the bond-S&P beta—and the alpha with respect to the U.S. S&P:

$$RP_{CAPM,i} = \hat{\kappa} b(bond, S\&P)_i,\ a_{CAPM,i} = \overline{RP}_i - RP_{CAPM,i}. \tag{34}$$

where $\hat{\kappa}$ is the slope coefficient estimated in Table 5, column (2). The estimated alpha a_{CAPM} may reflect measurement error of the CAPM risk premium, for instance if the S&P is an imperfect proxy for the world portfolio, or pricing errors on the part of investors, so we would expect LC debt shares to decrease with both RP_{CAPM} and a_{CAPM}. Table 6, column (2), supports the notion that sovereign issuers reduce LC issuance in response to higher LC bond risk premia, and that the riskiness of LC bonds for U.S. investors, as proxied by the bond-S&P beta, accounts for a substantial portion the downward-sloping relation between LC debt issuance and LC risk premia. Columns (2) and (3) show that while both components of the risk premium contribute significantly to the explanatory power of risk premia for LC debt shares, our proxy for the CAPM component enters with a larger coefficient and explains more than half the R-squared in column (1). Columns (4) through (6) show that the relation between risk premia and LC debt shares is robust to controlling for log GDP, foreign exchange rate regime, commodity share of exports, and average inflation.

5.3 Time Series Changes in LC Debt Issuance

One of the most striking developments in international bond markets over the past two decades is how many countries have gone from having very little LC debt during the 1990s to substantial LC debt shares in the 2000s. We now show evidence that the bond risks channel of monetary policy credibility can help us understand changes in LC debt issuance. Our analysis is constrained by the fact that our main proxy for the hedging properties of LC bonds—the bond-stock beta—can be constructed only if LC debt is actually available, which for many countries in our sample was not the case during the 1990s. We therefore rely on decade-by-decade estimates of inflation forecast betas to measure the risks of hypothetical LC bond risks over time. Figure 6 shows that the strongest increases in inflation-output forecast betas were accompanied by the most marked increases in LC debt shares, supporting the notion that the bond risks channel of monetary policy credibility explains not only level differences in LC debt shares across countries but also changes since the 1990s. Looking only at emerging countries, shown in green, the upward-sloping relation in Figure 6 looks even stronger. On the other hand, we should not be surprised to see that changes in LC debt shares for developed markets are zero. Developed markets in the data correspond to model governments that hit the 100% LC debt share constraint, so we should not expect them to change their LC debt shares for small changes in credibility. This evidence also shows that our main stylized empirical fact holds in changes, thereby controlling for omitted variables that are constant at the country level, such as natural resource endowments.[18]

6 Conclusion

This paper argues that differences in monetary policy credibility, combined with investors that require a risk premium for holding positive-beta bonds, explain the relation between sovereign debt portfolios and government bond risks across countries. We document that sovereigns whose LC bonds tend to lose value during recessions and hence provide the borrower with consumption-smoothing benefits, issue little LC debt. We explain this stylized fact with a model in which risk-averse investors charge a premium for holding LC bonds that lose value during recessions, thereby making LC debt expensive for low-credibility governments and driving them toward FC debt issuance. Importantly, both limited commitment on the issuer's part and investor risk aversion are necessary to match the empirical evidence. The key contribution of the paper is to demonstrate how the interaction of lender risk aversion and monetary credibility can explain why countries with positive bond-stock betas, which would seemingly achieve most consumption-smoothing from issuing LC debt, have the lowest LC debt share. Our simple framework gives rise to a number of testable predictions on inflation, inflation cyclicality, sovereign debt portfolios, and proxies of effective monetary policy credibility, which we verify in the data.

[18] We compute inflation-output forecast betas and LC debt shares separately for the decades 1995—2004 and 2004—2015 for 20 countries. The rest of 10 sample countries are excluded due to missing forecasting data for the 1995—2004 period.

