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DEFAULT OR DEPRECIATE

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Default or Depreciate [1]

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Abstract

We propose a theory of domestic and foreign currency debt and limited commitment to exchange-rate and debt repayment policies. Exchange-rate depreciation is costly, but reduces the real value of domestic-currency debt and helps smooth consumption without the full punishment of default. However, during a global liquidity shock, government debt balances endogenously tilt towards hard-currency as in the data, although issuing local-currency debt to foreigners is needed the most to transfer the currency risk. This is because foreign lenders become more risk averse to holding nominal sovereign debt during stress episodes. We show that a modest depreciation of currency following adverse shocks precludes a sovereign default by inflating away outstanding local-currency debt burdens in contrast to a counterfactual economy with fully dollarized sovereign debt. The quantitative application of our theory accounts for the business cycle properties and the currency composition of sovereign debt in Mexico.

Keywords: Sovereign default, inflationary bias, investor base, original sin
JEL Codes: E31, F34, F45

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1 Introduction

Emerging market economy (EME) governments' inability to issue foreign debt in their own currency (Eichengreen and Hausmann, 1999) resulting from an inflation bias under lack of monetary policy credibility (Kydland and Prescott (1977) and Calvo (1978)) has fairly dissipated in the last two decades. Yet, the so-called "original sin" finds its way to recur quickly during global crises. In Figure 1, we demonstrate this for both the Global Financial Crisis and the COVID-19 shock, during which a sharp reversal in the global risk appetite has coincided with a collapse in local-currency (LC) and a surge in hard-currency denominated EME sovereign debt held by foreign investors.[1] The ensuing portfolio rebalancing revives a debate on whether a wider foreign investor base for LC debt actually helps preclude defaults by inflating away debt burdens (Calvo, 1988) or makes EME sovereigns more vulnerable to reversals in the global risk appetite (IMF, 2020b) as per the difficulty in issuing LC debt to foreigners when it is needed the most to reduce the currency risk.

In this paper, we reassess these conflicting views by developing a theory and building a quantitative sovereign default model in which the sovereign faces an explicit portfolio choice in issuing debt in both local and foreign currencies. The government also sets the exchange-rate optimally by discretion and may outright default on its debt obligations, guided by the multifaceted interaction between LC sovereign debt issuance under an inflationary bias and default risk.

Incorporating nominal debt contracts in our setup marks an essential departure from the Eaton and Gersovitz (1981)-class of sovereign default models. Firstly, in reality, most of LC debt is issued under domestic law, whilst foreign-currency (FC) debt is typically overseen by foreign law. Therefore, it is key to account asymmetries in foreign investors' risk attitude toward holding domestic versus hard-currency denominated EME sovereign debt, potentially leading to jurisdiction premiums (Chamon et al., 2018). Secondly, while FC debt is essentially a real contract, domestic-currency debt helps the sovereign smooth consumption in times of stress as LC debt burdens may be inflated away under limited commitment to exchange-rate policy. In our model, although such ex post currency depreciations entail real distortions *à la* Rotemberg (1982)-type menu costs, the

[1] Lines with(out) diamonds in Figure 1 correspond to debt denominated in foreign (local) currency in Mexico. Solid and dashed lines correspond to the Global Financial Crisis and the COVID-19 crisis episodes, respectively. Time t on the horizontal axis denotes the quarter for each stress episode, in which monthly realizations of the volatility index VIX was five standard deviations above its historical mean. For comparability across stress episodes and currency denominations, real debt stocks are normalized to 100 in quarter $t-2$. This is representative of a broader pattern: foreign holdings of domestic-currency denominated EME sovereign debt declines substantially during global crises (Bertaut et al., 2021).

resulting inflation bias as in Barro and Gordon (1983) and Aguiar et al. (2014) reduces expected real payoffs to lenders and causes bond yields to reflect a currency risk premium. This additional premium leads to a cost of borrowing dominance, making LC debt issuance nonconforming for the sovereign. Thirdly, reflecting the original sin redux (Carstens and Shin, 2019), the pricing of EME sovereign bonds is strongly affected by global conditions, further widening jurisdiction premiums that favor hard-currency debt during stress episodes as documented by Chamon et al. (2018).

The key feature of our environment involves an empirically relevant segmentation among risk averse foreign lenders (Bertaut et al., 2021) so that during normal times with abundant global liquidity, LC debt holders tolerate risk more than hard-currency lenders, reflecting a search of yield motive. This offsets the currency risk premium included in LC bond yields and mitigates the cost of borrowing dominance problem over the business cycle. However, when global liquidity is scarce and macroeconomic fundamentals of the EME are dim, LC bond investors become as risk averse as hard-currency lenders, reflecting a reversal in investor sentiment as documented by IMF (2020b) and bringing back the cost of borrowing dominance effect that favors hard-currency debt issuance.[2]

The analytical characterization of our model suggests that optimal currency depreciations are countercyclical, when inflating LC debt away is useful to reduce outright default risk (which increases with bad fundamentals) and helps smooth consumption more effectively. Secondly, there is an unambiguous incentive to inflate higher levels of LC debt away. Finally, optimal currency structure of sovereign debt depends on the interplay among lenders' pricing behavior in holding the two bond classes, the default risk and the currency risk.

We calibrate our baseline specification to Mexico which is representative of the LC sovereign debt shares that are observed in EMEs in the 2004-2019 episode. Model simulations successfully match time series averages of total sovereign debt-to-GDP ratio, FC credit spreads, LC debt share of sovereign debt and inflation over the reference period. The baseline model also predicts empirically plausible volatility patterns for consumption and both debt-to-GDP ratios which are more volatile than output, whilst excess bond yields and inflation emerge as less volatile compared to output. The sovereign in our model aggressively switches between domestic and hard-currency debt

[2]Bertaut et al. (2021) present direct evidence on the characteristics of US based EME government debt holders in the last two decades. As illustrated in Figure D.1 in the Online Appendix, among US investors, a larger part of domestic-currency EME government bonds are held by mutual funds, who are more responsive to reversals in the global risk sentiment. Hard-currency sovereign bonds on the hand, are mostly held by insurance and pension funds, who prefer more stable and US dollar denominated returns to avoid currency mismatch under longer investment horizons.

issuance over the business cycle as in the data to minimize the likelihood of costly outright defaults. Inflation, excess bond yields, net exports and LC debt-to-GDP ratios emerge as countercyclical in our simulations, whereas the FC debt-to-GDP ratio is acyclical, reflecting empirical co-movements.

Using our model, we demonstrate that although higher foreign holdings of LC sovereign debt increases the vulnerability of EMEs to reversals in global risk appetite, transferring the exchange-rate risk and actively managing the currency structure of sovereign debt help avoid outright defaults. To that end, we feed the same path of adverse income shocks leading up to a reversal in global liquidity conditions to the baseline model and to a financially dollarized economy, in which no LC debt issuance is possible. We find while the dollarized economy defaults on its debt obligations, the sovereign in the baseline model tilts its debt portfolio toward LC denomination in the run-up to the liquidity crisis, depreciates its currency by a cumulative 100 basis points and continues to repay its debt. The intuition behind this finding is that although foreign investors reduce their demand for the newly issued LC debt during the risk-off episode, the previously accumulated stock of LC debt, the incentive to preserve sovereign debt sustainability and avoid costly outright defaults help achieve an incentive-compatible state contingency via ex post exchange-rate depreciations. This provides an alternative to the proper accounting of state-contingent inflation policies by an outside agency (Lucas and Stokey, 1983).

Since currency depreciations are distortionary and limited commitment to exchange-rate policy is ex ante priced in by foreign lenders, the normative question of whether LC debt issuance increases welfare arises. We find that an unanticipated switch from the dollarized economy to the baseline model with identical initial hard-currency debt-to-GDP ratios across the two economies increases welfare of households. This welfare gain is mainly linked with the frontloading of private consumption upon the announcement of LC debt issuance, which leads to an increase in the market value of sovereign debt enabled by the reduced default risk.

The debt sustainability benefits of optimal currency depreciations in our environment help explain EMEs' ability to weather the exceptional COVID-19 shock without a major debt event. In Figure A.1, we demonstrate that countries with a higher LC share in total foreign holdings of sovereign debt prior to the COVID-19 shock endured larger currency depreciations (with a correlation coefficient of 0.33) and lower rises in CDS spreads (with a correlation coefficient of -0.38) during the pandemic. Therefore, our analysis predicts that in countries with a higher LC share in foreign holdings of government debt prior to the pandemic, a major portion of the post-pandemic surge in sovereign bond yields (Hofmann et al., 2020) might be attributed to the increased currency risk rather than the credit risk.

Our contributions are threefold. Firstly, we demonstrate how an EME can avoid default by actively managing the currency structure of its sovereign debt, even during exceptional episodes such as the COVID-19 crisis that severely hamper LC debt issuance. On the theoretical dimension, we show that bringing lenders to the front line is instrumental in accounting for the dynamics of the currency structure of sovereign debt in EMEs who have a track record of chronic inflation. Finally, on computational grounds, we tackle a three dimensional optimization problem, which includes an explicit portfolio choice among two debt classes and currency depreciation.