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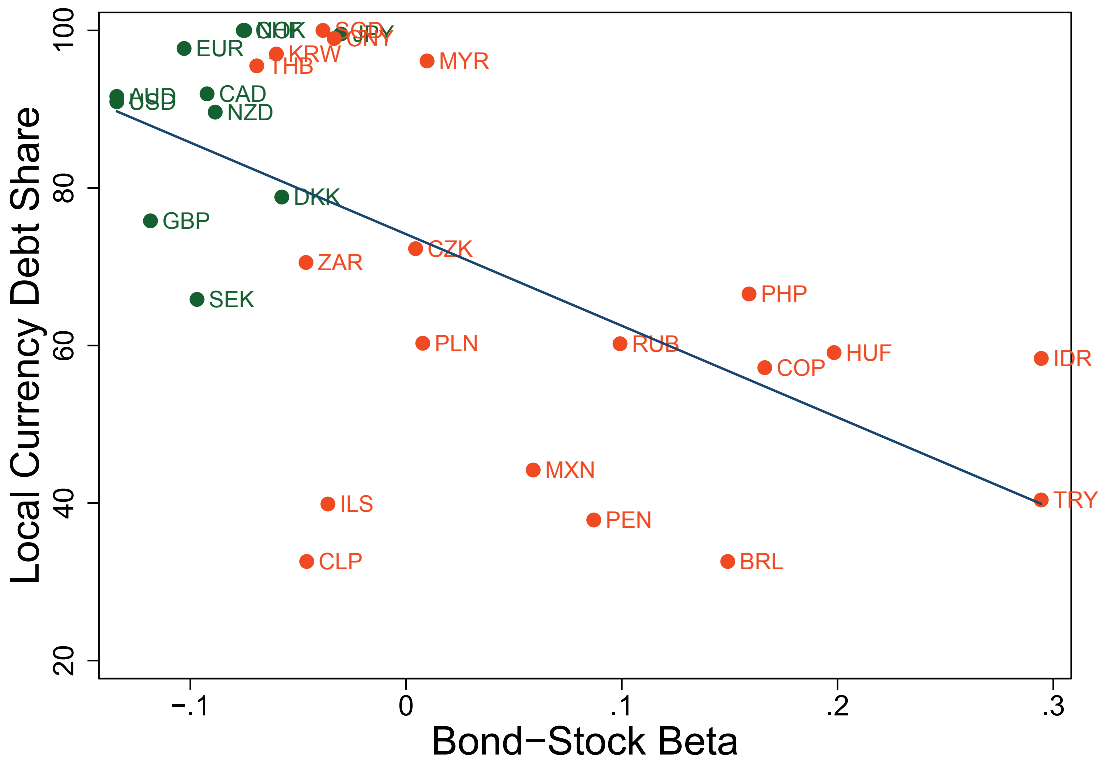
Figure 1: Local Currency Debt Shares and Bond Betas

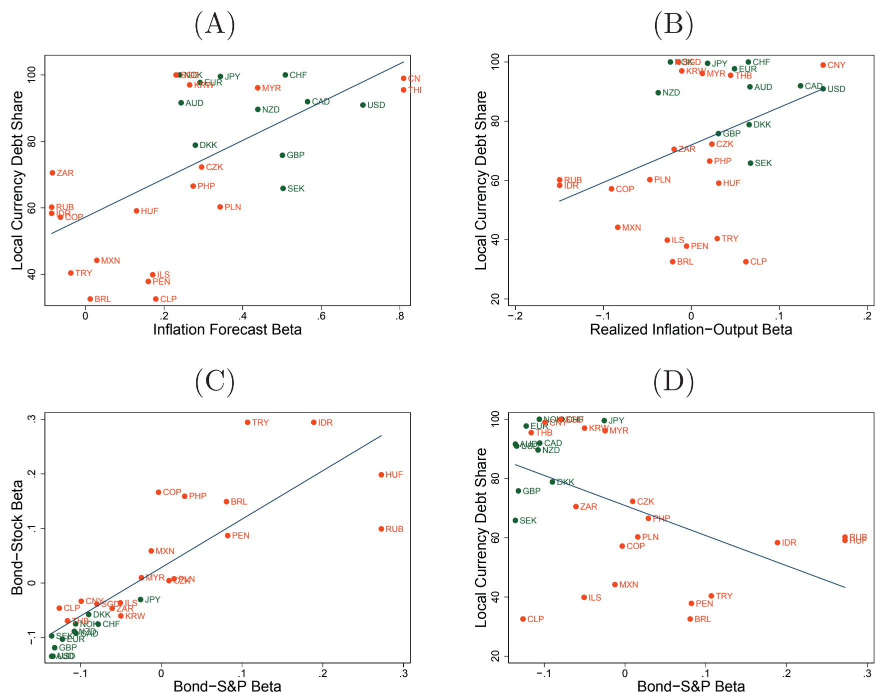


Note: This figure shows the share of LC debt as a fraction of central government debt (in %) over the period 2005--2014. Bond-stock betas are estimated as the slope coefficient of quarterly LC bond log excess returns onto local stock market log excess returns over the same time period

$$xr^{LC}_{t+\Delta t} = b_0 + b(bond, stock) \times xr^{m}_{t+\Delta t} + \epsilon_t.$$

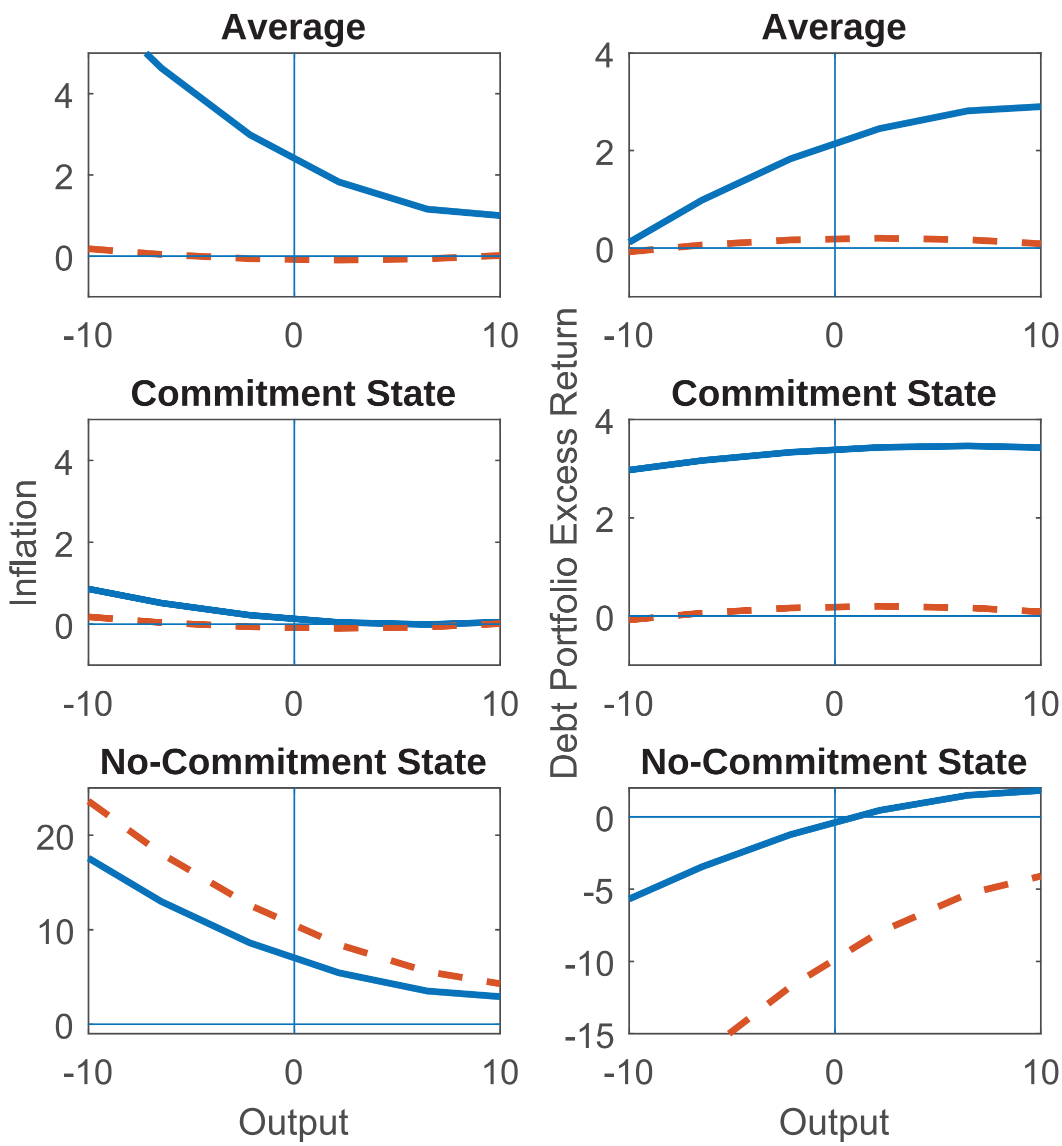
Three-letter codes indicate currencies. Emerging markets are shown in red and developed markets in green. The highest and lowest observations are winsorized.