Related literature

Our paper contributes to a vast literature on inflation bias and original sin. The earlier research attributes the lack of domestic-currency debt in international debt markets to an inflationary bias stemming from the lack of monetary policy credibility (Kydland and Prescott (1977) and Calvo (1978)). Later on, Calvo (1988) highlighted the benefits of mitigating the inflation bias which is the outcome of a time-inconsistency problem identified by Barro and Gordon (1983). Aguiar et al. (2015) indicates that a mixture of high- and low-debt member countries may constitute an optimal currency union arrangement under lack of commitment to price stability and the possibility of self-fulfilling debt crises. It is widely observed that a similar inflationary bias has been mitigated in the EMEs thanks to the adoption of stronger macroeconomic policy frameworks (most importantly the central bank independence), which accordingly enabled a dissipation in the original sin (Du and Schreger, 2016). However, we introduce a new dimension to the previous literature by exploring whether the increased foreign ownership of LC debt, associated with the reduced original sin, jeopardizes EME sovereigns' ability to avert debt crises in exceptional global stress episodes, during which foreigners tend to fire sell LC government bonds (Figure 1 and Bertaut et al. (2021)).

This paper is also closely related to the studies on currency composition of sovereign debt. Ottonello and Perez (2019) find avoiding dilution effects of high inflation and real exchange rate depreciation implies larger FC sovereign debt shares under limited commitment to the level of debt issuance and inflation policy. Engel and Park (2021) consider enforcement constraints pertaining to default and currency debasement choices and show that the debt composition is biased toward FC debt under less credible monetary policy.[3] Different from these studies, we incorporate equilibrium outright defaults and investigate how countries may benefit from optimal currency depreciations to reduce default risk. Önder and Sunel (2021) show higher borrowing costs faced by a country exiting a currency union result in welfare losses despite domestic-currency debt issuance is useful to avoid debt crises. All these studies abstract from the original sin redux, which makes LC debt issuance difficult in stress episodes and limits the debt sustainability benefits of discretionary inflation. By introducing this feedback, we are able to assess whether the original sin is really dissipating or weighing on EMEs in a different form via the increased vulnerability to global financial conditions. Du et al. (2020) show that if countercyclical discretionary inflation policies increase lenders' risk aversion towards holding LC debt, then, sovereigns that cannot commit to price stability would find it harder to issue more domestic currency debt despite its hedging benefits. These authors abstract from default and study a two-period model. In sharp contrast, we explore default risk implications as well as business cycle properties of the currency management of sovereign debt.

Finally, our paper relates to a strand of literature on currency devaluations that co-exist with defaults. Da-Rocha et al. (2013) show when there is no commitment not to devalue and self-fulfilling crises are possible, effective debt limits become tighter. This results in devaluation announcements to trigger defaults. Na et al. (2018) argue devaluations co-exist with defaults to help eliminate labor market disequilibria that occur during debt crises. Bianchi and Mondragon (2021) to explore self-fulfilling debt crises in the context of retaining monetary policy autonomy or joining a monetary union and find that the possibility of exchange-rate devaluations under independent monetary policy can eliminate self-fulfilling rollover crises. This strand of literature overlooks the benefit of issuing debt in domestic currency as it builds on Cole and Kehoe (2000), Aguiar and Gopinath (2006) and Arellano (2008) environments, which are essentially original sin economies. By modeling multiple currency sovereign debt issuance, we propose a new angle to this literature in showing that moderate exchange-rate depreciations might indeed mitigate the default risk.

[3] Both studies abstract from outright default. Ottonello and Perez (2019) argue in their online appendix that extending their environment to involve default explains about 60% of the empirically observed LC sovereign debt shares, whilst we are able to exactly match the currency composition of defaultable sovereign debt. Engel and Park (2021) consider an extension with defaults occurring in equilibrium but only when the economy is in the original sin state in which no LC debt issuance is possible.

The rest of the paper is organized as follows. The next section describes a theoretical model of the currency structure of defaultable sovereign debt and discretionary exchange-rate policy. Section 3 provides an analytical depiction of optimal currency management and exchange-rate policies and defines equilibrium. Section 4 reports quantitative insights from the baseline model. Section 5 explores underlying model mechanisms. Finally, Section 6 concludes the paper.

2 A model of the currency structure of sovereign debt

We study a small open economy model inhabited by a continuum of infinitely lived, identical households and a sovereign government. The domestic economy's output is subject to endowment shocks under incomplete markets. Time is discrete. The sovereign maximizes the utility of the representative household and has the option to default on its local and foreign currency denominated foreign debt obligations, should it find it optimal. In addition, it has a discretionary exchange-rate determination policy at its disposal-akin to a managed float, which allows the government to depreciate the currency ex post. A second source of uncertainty is the global state of liquidity which has a direct impact on the investors' tolerance of risk towards LC debt issuance. There is a single tradable final good for private consumption and the law of one price holds. Therefore, price inflation coincides with exchange-rate depreciations.[4] Unless otherwise noted, capital and lower case letters denote nominal and real variables, respectively.

2.1 Sovereign economy

Households and endowments. Households' preferences over consumption flows are defined as

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t), \tag{1}$$

where $0 < \beta < 1$ is the subjective discount factor (identical across individuals) and $\mathbb{E}$ is the mathematical expectation operator. The utility function $u(c)$ takes the standard CRRA form,

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma}, \tag{2}$$

[4]For simplicity, we abstract from a policy interest rate that follows an inflation targeting objective. If our framework were extended in that direction, optimal exchange-rate depreciations would have created an upward pressure on monetary policy rates due to the inflationary effects of the exchange-rate pass-through.

so that it is continuous and strictly concave in consumption and satisfies the Inada condition, $\lim_{c\to 0^+} u_1(c) = \infty$. $\sigma > 1$ is the constant relative risk aversion parameter.

The small open economy's endowment y is a single tradable good that follows the process

$$\log y_{t+1} = (1-\rho)\bar{y} + \rho \log y_t + \varepsilon_{t+1} \tag{3}$$

subject to zero mean and constant variance Gaussian innovations with $|\rho| < 1$.

Debt contracts. The sovereign issues local and foreign currency (say, peso and dollar) denominated debt in international bond markets. For tractability, we abstract from seigniorage as a fiscal revenue source. The receipts from external debt issuance finance the trade deficit and are rebated back to households in a lump-sum fashion.

We rule out selective defaults so that the government negates on its bond obligations without discriminating in the currency dimension. Furthermore, upon default, it is barred from issuing debt immediately and loses access to foreign debt markets for a random number of periods into the future. Notice that as in Calvo (1988), government can strategically inflate away its external liabilities to the extent that it issues peso debt.

Let T denote the total nominal revenue (denominated in domestic currency units) collected by sovereign debt issuance. Therefore, T would be defined as:

$$T_t = (1-d_t)[\underbrace{q_t^F E_t(b_{t+1}^F - (1-\delta)b_t^F) - \kappa E_t b_t^F}_{\text{net debt revenue on dollar bonds}} + \underbrace{q_t^L(B_{t+1}^L - (1-\delta)B_t^L) - \kappa B_t^L}_{\text{net debt revenue on peso bonds}}]. \tag{4}$$

The total bond revenue is multiplied by an indicator (credit standing) function $1-d_t$. If the economy is in default or in a financial exclusion spell that followed a previous default, the credit standing is "bad" ($d_t = 1$), so that the sovereign cannot issue any bonds. b_t^F stands for dollar denominated real amount of bonds that accrue from the previous period. Since we assume that foreign price level is exogenous and constant at $P_t^* = 1 \;\; \forall t$, when we multiply this object by the nominal exchange rate of dollar against pesos E_t, we arrive at its nominal value in peso units. B_t^L on the other hand, represents peso denominated debt obligations issued in foreign capital markets in the previous period. q_t^F and q_t^L are the discount prices of dollar and peso denominated bonds, which are inversely related to the nominal yield paid on each respective bond.

Foreign obligations of the sovereign in (4) are long term. We assume so, in order to generate more realistic levels of indebtedness as well as interest rate spreads faced by emerging economies as in Hatchondo and Martinez (2009). Specifically, long-term bonds mature geometrically at the rate δ and carry a coupon payment of κ units in terms of the consumption good. Implicit in equation (4) is also the ruling out of selective defaults. That is, there is a single credit stance indicator d_t for both bond issuances. Note however, that the two types of debt are priced differently due to the currency depreciation risk on peso denominated debt and potential differences in investors' risk appetite towards the purchase of each bond as we illustrate below.

The dollar debt has a return of $R^F_{t-1}q^F_{t-1}b^F_t$, where R^F_{t-1} is the gross nominal interest in dollars between periods $t-1$ and t. Since foreign prices are taken as given and constant, dollar debt is a real contract. On the contrary, the peso debt contract is nominal as its real return is determined ex post. In particular, international lenders earn a real return of $R^L_{t-1}q^L_{t-1}B^L_t/P_t$ on previously issued peso debt, where R^L_{t-1} is the gross nominal interest on peso debt between periods $t-1$ and t and P_t is the aggregate price level of the domestic economy in period t, which is implied by the discretionary exchange-rate policy at date t. We assume that the law of one price holds with $P_t = E_t P^*_t = E_t$. Therefore, the depreciation of the exchange rate determines the domestic inflation with $1+\pi_t = \frac{P_t}{P_{t-1}} = \frac{E_t}{E_{t-1}}$. At date t, the government sets the net depreciation rate of the currency $\frac{E_t}{E_{t-1}} - 1$ and hence the net rate of inflation π_t (so that the two concepts are used interchangeably, hereafter) without committing to a pre-announced exchange-rate path.

Repayment. If the government does not repudiate on its outstanding debt, it can issue new debt in both currencies. For a given rate of inflation, new issuances of dollar and peso debt in real terms are denoted by b^F_{t+1} and $b^L_{t+1} = B^L_{t+1}/P_t$, whereas gross real debt payments that accrue from the previous period are $R^F_{t-1}q^F_{t-1}b^F_t$ and $R^L_{t-1}q^L_{t-1}b^L_t/(1+\pi_t)$. Hence, the government may inflate away its real burden of peso denominated debt by choosing a high currency depreciation rate.

Under repayment, the economy faces the resource constraint,

$$c_t = y_t\left(1 - \frac{\theta}{2}\left[\pi_t - \pi^*\right]^2\right) + \frac{T_t}{E_t} \tag{5}$$

with the quadratic term in the deviation of the net inflation rate from a target rate of inflation π^* reflecting Rotemberg (1982)-type output costs of inflation, which are created by exchange-rate depreciations in our model economy. The scaling parameter $\theta > 0$ measures the distaste of the sovereign for inflation, as output costs of inflation increase with a higher θ. These output costs and the fact that foreign lenders' pricing function would take into account the expectation of future depreciations result in equilibrium inflation to be bounded from above.

Conditional on repaying debt, the interest earned on dollar and peso bonds R_t^F, R_t^L read,

$$R_t^F = \frac{(1-\delta)q_{t+1}^F + \kappa}{q_t^F} \quad \text{and} \quad R_t^L = \frac{(1-\delta)q_{t+1}^L + \kappa}{q_t^L}. \tag{6}$$

The price and yield of both debt instruments are functions of the sovereign debt portfolio, current endowment level and the state of global liquidity as we explicitly demonstrate below. When the sovereign repays, real transfers that are rebated back to the households become

$$\frac{T_t}{E_t} = q_t^F b_{t+1}^F - R_{t-1}^F q_{t-1}^F b_t^F + q_t^L b_{t+1}^L - \frac{R_{t-1}^L q_{t-1}^L b_t^L}{1+\pi_t}. \tag{7}$$

Combining interest rate definitions in (6) with real transfers (7) and plugging them in (5) imply

$$c_t = y_t \left(1 - \frac{\theta}{2}\left[\pi_t - \pi^*\right]^2\right) + q_t^F(b_{t+1}^F, b_{t+1}^L, y_t, l_t)\left(b_{t+1}^F - (1-\delta)b_t^F\right) - \kappa b_t^F$$

$$+ q_t^L(b_{t+1}^F, b_{t+1}^L, y_t, l_t)\left(b_{t+1}^L - \frac{(1-\delta)b_t^L}{1+\pi_t}\right) - \kappa\frac{b_t^L}{1+\pi_t}, \tag{8}$$

where l_t is the state of global liquidity at date t.

Default. When government repudiates on its debt obligations, it is excluded from international capital markets and is not able to issue new debt for a finite but stochastic number of periods. That is, re-entry to debt markets occurs only with probability $0 < \psi < 1$. Being in financial autarky implies households can consume only the endowment of the economy, which reflects a resource penalty of being in the default state. That is,

$$c_t = y_t - \phi\left(y_t\right). \tag{9}$$

We assume $\phi(.)$ takes a quadratic form, $\phi(y) = \max\{0,\ d_0 y + d_1 y^2\}$ with $d_1 > 0$ to avoid default in high income realizations as discussed by Arellano (2008) and Chatterjee and Eyigungor (2012). We calibrate the parameters of this default cost function to match the moments of debt statistics such as debt-to-GDP levels and sovereign spreads.

To model defaults more realistically, we assume that a fixed haircut rate of $0 < 1 - \omega < 1$ is applied to bonds in default so that partial recovery is possible even when debt is repudiated. During default, the recovered stock of debt grows with the international interest rate r^*. Suppose that the sovereign is out of the debt restructuring procedures T periods after the most recent default, which, say, had occurred at date t^*. In this case, it enters the markets with a stock of $\omega b^F (1 + r^*)^T$ in dollar debt and a stock of $\frac{\omega b^L (1+r^*)^T}{\prod_{t=t^*}^{T} \left(1+\hat{\pi}_t(b_t^F, b_t^L, y_t, l_t)\right)}$ in peso debt with r^* standing for the international risk free real interest rate. The term $\hat{\pi}_t(b_t^F, b_t^L, y_t, l_t)$ in the denominator of the latter denotes the debt reducing impact of accumulated exchange rate depreciations that the government would have chosen optimally during the state of default. Note however, that the sovereign cannot issue or repay any new debt when in default. Therefore, $\{\hat{\pi}_t(b_t^F, b_t^L, y_t, l_t)\}_{t=t^*}^{T-1} = 0$ and depreciations can only play a role at date T, when financial autarky ends. This also results in suppressing the output cost of inflation in equation (9).

No-buyback constraints. In our simulations, although rarely, the government finances the buy back of FC debt prior to defaults by issuing unrealistic sums of LC bonds to reduce the overall debt burden at the expense of hyper-inflating the economy. This perverse incentive, which eliminates some of the defaults, results in the occasional co-existence of hyper-inflation and excessive LC debt issuance, which is empirically implausible. On the other side of the coin, we (again rarely) observe that under favorable income shocks, the sovereign has the incentive to issue dollar debt to buy back its peso denominated bonds to avoid output costs of inflation. This is because inflating the economy in good times is not as much necessary as under bad income shocks as we analytically demonstrate in Section 3.3. To avoid such instances, we impose $b_{t+1}^F - (1-\delta) b_t^F \geq 0$ should be satisfied when $b_{t+1}^L - \frac{(1-\delta) b_t^L}{1+\pi_t} > 0$ and $b_{t+1}^L - \frac{(1-\delta) b_t^L}{1+\pi_t} \geq 0$ should hold when $b_{t+1}^F - (1-\delta) b_t^F > 0$.

2.2 Lenders are in the front line in explaining the currency structure of sovereign debt

Investigating currency management of foreign-held, risky sovereign debt requires assigning international lenders a pivotal role in the analysis. Firstly, studying an environment with foreign ownership of LC sovereign debt constitutes a sharp deviation from the Eaton and Gersovitz (1981)-class of sovereign default models. That is, whilst the contractual obligations of hard-currency EME sovereign debt is mainly overseen by foreign jurisdictions, almost entire EME LC sovereign debt is issued under domestic law (Du and Schreger, 2016). This highlights a fundamental difference between the holders of domestic and foreign currency denominated EME sovereign debt in their attitude toward risk, potentially leading to jurisdiction premiums (Chamon et al., 2018).

Secondly, while hard currency debt perfectly hedges lenders against currency risk, peso debt is fully susceptible to an ex post currency depreciation bias under limited commitment to exchange-rate policy. This is due to the sovereign's urge to smooth consumption by reducing real repayments of peso denominated debt as we analytically demonstrate in the next section. Therefore, anticipating this motive, purchasers of domestic-currency bonds would charge a currency depreciation premium to protect their returns from the inflation bias that is well explored in the literature (Barro and Gordon, 1983). This makes equilibrium issuance of LC debt (to be purchased by foreign investors) extremely difficult from the perspective of the government, due to a cost of borrowing dominance.

Thirdly, the pricing of EME sovereign bonds is strongly affected by global conditions making foreign ownership of LC sovereign debt a source of financial vulnerability for EME governments. In recent work, Morelli et al. (2021) establish that EME sovereign bonds that have been purchased by global financial intermediaries who are hit more strongly by aggregate shocks suffer larger price declines than other EME government bonds. Further discussions by Borri (2018), Carstens and Shin (2019) and Bertaut et al. (2021) highlight the role of the currency structure of sovereign debt in EMEs in the transmission of such pricing effects. Specifically, the increase in the foreign ownership of domestic-currency EME sovereign debt (the so-called dissipating original sin) in the last two decades has transferred the currency risk from EME sovereigns to foreign lenders. However, since foreign lenders typically compute their losses in dollar units and EME currencies tend to depreciate vis-à-vis hard currencies in stress episodes, the migration of the currency risk from borrowers to lenders induce the latter to sell LC sovereign bonds at a more rapid pace in such *risk-off* episodes, further reducing the price of those bonds. Indeed, Chamon et al. (2018) show although jurisdiction premiums between debt issued under domestic versus foreign law are negligible during tranquil times, in episodes of stress, debt issued under foreign jurisdictions (mainly denominated in dollars) trades at a premium relative to the debt overseen by domestic law (mainly denominated in LC).