Figure 2: Local Currency Debt Shares, Inflation Betas, and Bond-S&P Betas



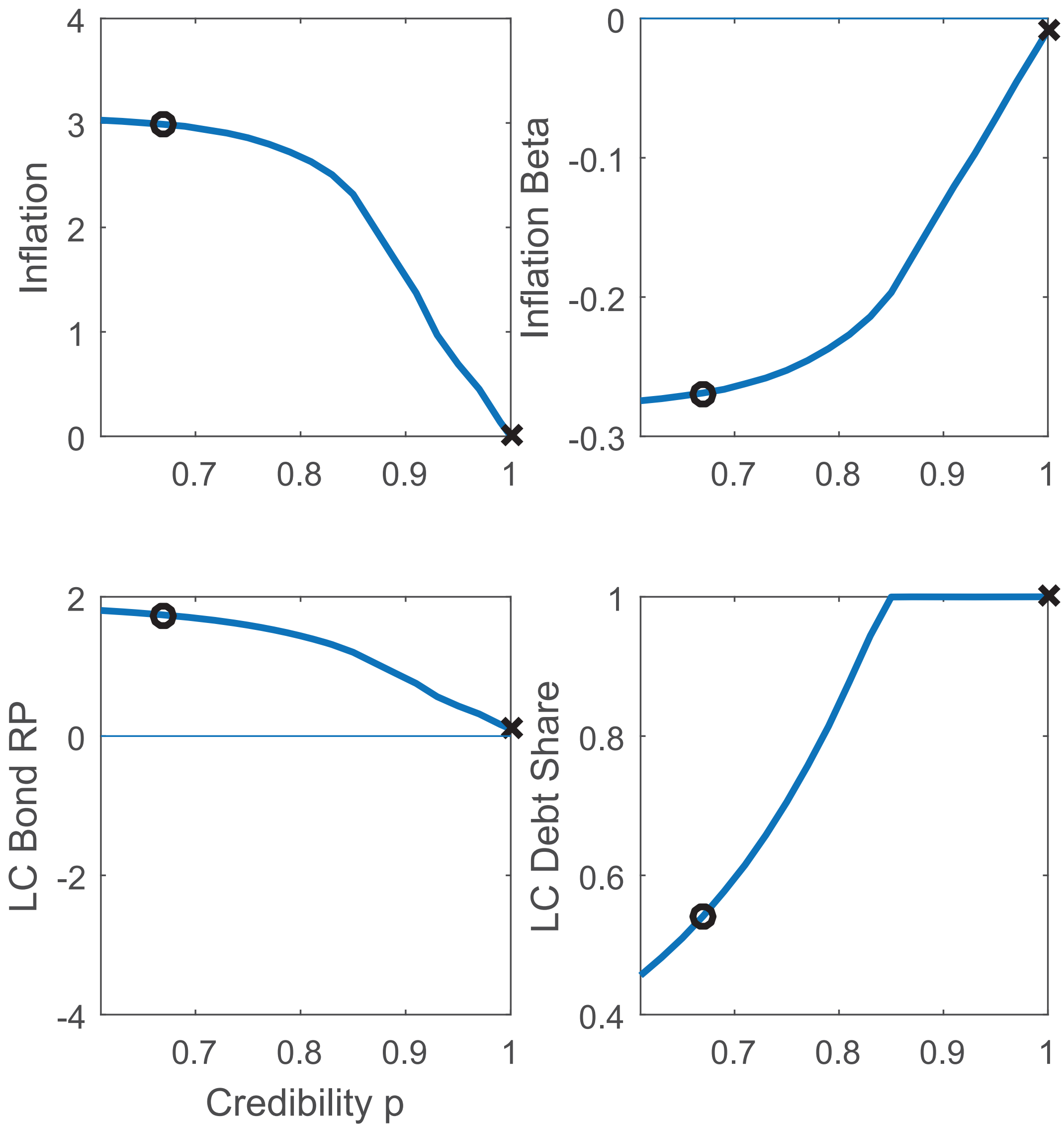
Note: Panels A, B, and D plot the share of LC debt in the sovereign debt portfolio on the y-axis against expected inflation-output betas, realized inflation-output betas, and the beta of LC bond returns with S&P returns, respectively. Panel C shows bond betas against local stock returns on the y-axis against bond-S&P betas on the x-axis. Developed markets are denoted by green dots, and emerging markets are denoted by red dots. The three-letter currency code is used to label countries. The highest and lowest observations are winsorized. More details on variable definitions can be found in Section 2.