In the light of this discussion, we assume that risk averse foreign investors price loans made to the sovereign in both currencies, taking decision rules for default d, currency depreciation π, the borrowing portfolio b^F, b^L, macroeconomic fundamentals of the small open economy y and the state of global liquidity l, as given. Lenders seek to maintain no-arbitrage over investing in risk-free debt versus purchasing the two types of sovereign bonds. We further assume that risk averse lenders are grouped into two in which, during normal times with abundant liquidity, domestic-currency debt holders are slightly more tolerant to risk than hard-currency debt holders, reflecting a search of yield motive, even though buying LC sovereign debt entails currency risks.[5] This allows the excess tolerance of risk by holders of LC debt to counteract the currency risk premium, eliminating the cost of borrowing dominance in normal times.[6]

Particularly, dollar bond investors price payoff streams at the kernel

$$m^F_{t,t+1} = \exp\left[-\left(r^* + \bar{\alpha}\varepsilon_{t+1} + \frac{\bar{\alpha}^2\sigma^2_\varepsilon}{2}\right)\right] \tag{10}$$

with $\bar{\alpha} > 0$. This specification is a simplified version of the one that is used by Arellano and Ramanarayanan (2012) and is a particular case of the form studied by Vasicek (1977). Specifically, $\bar{\alpha} > 0$ suggests that lenders would discount dollar debt at a higher rate under more favorable macroeconomic fundamentals in the subsequent period ε_{t+1}, against which the sovereign would like to borrow heavily. Note also that even if $\varepsilon_{t+1} = 0$, an aversion premium would still arise by the virtue of the last term, which includes σ^2_ε, the variance of innovations that hit the log-normal exogenous income process (3).

The pricing kernel of peso bond investors on the other hand, features a lower risk aversion premium in normal times and reflects a feedback from the state of global liquidity borrowing a variant of the formulation in Hatchondo et al. (2021) and in accordance with the evidence

[5]For further insights from the literature on the expanding foreign investor base of domestic-currency EME public debt, see Online Appendix A.1

[6]This modeling choice is only one way to ensure that large enough LC debt is traded in equilibrium during tranquil episodes even though it bears currency risk. For instance, in Section 5.3, we demonstrate that costs of ex post exchange-rate depreciations act as a commitment device that partly boosts the prevalence of LC debt issuance.

documented by Bertaut et al. (2021) and IMF (2020b) on the increased responsiveness of LC bond investors to EME fundamentals and global financial conditions. That is,

$$m_{t,t+1}^{L} = \exp\left[-\left(r^{*} + \alpha(l_t)\varepsilon_{t+1} + \frac{\alpha(l_t)^2\sigma_{\varepsilon}^2}{2}\right)\right] \tag{11}$$

where for the binary state of global liquidity $l_t \in \{l^H, l^L\}$, the risk aversion of peso bond investors takes the values of $\alpha(l^H) = \underline{\alpha}$ and $\alpha(l^L) = \bar{\alpha}$ for $l^H > l^L$ and $\bar{\alpha} > \underline{\alpha}$. The two inequalities suggest that when global liquidity is scarce, the pricing kernel of LC debt holders entails a larger discount rate of future payoff streams. Therefore, during risk-off episodes, the search for yield motive dissipates and peso bond investors' risk tolerance declines as has been discussed by Chamon et al. (2018).[7] This feature of our environment reflects the idea that the government's ability to issue domestic-currency debt is precisely hindered in times when it needs to transfer the currency risk to foreigners the most as was exemplified by the experience of EMEs during the Global Financial Crisis and the COVID-19 crisis (see Figure 1 and Figure 1.17-2 in IMF (2020a)).

Global liquidity follows a two-state Markov chain with the transition matrix

$$\mathbf{P} = \begin{bmatrix} p_{LL} & p_{LH} \\ p_{HL} & p_{HH} \end{bmatrix}. \tag{12}$$

$p_{LH} \in [0,1]$ is the transition probability of switching back to a high liquidity state following a stress episode. This parameter is calibrated to target the duration of liquidity crises in our sample, so that $p_{LL} = 1 - p_{LH}$ follows from the Markov transition property. $p_{HL} \in [0,1]$ on the other hand, is the likelihood of entering a liquidity crisis following a tranquil period. This probability reflects the idea that financial conditions for the EME tighten under less favorable macroeconomic fundamentals as discussed by Calvo et al. (2004) and is consistent by the recent findings of Bertaut et al. (2021) and IMF (2020b) that domestic currency bond flows to EMEs become more responsive to domestic fundamentals than FC debt flows when global capital flows are exceptionally volatile. Specifically,

$$p_{HL} = \min\left\{p_{HL}^{0}\exp\left[-p_{HL}^{1}\log(y_t) - \frac{(p_{HL}^{1})^2\sigma_{\varepsilon}^2}{2}\right], 1\right\}, \tag{13}$$

[7] Modeling explicit jurisdiction differences is beyond the scope of this paper. Nonetheless, we partly capture the idea of rising jurisdiction premiums that favor the legally safer hard-currency debt during episodes with exceptionally low global liquidity, by assuming that in such episodes, foreign investors' appetite towards peso debt declines.

with $0 < p^1_{HL} < 1$ suggesting that a lower and more volatile EME output increases the likelihood of the co-existence of reduced risk appetite of LC bond holders and global liquidity crises. Parameters $0 < p^0_{HL}, p^1_{HL} < 1$ can be jointly picked to target the frequency of liquidity crises and the size of income shortages relative to a trend that are associated with such stress episodes, respectively. Finally, $p_{HH} = 1 - p_{HL}$ follows from the Markov transition property.

3 Analytical framework

In this section, we provide the recursive representation of the sovereign's dynamic problem, define the Markov perfect equilibrium concept and analytically explore how the optimal currency composition of defaultable sovereign debt as well as the exchange-rate policy are determined.

3.1 Recursive representation

Let v^r and v^d represent value functions of repayment versus default on the government debt, respectively. Since there is partial debt recovery, both value functions are defined over the debt composition, output and the state of global liquidity. For any combination of debt portfolio and income, the default decision is determined by comparing these two values. That is,

$$v(b^F, b^L, y, l) = \max\left\{v^r(b^F, b^L, y, l), v^d(b^F, b^L, y, l)\right\} \tag{14}$$

so that if $v^r(b^F, b^L, y, l) > v^d(b^F, b^L, y, l)$, the decision rule for default takes the value $\hat{d}(b^F, b^L, y, l) = 0$. Otherwise, one obtains $\hat{d}(b^F, b^L, y, l) = 1$.

Value of repayment satisfies,

$$v^r(b^F, b^L, y, l) = \max_{b^{F'}, b^{L'}, \pi, c \geq 0} \left\{u(c) + \beta\, \mathbb{E}_{y', l' | y, l}\left[v(b^{F'}, b^{L'}, y', l')\right]\right\}, \quad \text{subject to} \tag{15}$$

$$c = y\left(1 - \frac{\theta}{2}\left[\pi - \pi^*\right]^2\right) + q^F\left(b^{F'} - (1-\delta)b^F\right) - \kappa b^F + q^L\left(b^{L'} - \frac{(1-\delta)b^L}{1+\pi}\right) - \kappa\frac{b^L}{1+\pi}$$

$$b^{F'} - (1-\delta)b^F \geq 0 \;\text{ if }\; b^{L'} - \frac{(1-\delta)b^L}{1+\pi} > 0, \;\; b^{L'} - \frac{(1-\delta)b^L}{1+\pi} \geq 0 \;\text{ if }\; b^{F'} - (1-\delta)b^F > 0,$$

where $q^F = q^F(b^{F'}, b^{L'}, y, l)$ and $q^L = q^L(b^{F'}, b^{L'}, y, l)$ for ease of exposition and the mathematical expectation $\mathbb{E}$ is calculated over the processes of income and global liquidity y, l.

When the government defaults on its debt, the continuation value reflects the random re-entry to the international capital markets with probability ψ. If random re-entry occurs, the sovereign starts out with a restructured debt stock that reflects the exogenous haircut rate of $1-\omega$ on both bonds. If financial autarky continues, debt stocks grow with the international interest rate. That is,

$$v^d(b^F, b^L, y, l) = u(y - \phi(y))$$

$$+\beta\,\mathbb{E}_{y',l'|y,l}\left[\psi\, v(\omega b^F(1+r^*), \omega b^L(1+r^*), y', l') + (1-\psi)\, v^d(b^F(1+r^*), b^L(1+r^*), y', l')\right] \quad (16)$$

Inflation in default states would always be zero as there is no incentive for the sovereign to depreciate the currency (which is costly) when no peso debt is repaid.

The solution to the government's problem yields a policy function for consumption $\hat{c}(b^F, b^L, y, l)$, a default decision rule $\hat{d}(b^F, b^L, y, l) \in \{0, 1\}$, borrowing rules for dollar $\hat{b^F}(b^F, b^L, y, l)$ and peso debt $\hat{b^L}(b^F, b^L, y, l)$ and a discretionary depreciation rate $\hat{\pi}(b^F, b^L, y, l)$. In equilibrium, defined in Section 3.2, lenders use these decision rules to price contracts. Particularly, equilibrium pricing schedules for dollar q^F and peso q^L debt solve the following functional equations evaluated at equilibrium decision rules for borrowing, default and inflation:

$$q^F(b^{F'}, b^{L'}, y, l) \;=\; \mathbb{E}_{y',l'|y,l}\left\{m^F_{y,y'}\left[(1-d')\left[(1-\delta)q^{F'} + \kappa\right] + d' q_d^{F'}\right]\right\}, \quad (17)$$

$$q^L(b^{F'}, b^{L'}, y, l) \;=\; \mathbb{E}_{y',l'|y,l}\left\{m^L_{y,l,y'}\frac{\left[(1-d')\left[(1-\delta)q^{L'} + \kappa\right] + d' q_d^{L'}\right]}{1+\pi'}\right\}. \quad (18)$$

$$q_d^F\left(b^{F'}, b^{L'}, y, l\right) = \mathbb{E}_{y',l'|y,l}\left\{m^F_{y,y'}(1+r^*)\left[\psi\,\omega\left((1-d')\left[(1-\delta)q^{F'} + \kappa\right] + d' q_{dd}^{F'}\right) + (1-\psi)q_d^{F'}\right]\right\}, \quad (19)$$

$$q_d^L\left(b^{F'}, b^{L'}, y, l\right) = \mathbb{E}_{y',l'|y,l}\left\{m_{y,l,y'}^L (1+r^*)\left[\psi\,\omega\frac{\left[(1-d')\left[(1-\delta)q^{L'}+\kappa\right]+d' q_{dd}^{L'}\right]}{1+\pi'} + (1-\psi) q_d^{L'}\right]\right\}, \tag{20}$$

with respective equations (17) and (18) denoting pricing schedules for dollar and peso bonds when the sovereign is in a good credit standing and equations (19) and (20) representing pricing schedules for dollar and peso bonds when they are in default. The default decision in the subsequent period $d' = \hat{d}(b^{F'}, b^{L'}, y', l')$ follows the policy function $\hat{d}$ evaluated at next period's states. $q^{F'} = q^F(b^{F''}, b^{L''}, y', l')$, and $q^{L'} = q^L(b^{F''}, b^{L''}, y', l')$ are fixed points to the functionals (17) and (18) evaluated at next period's aggregate endowment and liquidity states as well as the borrowings $b^{F''} = \hat{b^F}(b^{F'}, b^{L'}, y', l')$ and $b^{L''} = \hat{b^L}(b^{F'}, b^{L'}, y', l')$.

A few aspects of the pricing schedules deserve discussion. First, we model lenders in a reduced-form way for simplicity and assume that they have deep pockets. This implies that creditors are ready to purchase sovereign debt as long as they are as well off as an outside option. For risk averse investors, this option entails selling the bonds in the subsequent period and discounting receipts from that sale by the risk-free world interest rate plus an additional risk premium asked from the sovereign borrower reflected in the pricing kernels (10) and (11). Second, since there is limited commitment to exchange-rate policy, next period's expected payoff is calculated by taking into account default risk for dollar debt and additionally currency depreciation risk for peso debt.

Focusing on the pricing menu (17) reveals that if dollar bonds are not defaulted in the subsequent period, lenders earn a coupon payment of κ and could sell the non-matured debt at the price $q^{F'}$. On the contrary, if default occurs, lenders can sell debt only at the restructuring price of $q_d^{F'}(b^{F'}, b^{L'}, y', l')$, which exclusively depends on debt issued in the previous period (as new debt issuance is not possible under default) and the aggregate state of the economy in the subsequent period. A similar reasoning applies to the pricing of peso debt denoted by (18) with the additional key feature that payoffs from holding peso debt could be inflated away at the rate $\pi' = \hat{\pi}(b^{F'}, b^{L'}, y', l')$.

Functionals (19) and (20) determine how dollar and peso debt that are in default are traded in equilibrium. These pricing menus do not collapse to zero as the haircut rate $1-\omega$ in case of debt repudiation is less than one. Pricing functional (19) reflects the possibility of the sovereign to regain access to debt markets after default. In particular, financial autarky ends with the exogenous probability ψ allowing lenders to earn a payoff that is multiplied by the recovery rate ω. After gaining access to debt markets in the subsequent period, the sovereign has the option to repay its debt $d' = \hat{d}(\omega b^{F'}(1+r^*), \omega b^{L'}(1+r^*), y', l') = 0$ or serially default $d' = 1$. Note that the recovered debt grows into the subsequent period at the world interest rate $1+r^*$. If the sovereign repays, lenders receive the coupon payment κ and could sell the non-matured debt at the price $q^{F'} = q^F(b_d^{F'}, b_d^{L'}, y', l')$, with $b_d^{F'} = \hat{b}^F(\omega b^{F'}(1+r^*), \omega b^{F'}(1+r^*), y', l')$ and $b_d^{L'} = \hat{b}^L(\omega b^{F'}(1+r^*), \omega b^{F'}(1+r^*), y', l')$ denoting equilibrium borrowings in dollar and peso debt upon re-entering debt markets after the default state. If on the other hand, the sovereign defaults again, $d' = 1$, then the dollar and peso debt trades at the prices $q_{dd}^{F'} = q_d^F(\omega b^{F'}(1+r^*), \omega b^{L'}(1+r^*), y', l')$ and $q_{dd}^{L'} = q_d^L(\omega b^{F'}(1+r^*), \omega b^{L'}(1+r^*), y', l')$ reflecting a serial default feature.

Finally, the government continues to be barred from borrowing from international debt markets in the subsequent period with probability $1-\psi$. In this case, the debt restructuring does not take place, so that the outstanding stock of debt grows into the next period at the international risk free interest rate without reflecting a haircut, so that the debt can be traded at the price $q_d^{F'} = q_d^F(b^{F'}(1+r^*), b^{L'}(1+r^*), y', l')$. Once again, the pricing of peso debt in default (20) is determined akin to that of dollar debt with the only difference that should the sovereign re-enter debt markets, it can reduce the real payoff to lenders at the net rate of $\pi' = \hat{\pi}(b_d^{F'}, b_d^{L'}, y', l')$, .

The borrower does not discriminate creditors while declaring outright default as the default policy is symmetric across debt instruments. This allows the sovereign to reduce the default risk on both debt classes, should it inflate away peso debt burdens by choosing a positive depreciation rate. As a result, it is the dynamic interplay between the premiums paid for currency and default risk and lender aversion, which ultimately pins down the sovereign debt portfolio in equilibrium.

3.2 Equilibrium

Limited commitment to repayment and exchange-rate policy are observed by lenders so that there is no reputation building via signaling. Krusell and Smith (2003) show that such lack of commitment to future policies might cause indeterminacy of Markov equilibria in the infinite horizon. Therefore, we focus on Markov perfect equilibria (MPE) which arise as the limits of finite horizon economies wherein the government's equilibrium default, borrowing and exchange-rate depreciation decisions depend only on payoff relevant state variables.

Definition 1 (Markov perfect equilibrium) *Given the exogenous states of the economy y, l, a Markov perfect equilibrium is characterized by value functions v, v^r and v^d, bond pricing functionals q^F, q^L, q_d^F, q_d^L, a symmetric default rule $\hat{d}$, borrowing rules $\hat{b^F}, \hat{b^L}$ and a currency depreciation rule $\hat{\pi}$ such that*

1. *Given the bond pricing functionals, government policy rules $\left\{\hat{d}, \hat{b^F}, \hat{b^L}, \hat{\pi}\right\}$ solve the utility maximization problem defined in equations (14), (15), and (16).*
2. *Given government policy rules $\left\{\hat{d}, \hat{b^F}, \hat{b^L}, \hat{\pi}\right\}$, the bond pricing functionals q^F, q^L, q_d^F, q_d^L satisfy conditions (17), (18), (19) and (20).*

3.3 Characterization of equilibrium

In this section, we analytically study the optimal debt portfolio and currency depreciation choices of the sovereign using some illustrative simplifications. This is because the government in our framework faces a nontrivial portfolio choice problem, while simultaneously deciding on the optimal currency depreciation policy. Therefore, it is useful to follow the strategy developed by Bianchi et al. (2018) and Aguiar et al. (2019) and focus on a triple of debt portfolio objects and currency depreciation rate that support a constant consumption level. In addition, to facilitate exposition, we assume that both bond pricing functionals and the value function in problem (15) are differentiable as in Arellano and Ramanarayanan (2012). We also abstract from debt recovery, the no-buyback constraints and set the target inflation rate π^* to zero.[8] In particular, the budget constraint of the sovereign who enters the current period with a good credit standing is written as

$$\bar{c} = y\left(1 - \frac{\theta}{2}\pi^2\right) + q^F\left(b^{F'} - (1-\delta)b^F\right) - \kappa b^F + q^L\left(b^{L'} - \frac{(1-\delta)b^L}{1+\pi}\right) - \kappa\frac{b^L}{1+\pi} \tag{21}$$

with $\bar{c}$ representing our reference consumption level and bond prices q^F and q^L defined over $(b^{F'}, b^{L'}, y, l)$. With no loss of generality, our focus is on the determination of optimal LC denominated debt for given currency depreciation and FC debt issuance policy. Therefore, define peso