Figure 3: Policy Functions



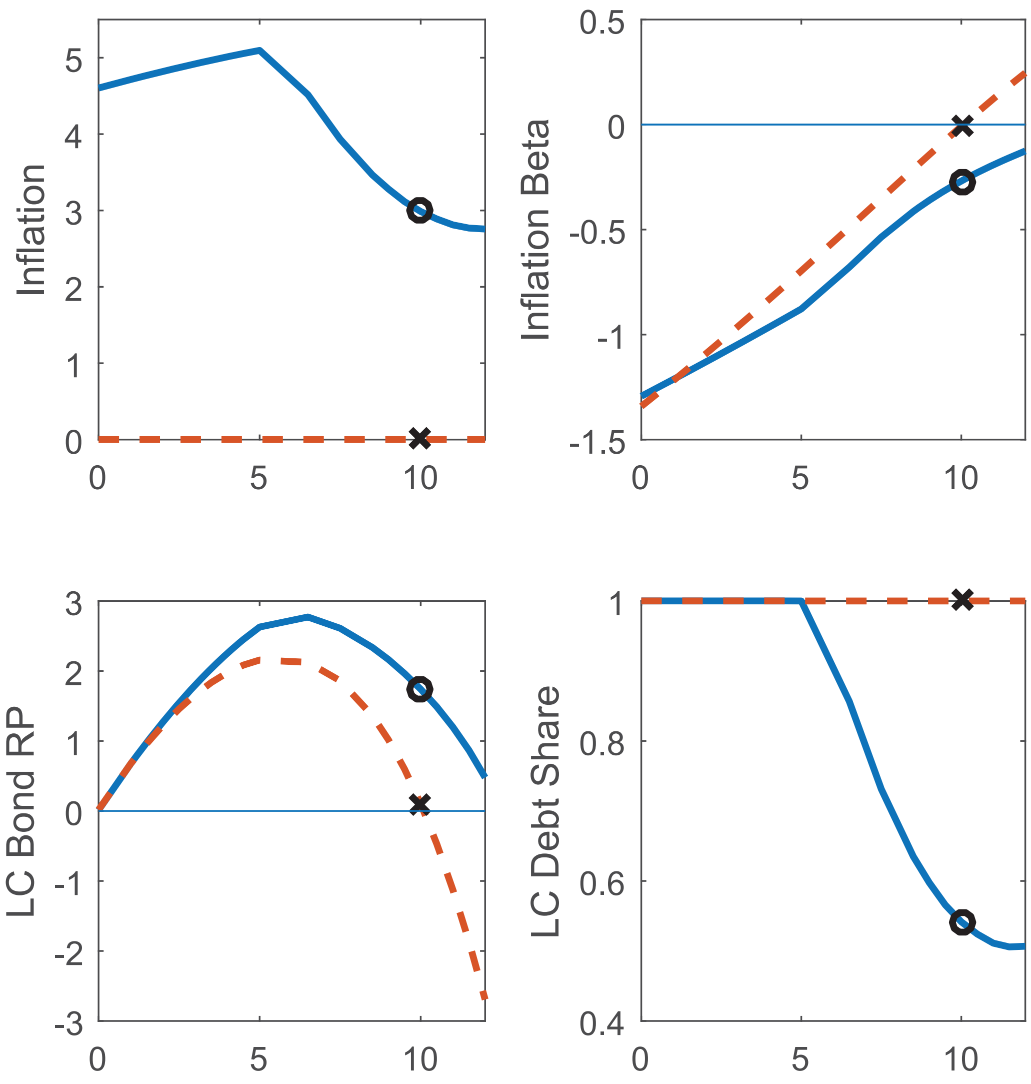
Note: The solid blue lines indicate the low-credibility calibration, while the dashed red lines indicate the high-credibility calibration. Left panels show log inflation. Right panels show real debt portfolio excess returns in percent, following equation (17). The y-axis shows log output in percent deviations from the steady-state. "Average" refers to the weighted average across commitment and no-commitment states, where the weights are given by credibility p.