[8] Simplifying assumptions in this section are for the purposes of analytical exposition. Our numerical solution does not rely on Euler equation methods and neither imposes any differentiability assumption on optimality conditions nor imposes any restriction on the level of consumption.

borrowing that supports a constant level of consumption as $\widehat{b^L}(b^{F'},\pi,s)$ with $s=\{y,l,\bar{c},b^F,b^L\}$ denoting the "state of the world". Applying the implicit function theorem to equation (21) shows how optimal LC borrowing depends on currency depreciation and FC debt, while keeping $\bar{c}$ constant:

$$\frac{\partial \widehat{b^L}}{\partial \pi}=\frac{\overbrace{\theta y\pi-\left[q^L(b^{F'},\widehat{b^L},y,l)(1-\delta)+\kappa\right]b^L\Big/(1+\pi)^2}^{\text{Net reduction in the budget introduced by inflation}}}{\underbrace{q^L(b^{F'},\widehat{b^L},y,l)+\frac{\partial q^L(b^{F'},\widehat{b^L},y,l)}{\partial \widehat{b^L}}\left[\widehat{b^L}-\frac{(1-\delta)b^L}{1+\pi}\right]+\frac{\partial q^F(b^{F'},\widehat{b^L},y,l)}{\partial \widehat{b^L}}[b^{F'}-(1-\delta)b^F]}_{\text{Net revenue from issuing peso debt}}} \tag{22}$$

$$\frac{\partial \widehat{b^L}}{\partial b^{F'}}=\frac{\overbrace{-\left(q^F(b^{F'},\widehat{b^L},y,l)+\frac{\partial q^F(b^{F'},\widehat{b^L},y,l)}{\partial b^{F'}}[b^{F'}-(1-\delta)b^F]+\frac{\partial q^L(b^{F'},\widehat{b^L},y,l)}{\partial b^{F'}}\left[\widehat{b^L}-\frac{(1-\delta)b^L}{1+\pi}\right]\right)}^{\text{Net revenue from issuing dollar debt}}}{\underbrace{q^L(b^{F'},\widehat{b^L},y,l)+\frac{\partial q^L(b^{F'},\widehat{b^L},y,l)}{\partial \widehat{b^L}}\left[\widehat{b^L}-\frac{(1-\delta)b^L}{1+\pi}\right]+\frac{\partial q^F(b^{F'},\widehat{b^L},y,l)}{\partial \widehat{b^L}}[b^{F'}-(1-\delta)b^F]}_{\text{Net revenue foregone by reducing peso debt}}} \tag{23}$$

with $\frac{\partial \widehat{b^L}}{\partial \pi}=\frac{\partial \widehat{b^L}(b^{F'},\pi,s)}{\partial \pi}$ and $\frac{\partial \widehat{b^L}}{\partial b^{F'}}=\frac{\partial \widehat{b^L}(b^{F'},\pi,s)}{\partial b^{F'}}$. The numerator of equation (22) reflects the *net* reduction in the budget (that would support any constant $\bar{c}$) resulting from a rise in inflation driven by the exchange-rate pass-through. An incremental increase in inflation reduces output by the first term, whereas the second term expands the budget because LC debt repayments are inflated away. The denominator of equation (22) represents the net revenue from issuing peso debt. For each unit of bond issued, the sovereign raises q^L units of resources. In addition to this, one has to factor in the endogenous impact of new bond issuance on the prices of domestic and hard currency debt, which is captured in the second and third terms. If $\frac{\partial \widehat{b^L}(b^{F'},\pi,s)}{\partial \pi}>0$, then the net reduction in budget set is positive, so that it is compensated by selling more LC bonds to attain reference consumption.

Equation (23) characterizes the optimal portfolio maintaining the reference consumption. The numerator reflects the net revenue raised by issuing FC debt. Notice again that dollar debt issuance affects both bond prices (captured by partial derivatives) akin to peso debt. If there is a portfolio shift toward dollar debt away from peso debt, so that $\frac{\partial \widehat{b^L}(b^{F'},\pi,s)}{\partial b^{F'}}<0$, then this term is positive and compensates for the reduction in the budget, which would be captured by the denominator.

Optimal debt portfolio. Having characterized the implications of inflation and portfolio rebalancing on the budget frontier, we now proceed to exploring how optimal currency depreciation and portfolio choices are determined in the recursive formulation. Since we fixed consumption, optimal portfolio and currency depreciation policy can be characterized by maximizing the return value in problem (15) subject to all future portfolio and currency depreciation policies being optimal. Particularly, optimal portfolio and currency depreciation solve,

$$\max_{b^{F'},\pi\geq 0} \; \mathbb{E}_{y',l'|y,l}\left[v(b^{F'},\widehat{b^{L}}(b^{F'},\pi,s),y',l')\right], \tag{24}$$
$$\text{subject to } \widehat{b^{L}}(b^{F'},\pi,s)\geq 0.$$

We relegate the explicit derivations regarding the solution of this problem to Online Appendix A.2 (which also includes an Euler equation approach). The solution yields two optimality conditions for sovereign debt portfolio and currency depreciation:

$$\mathbb{E}_{y',l'|y,l}\left[(1-d')\underbrace{u_1(c')[q^{F'}(1-\delta)+\kappa]}_{\text{Cost of increasing dollar debt}}\right] = \mathbb{E}_{y',l'|y,l}\left[(1-d')\underbrace{u_1(c')\frac{[q^{L'}(1-\delta)+\kappa]}{1+\pi'}}_{\text{Benefit of reducing peso debt}}\right]\overbrace{\left(-\frac{\partial\widehat{b^{L}}}{\partial b^{F'}}\right)}^{\substack{\text{Portfolio}\\ \text{adjustment}}} \tag{25}$$

$$\mathbb{E}_{y',l'|y,l}\left[(1-d')u_1(c')\frac{[q^{L'}(1-\delta)+\kappa]}{1+\pi'}\right]\underbrace{\frac{\partial\widehat{b^{L}}}{\partial\pi}}_{\substack{\text{Effect of inflation}\\ \text{on portfolio}}}=0 \tag{26}$$

Equation (25) equates cost of tilting debt portfolio towards FC to its benefit. The left-hand side represents the utility cost of repaying one more unit of the coupon κ and carrying $q^{F'}(1-\delta)$ amounts of long-term FC debt over the next period. The right-hand side displays the benefit of avoiding the repayment of LC debt in the next period thanks to the portfolio rebalancing toward dollar bonds in the current period. Both payoffs are taken into account in repayment states so that they are multiplied by $1-d'$. They are also affected from the pricing behavior of international lenders coded in $q^{F\prime}$ and $q^{L\prime}$ as well as the expected optimal inflation bias $\pi'>0$ in the subsequent period.

Currency depreciation policy. Equation (26) characterizes optimal currency depreciation policy. Since $q^{L'}$ would be positive in a repayment state and $\kappa > 0$, using equation (22), one can show that optimal currency depreciation policy satisfies

$$\theta y \pi = \left[q^L(b^{F'}, \widehat{b^L}, y, l)(1-\delta) + \kappa\right] b^L \Big/ (1+\pi)^2 \tag{27}$$

This condition equates marginal output cost of inflating away the economy (left) to the marginal benefit of reducing real payments of peso debt. Applying the implicit function theorem to (27) relates the currency depreciation policy to endowment and the outstanding stock of LC debt by:

$$\frac{\partial \pi}{\partial y} = \frac{-\theta\pi + \frac{\partial q^L(b^{F'}, \widehat{b^L}, y, l)}{\partial y} \frac{(1-\delta)b^L}{(1+\pi)^2}}{\theta y + 2[q^L(b^{F'}, \widehat{b^L}, y, l)(1-\delta) + \kappa] b^L \Big/ (1+\pi)^3}. \tag{28}$$

For ease of exposition, let us assume that debt contracts are short-term and entail only one period. In this case, $\delta = \kappa = 1$, so that bond price plays no role in the determination of optimal currency depreciation policy in condition (27) and whole outstanding debt is inflated away. Since $\theta > 0$, one obtains $\frac{\partial \pi}{\partial y} < 0$. This finding highlights the deviation from commitment to exchange-rate policy. That is, optimal currency depreciation is countercyclical, to achieve better consumption smoothing by inflating LC debt away in bad times. The resulting currency depreciation would then translate into an inflation bias via pass-through and create deviations from price stability. This feature makes the introduction of liquidity shocks consistent with the concept of the original sin redux discussed by Bertaut et al. (2021), as EME currency depreciations during stress times hurt the balance sheet of exposed international lenders who fund themselves with hard currency funds. This in turn, increases the likelihood of a bond sell-off by these investors followed by a reduction in their tolerance to risk, which is captured by the liquidity shock in their pricing kernel (11).

Now, consider the case of long-term debt with $0 < \delta, \kappa < 1$. In this case, there may be certain situations in which currency depreciation policy becomes procyclical. Particularly, one has $\frac{\partial \pi}{\partial y} \geq 0$ if $\frac{\partial q^L(b^{F'}, \widehat{b^L}, y, l)}{\partial y} \frac{(1-\delta)b^L}{(1+\pi)^2} \geq \theta\pi$. The left-hand side of this inequality is the incremental increase in marginal benefit of reducing real debt burdens via inflation as income increases, while the right-hand side stands for the incremental increase in marginal cost of doing so. Therefore, the sovereign shall find it useful to set currency depreciation procyclically if the former outweighs the latter.