Figure 4: Varying Credibility



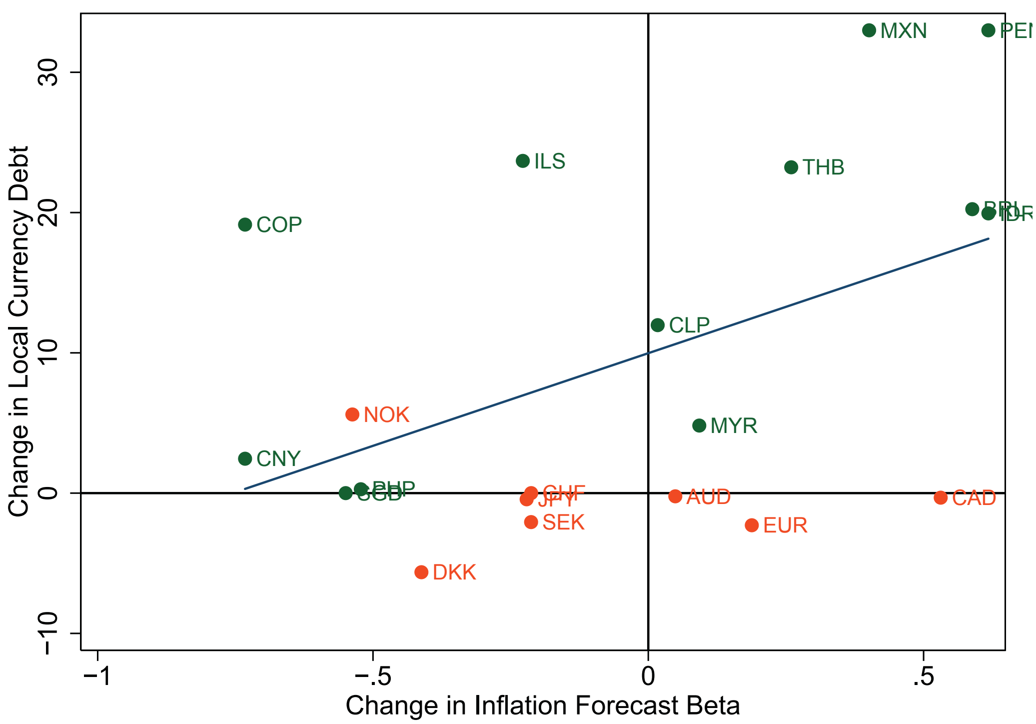
Note: This figure shows average inflation, the inflation-output beta, LC bond risk premia, and the LC debt share while varying credibility p. All other parameters are held constant at values shown in Table 3.

Figure 5: Varying Effective Investor Risk Aversion



Note: This figure shows average log inflation, the inflation-output beta, LC bond risk premia, and the LC debt share against effective investor risk aversion ϕ for low-credibility (blue solid) and high-credibility (red dashed) calibrations. All other parameters are held constant at values shown in Table 3.

Figure 6: Changes 1995—2004 versus 2005—2014



Note: This figure shows decade-over-decade changes in the inflation forecast beta on the x-axis and changes in LC debt shares on the y-axis, where changes are from 1995—2004 versus 2005—2014. The highest and lowest observations are winsorized.