Finally, it is more straightforward to discuss the relationship between currency depreciation policy and the outstanding stock of LC debt. Condition (27) implies,

$$\frac{\partial \pi}{\partial b^L} = \frac{q^L(b^{F'}, \widehat{b^L}, y, l)(1-\delta) + \kappa}{\theta y(1+\pi)^2 + 2[q^L(b^{F'}, \widehat{b^L}, y, l)(1-\delta) + \kappa]b^L \Big/ (1+\pi)} > 0, \tag{29}$$

so that, all else equal, it is optimal to increase currency depreciation when LC debt is higher.

If we sum up our analytical findings, we observe that (i) currency depreciation is countercyclical when inflating away peso debt is useful for consumption smoothing purposes, (ii) there is an unambiguous incentive to inflate away the peso debt and (iii) optimal portfolio depends on how outright default risk premium weighs against the currency depreciation risk premium.

4 Quantitative analysis

We calibrate the quantitative version of the model described in Section 2 to the 2004Q1-2019Q4 episode of the Mexican economy to exclude the exceptional COVID-19 crisis. This period is characterized by the well documented fact that EMEs started using domestic currency denominated external debt instruments more frequently compared to the past.[9] We use the updated version of the Arslanalp and Tsuda (2014) database in computing our key empirical target of domestic currency share in foreign-held sovereign debt. These authors report the local/foreign currency breakdown of central government debt securities held by foreign lenders for 24 EMEs during the 2004Q1-2020Q4 episode. Therefore, dividing the LC denominated stock of central government debt securities to the general government gross debt held by foreign lenders provides a proxy for the portfolio share of domestic currency in foreign-held sovereign debt.[10] This allows us to study cyclical properties of the currency composition of sovereign debt for the Mexican economy.

After approximating for the MPE, we simulate the model economy many times for a large number of periods and take the averages over those simulated samples to compute business cycle moments. While computing the moments, we use the deviations of the natural logarithm of

[9]See Ottonello and Perez (2019), Du and Schreger (2021) and Engel and Park (2021).

[10]The investor base for each type of lender comprises of the official sector (central bank for the case of domestic holders), banks and nonbanks. Our definition of the portfolio might understate the peso share of external public debt if local governments are able to issue external debt in domestic currency, which is less likely relative to the ability of the central government. See Online Appendix A.3 for further details on Arslanalp and Tsuda (2014) data.

model variables from a linear trend. For empirical consistency, we pick time series that exclude outright default events while calculating cyclical moments implied by the model. The details of the quantitative solution algorithm of the model economy are provided in Online Appendix A.4.

4.1 Model calibration and parameterization

The parameters used in the computation of the baseline model are reported in Table 1. The model period is a year. The discount factor of households is parameterized at $\beta = 0.92$. We use a standard value for the risk aversion parameter of the CRRA class utility functions and set $\sigma = 2$. The persistence $\rho = 0.65$ and volatility $\sigma_\epsilon = 0.0283$ parameters of the income process are determined to match the linearly detrended component of the logarithm of Mexico's annualized real GDP for the period 1980-2019. Seasonally adjusted GDP series are taken from the OECD. The implied mean log-income becomes $\bar{y} = -\frac{\sigma_\epsilon^2}{2} = -0.0004$. The decay rate for long-term bonds is set to $\delta = 0.2845$, which implies about 3 years for the maturity of sovereign debt.[11] The coupon payment ratio κ is determined by imposing a no-default risk condition on the bond pricing equation (17), in which $q^F(b^{F'}, b^{L'}, y, l)$ approximately takes the value $\frac{1}{1+r^*}$, with $r^* = 4\%$ denoting the annual net real risk-free rate in international markets. This implies, $\kappa = \frac{\delta + r^*}{1+r^*} = 0.312$. Probability of re-entering foreign debt markets $\psi = 0.6667$ is calibrated to a standard value and implies about one and a half year of exclusion from international capital markets following a default. We set the exogenous debt recovery rate $\omega = 0.63$ following Cruces and Trebesch (2013) who report historical debt recovery patterns during sovereign default episodes. The periodic target rate for inflation is set to $\pi^* = 3\%$ taking the central bank of Mexico's inflation target as reference.

We take the Global Financial Crisis and the COVID-19 crisis as reference for extreme risk-off episodes of the last two decades during which there has been a large reversal in global risk sentiment. The monthly VIX index, a gauge for global risk sentiment, has been around five standard deviations above its average in each of these episodes. Additionally, for a representative set of EMEs, real GDP has been below its trend by around 3.8 percentage points in these two episodes.[12] Therefore,

[11]The Macaulay formulation of duration for decaying coupon payments suggests that the duration of a long-term bond in our framework becomes $\frac{1+i}{\delta+i}$, where i is the risky yield on the sovereign bond, an endogenous equilibrium object. Observe that if the bond fully matures in the current period $\delta = 1$, the duration becomes one period. The model-implied debt maturity resembles that in Bianchi et al. (2018) to ensure comparability with the literature.

[12]This figure is computed by Mimir and Sunel (2021) as the average deviation of real GDP below a HP-trend during the Global Financial Crisis and the pandemic for thirteen EMEs who deployed quantitative easing policies during the COVID-19 crisis to respond to the sovereign bond sell-off by foreign investors.

the two parameters, $p_{HL}^0 = 0.38$ and $p_{HL}^1 = 38$, that affect the Markov transition probability (13) of switching from high risk tolerance to low risk tolerance towards domestic-currency EME sovereign debt are jointly calibrated to target a frequency of once every decade and an output loss of 3.7% (relative to trend), respectively. Finally, given the moderate duration of the liquidity crises, we set the Markov transition probability of switching from low to high risk tolerance towards peso bonds $p_{LH} = 1$ to ensure that extreme stress episodes last for one year.

We normalize the risk aversion parameter of peso investors to $\underline{\alpha} = 1$. The remaining four parameters are jointly calibrated to get the baseline model match four empirical moments: The two penalty parameters for the output costs of outright default $d_0 = -1.45$ and $d_1 = 1.6$, the output cost intensity parameter of inflation $\theta = 4$ and the risk aversion parameter $\alpha = 6.25$ of hard-currency sovereign bond investors. These parameters are jointly picked by simulating the model to match a sovereign debt-to-GDP ratio of 30.3%, a FC denominated sovereign bond spread of 2.2% and inflation rate of 4.1% per annum and a LC share of foreign-held sovereign debt of 48%, where these figures correspond to the time series averages of their respective moment in the sample period.[13]

We extend the methodology of Du and Schreger (2016) to compute model-generated local currency credit spreads in an environment with multiple currency debt instruments. Specifically, we first solve for the pricing schedule of a synthetic and default risk-free peso denominated bond as explained in greater detail in Appendix A.2. This allows us to obtain a default risk-free yield to maturity of r_t^{*L} for peso bonds. The credit spread on peso denominated bonds can then be calculated by $r_t^L - r_t^{*L} = \frac{\kappa}{q_t^L} - \delta - r_t^{*L}$. The definition of the yield-to-maturity of defaultable peso bonds r_t^L follows our geometrically decaying long-term bonds formulation.

4.2 Baseline model vs. data

The first two columns of Table 2 report baseline model's performance in replicating long-term and cyclical properties of the Mexican economy in the sample period. The upper panel suggests that the model is able to generate an empirically plausible inflation rate as well as a LC sovereign debt share. Particularly, the portfolio share of domestic currency debt is 46.5% against 48%, and average

[13] Data on total sovereign debt-to-GDP ratio and the currency composition of foreign-held sovereign debt are collected from the updated dataset of Arslanalp and Tsuda (2014) that spans 2004-2019. For dollar denominated country risk premiums, we use the EMBI Global index compiled by JP Morgan. We use year-on-year changes in the consumer price index published by the OECD to measure inflation.

inflation emerges as 4.2% vis-à-vis 4.1% in the data. The calibration exercise is also successful in matching the sovereign debt-to-GDP ratio and credit spreads on FC debt. Using fixed-for-fixed cross currency swaps and under certain assumptions, Du and Schreger (2016) isolate credit risk of domestic currency bonds as deviations from covered interest parity. These authors' dataset imply an average credit spread on Mexican peso denominated bonds of 0.5% per annum in the sample period. The model overestimates the credit risk on peso debt (which has not been targeted in the calibration routine) with an average domestic currency credit spread of 1.5%.

The baseline model produces empirically plausible volatility patterns (the middle panel of Table 2) without targeting these moments. Specifically, consumption and both debt-to-GDP ratios are more volatile than output. On the other hand, excess yields on both bonds as well as inflation are less volatile than output. Given the lack of commitment to exchange-rate policy, calibrated currency depreciation costs emerge as large to support high enough equilibrium inflation in the model. This results in the sovereign's reduced appetite to create excessive fluctuations in the exchange-rate. Instead, the sovereign, proactively tilts the currency of debt to minimize the likelihood of costly outright defaults. This is evident in large standard deviations in debt-to-GDP ratios in both currencies in the effort of reducing real debt burdens over the business cycle. Finally, the volatile debt dynamics cause the net exports-to-GDP ratio to be more volatile in the model than in the data.