Table 1: Summary Statistics for Developed and Emerging Markets (2005—2014)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	π	Survey π	y^{LC}	$b(\widetilde{\tilde{\pi},gdp})$	$b(\pi, IP)$	$b(bond, stock)$	b(stock, S&P)	s
(A) Developed Markets ($N = 11$)								
Mean	1.70	1.83	2.62	0.42	0.05	-0.10	0.95	89.27
S.d.	0.81	0.64	1.24	0.15	0.06	0.04	0.21	11.23
Max	2.68	2.68	4.87	0.71	0.15	-0.03	1.34	100.00
Min	0.26	0.32	0.61	0.24	-0.04	-0.18	0.60	65.85
(B) Emerging Markets ($N = 19$)								
Mean	4.09	3.83	6.01	0.20	-0.02	0.06	1.00	63.11
S.d.	2.05	1.66	2.91	0.32	0.15	0.12	0.27	25.58
Max	9.07	7.90	12.33	1.07	0.35	0.32	1.55	100.00
Min	2.05	2.06	1.67	-0.25	-0.50	-0.07	0.58	11.97
(C) Full Sample ($N = 30$)								
Mean	3.21	3.10	4.77	0.28	0.01	0.01	0.98	72.70
S.d.	2.05	1.68	2.92	0.28	0.13	0.13	0.24	24.78
Max	9.07	7.90	12.33	1.07	0.35	0.32	1.55	100.00
Min	0.26	0.32	0.61	-0.25	-0.50	-0.18	0.58	11.97
(D) Mean Difference between Emerging and Developed Markets								
Mean Diff.	-2.391***	-2.004***	-3.388***	0.215**	0.0736*	-0.160***	-0.04	26.16***
	(0.531)	(0.428)	(0.767)	(0.0858)	(0.0388)	(0.0303)	(0.09)	(6.791)

Note: This table reports summary statistics for the cross-sectional mean of seven variables for developed and emerging market groups. The variables include (1) π, realized inflation (%), (2) Survey π, survey inflation (%), (3) y^{LC}, five-year LC bond yield, (4) $b(\widetilde{\tilde{\pi},gdp})$, inflation-output forecast beta, (5) $b(\pi, IP)$, realized inflation-output beta, (5), (6) $b(bond, stock)$, bond-stock beta, (7) $b(stock, S\&P)$ beta of local log equity excess returns with respect to log U.S. S&P 500 excess returns, and (8) s, percentage share of LC debt in total sovereign debt portfolios. Panel (A) reports results for developed markets. Panel (B) reports results for emerging markets. Panel (C) reports results for the pooled sample. Panel (D) tests the mean difference between developed and emerging markets. Robust standard errors are reported in parentheses. Significance levels are denoted by *** p<0.01, ** p<0.05, * p<0.1.

Table 2: Cross-Sectional Regression of Local Currency Debt Shares on Nominal Risk Betas

	(1)	(2)	(3)	(4)
Local Currency Debt Share	s	s	s	s
$b(bond, stock)$	-116.3***			-106.3**
	(21.40)			(31.05)
$b(\tilde{\pi}, \widetilde{gdp})$		57.63***		
		(8.986)		
$b(\pi, IP)$			126.6***	
			(31.84)	
log(GDP)				1.092
				(3.815)
FX Regime				-1.412
				(2.998)
Commodity Share				-0.172
				(0.179)
Constant	74.14***	57.24***	72.00***	71.80*
	(3.460)	(4.857)	(3.993)	(39.48)
Observations	30	30	30	30
R-squared	0.367	0.392	0.156	0.401

Note: This table shows the cross-country regression results of the LC debt share, s (between 0 and 1), on measures of inflation cyclicality. The independent variables in the first three columns are the bond-stock beta ($b(bond, stock)$), the inflation forecast beta ($b(\tilde{\pi}, \widetilde{gdp})$) and the realized inflation-output beta ($b(\pi, IP)$), respectively. In column (4), we control for the mean log per capita GDP level between 2005 and 2014, log(GDP), the average exchange rate classification used in Reinhart and Rogoff (2004), FX regime, and the commodity share of exports. The "Commodity Share" is defined as the sum of "Ores and Metals" and "Fuel" exports as a percentage of total merchandise exports from World Bank World Development Indicators. More details on variable definitions can be found in section 2. The top and bottom observations are winsorized. Robust standard errors are used in all regressions with the significance level indicated by *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Calibration Parameters

Parameter		Low Credibility	High Credibility
Credibility	p	0.67	1.00
Inflation Cost	α	0.50	
Output Vol.	σ_x	0.08	
Government Risk Aversion	γ	10	
Effective Investor Risk Aversion	ϕ	10	
Debt/GDP	$\bar{D}$	0.13	
Exchange Rate Vol.	σ_ε	0.14	

Note: All parameters are in annualized natural units.

Table 4: Empirical and Model Moments

	Data	Model	
	Emerging-Developed	Low Credibility	High Credibility
Average Inflation	2.00	2.99	0.00
No-Commitment Inflation	6.07	8.48	12.00
Inflation Beta	-0.21	-0.27	-0.01
LC Debt Share	0.63	0.54	1.00
Equity Risk Premium	6.35	6.25	6.25

Note: All moments are in annualized natural units. The empirical moment for average inflation is the difference between average survey inflation for emerging and developed markets in Table 1. The empirical inflation-output beta is computed as the difference between average expected inflation-output betas in emerging and developed markets. The empirical no-commitment inflation is computed as the difference between maximum emerging market survey inflation and average developed market survey inflation in Table 1. The equity risk premium is the average local equity excess return in our sample. All model moments are computed using global solution methods.

Table 5: Empirical Drivers of Bond Risk Premia

	(1)	(2)	(3)	(4)	(5)	(6)
LC Bond Risk Premium	RP	RP	RP	RP	RP	RP
$b(bond, stock)$	15.30***					
	(3.117)					
$b(bond, S\&P)$		11.36***				
		(4.194)				
$b(bond, stock) \times b(stock, S\&P)$			14.60***			
			(2.805)			
$b(stock, S\&P)$				1.041		
				(1.553)		
News Correlation					36.08***	
					(9.524)	
Credibility Gap						3.637***
						(0.989)
Constant	1.773***	2.151***	1.661***	0.856	-5.559***	0.508
	(0.264)	(0.449)	(0.248)	(1.383)	(1.735)	(0.392)
Observations	30	30	30	30	30	22
R-squared	0.610	0.302	0.616	0.010	0.472	0.323

Note: This table regresses the empirical risk premium proxy (32) on bond-stock betas and measures of monetary policy credibility. $b(bond, stock)$ is the beta of LC bond excess returns with respect to the local stock market. $b(bond, S\&P)$ is the beta of LC bond returns with respect to U.S. S&P returns. $b(bond, stock) \times b(stock, S\&P)$ is the interaction of bond-local stock return betas and the beta of local on U.S. equity returns. $b(stock, S\&P)$ is the beta of local on U.S. equity returns. "News Count" is the correlation of the keywords "debt" and "inflation" in *Financial Times* articles 1996—2015 from ProQuest Historical Newspapers. We compute the correlation as the number of articles mentioning both "debt" and "inflation" divided by the geometric average of articles that mention either "debt" or "inflation." We require articles to also mention the country name. The inflation credibility gap is measured as the mean difference between the survey inflation expectations from Consensus Economics and the announced inflation target since 2005. The top and bottom observations are winsorized. Robust standard errors are used in all regressions with the significance level indicated by *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Local Currency Debt Share and Bond Risk Premia

	(1)	(2)	(3)	(4)	(5)	(6)
LC Debt Share	s	s	s	s	s	s
Risk Premium	-6.581***			-5.841***	-5.481***	-5.725***
	(0.871)			(0.915)	(0.939)	(1.008)
RP_{CAPM}		-8.937***	-8.937***			
		(2.600)	(1.886)			
a_{CAPM}			-5.562***			
			(0.985)			
Log (GDP)				2.985		2.777
				(2.939)		(3.392)
FX Regime				1.975		1.984
				(3.103)		(3.151)
Commodity Share				-0.144		-0.137
				(0.171)		(0.197)
Average Inflation					-1.943*	-0.303
					(1.092)	(1.791)
Constant	85.70***	70.88***	82.85***	53.80*	89.88***	56.25
	(3.796)	(3.739)	(3.574)	(31.31)	(5.271)	(37.55)
Observations	30	30	30	30	30	30
R-squared	0.451	0.251	0.476	0.498	0.468	0.498

Note: This table regresses the average LC debt share onto our empirical risk premium proxy, defined in equation (32). RP_{CAPM} is the risk premium component explained by the bond-S&P beta and a_{CAPM} is the corresponding alpha, as defined in (34). The FX Regime is from Reinhart and Rogoff (2004). The "Commodity Share" is defined as the sum of "Ores and Metals" and "Fuel" exports as a percentage of total merchandise exports from World Bank World Development Indicators. The top and bottom observations are winsorized. Robust standard errors are used in all regressions with the significance level indicated by *** p<0.01, ** p<0.05, * p<0.1.