Our model correctly predicts the acyclicality of the FC debt-to-GDP ratio and the countercyclicality of net exports- and LC debt-to-GDP ratios, dollar and peso bond spreads (although stronger than data) and inflation (the bottom panel of Table 2).[14] The negative co-movement between inflation and income in the model suggests that the sovereign relies on inflating away the economy via excess currency depreciations under adverse macroeconomic fundamentals to make peso debt payments state-contingent in a way to improve consumption smoothing.

The model is successful in generating strong substitutability between hard and domestic currency sovereign debt over the business cycle as a partial sign of active currency management of debt to reduce default risk. We highlight that as shown in the last row of Table 2, simulations produce a strong negative cross correlation coefficient of -0.9 between dollar and peso debt-to-GDP

[14]The mild countercyclicality of inflation in the data implies that on average, in bad times, the exchange-rate pass-through repercussions on inflation have dominated the effects of subdued domestic demand in the Mexican economy. It is straightforward to modify quadratic inflation costs formulation to obtain procyclical inflation dynamics over the business cycle in simulations.

ratios as in the data (see Figure 1) without targeting this empirical moment. The model-implied evolution of optimal portfolio composition over the business cycle, as depicted in Figure 2, asserts that there is a very clear negative relationship between the debt accumulation paces of the two instruments.[15] Simulations are implied by the quantitative solution of the full model and do not consider reference consumption levels while solving the dynamic program of the sovereign as opposed to our illustrative discussion in Section 3.3.

4.3 Optimal currency management of sovereign debt helps avert debt crises

We establish that debt sustainability benefits of dissipating original sin outweigh the risks that emanate from the original sin redux. That is, even under increased susceptibility to reversals in global risk sentiment with higher foreign holdings of domestic-currency sovereign debt, transferring the exchange-rate risk to foreigners continues to provide meaningful fiscal relief to EME sovereigns. We accomplish this by feeding two model economies, the baseline and a counterfactual specification with the same hypothetical path of income shocks as well as the occurrences of liquidity crises. The counterfactual specification, which we call as the dollarized economy, is one in which the sovereign does not have access to a peso bond instrument so that all outstanding sovereign debt and new issuance have to be denominated in hard currency. We then analyze how the optimal currency management, borrowing and exchange-rate policies of the sovereign compare in the two specifications during an exceptional episode of increased risk aversion of peso lenders coinciding with adverse macroeconomic fundamentals as observed during the COVID-19 crisis.

Figure 3 shows the total debt-to-GDP ratio (fine-dashed line in the left-panel) consistently rises in the dollarized economy as it approaches the liquidity crisis during which an outright default is declared around year 50 as evident by the applied haircut to debt. The debt event also results in hard-currency bond spreads (dashed-line in the right-panel) to spike by about 15 percentage points just prior to the default. By contrast, the gradual build-up of consecutive negative shocks in the run-up to the liquidity crisis induces the sovereign in the baseline economy to tilt the currency structure of its debt towards pesos (dashed lines in the left-panel) and deleverage in dollars (dotted-lines in the left-panel). At the same time, the sovereign announces larger exchange-rate depreciations

[15] The chart plots the time series for FC (dotted line) and LC debt (dashed line) as a percentage of GDP for 25 years. The simulated value in any period reflects the average of realizations across 2000 sample paths.

(fine-dashed lines in the right-panel) as it approaches the liquidity crisis (leading to an accumulated increase of 100 basis points per annum in inflation) with the motive of reducing domestic-currency debt burdens. Intriguingly, even if the peso debt-to-GDP ratio declines due to the increased risk aversion towards LC debt, the sovereign continues to repay debt during the liquidity crisis, which limits the rise in hard-currency bond spreads by around 3 percentage points (dotted-line in the right-panel). Meeting the trade-off between default and inflating the debt away, the sovereign finds financial exclusion and output costs of default to be larger than distortions created by exchange-rate depreciations in the form of higher output and borrowing costs.

Our findings help explain how EME sovereigns successfully weathered the onset of the COVID-19 crisis without a major debt event, although the pandemic was an exceptional risk-off episode coinciding with adverse macroeconomic fundamentals. We showed that LC debt facilitates an incentive-compatible state contingency via the ex post choice of exchange-rate depreciation. Drawing a nice parallel with our results, many countries with a higher LC share in foreign-held sovereign debt prior to the pandemic endured larger currency depreciations, while at the same time having lower rises in country risk premia during the COVID-19 crisis (see Figure A.1 in the Appendix).

4.4 Issuing domestic-currency debt increases welfare

How do the avoided output losses of sovereign default under LC debt issuance fare against costly currency depreciations without any commitment to exchange-rate policy? We answer this question by computing welfare gains of an unanticipated switch from the counterfactual dollarized economy to our baseline specification. In particular, we compute state-dependent welfare gains in terms of percentage changes in compensating consumption variations that would leave sovereign indifferent between staying in the dollarized economy or switching to the environment with both dollar and peso debt issuance. We measure consumption-equivalent welfare gains denoted by η as,

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u\left(\tilde{c}_t[1+\eta]\right) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t\right), \tag{30}$$

in which the consumption streams $\{\tilde{c}_t\}_{t=0}^{\infty}$ and $\{c_t\}_{t=0}^{\infty}$ are attained in the dollarized and baseline economies, respectively. Welfare gain measure η is evaluated at the triple of initial hard-currency debt, endowment and the state of liquidity and is derived from equilibrium value functions with

$$\eta(b^F, y, l) = \left[\frac{v(b^F, 0, y, l)}{\tilde{v}(b^F, y)}\right]^{\frac{1}{1-\sigma}} - 1,$$

utilizing the CRRA form for household preferences. $\tilde{v}(b^F, y)$ and $v(b^F, 0, y, l)$ are value functions evaluated at identical levels of initial dollar debt and output in the dollarized and baseline economies, respectively. To make a proper comparison, we set the initial stock of peso debt in the baseline economy to nil. Positive values for η imply that the benevolent sovereign would prefer issuing dollar and peso debt thereafter instead of staying financially dollarized.

We find that moving to the regime with dollar and peso debt issuance improves welfare. In particular, welfare gains from the unanticipated regime change evaluated at the ergodic mean debt-to-GDP ratio of the dollarized economy are positive over varying income realizations (see the left panel of Figure 4). We also find that gains are higher as the endowment of the economy gets closer to the default threshold (moving to the left on the horizontal axis) after which they display a discrete fall upon inevitable default. Finally, welfare gains shrink under low liquidity (dashed lines) for output levels nearing the default threshold as the increased risk aversion of peso lenders in this case hampers the revenue raising capacity of the sovereign.

Welfare gains from issuing both hard- and domestic-currency sovereign debt even without commitment to exchange-rate policy are mainly linked with the frontloading of private consumption upon the announcement of peso debt issuance. Specifically, despite being costly, the lever to reduce real debt burdens via discretionary exchange-rate depreciations lead to an increase in the market value of sovereign debt enabled by improved debt sustainability. We demonstrate this by plotting the pricing schedules as a function of net debt issuance under the dollarized (solid line) and the baseline economy (dashed lines, with the one in the south denoting the pricing schedule of peso debt) on the right panel of Figure 4. For given debt stock and income, bond prices decrease with the net debt issuance-to-income ratio. Without loss of generality, we consider the low liquidity state in the baseline specification, which results in the pricing menu of peso debt to shift down, reflecting the currency and the increased risk aversion premiums charged by peso lenders. The thick dots on the pricing menus coincide with equilibrium decision rules evaluated at the particular state of the economy and imply that the sovereign in the baseline economy is able to issue more bonds relative to income after the announcement of peso debt issuance. This finding extends to comparing market values that take into account pricing effects as we find that the market value of net debt issuance in the baseline economy is 9% larger than in the dollarized specification.[16]

5 Model mechanics

In this section, we quantitatively explore the optimal currency management and exchange-rate policies of the sovereign in our environment to sharpen our understanding of the inner workings of the model. The discussion relates to our analytical investigation in Section 3.3. We also illustrate the importance of bringing lenders to the front line in understanding currency dynamics of sovereign debt and the role of real distortions created by exchange-rate depreciations.

5.1 Decision rules

How does the sovereign adjust the currency structure of its debt portfolio in the face of liquidity crises? The left panel of Figure 5 plots gross debt issuance frontier as a function of lenders' aversiveness towards peso debt. Specifically, the frontiers represent the doubles of gross dollar ($b^{F'}$) and peso ($b^{L'}$) debt issuance amounts (as a percentage of mean income, which is normalized to one) that support a reference consumption level, echoing the strategy adopted in Section 3.3. The solid and dashed lines plot the frontiers that correspond to foreign lenders' strong and weak tolerance of risk towards holding LC debt, respectively. The thick dots on the frontiers correspond to equilibrium choices, which maximize value of repayment.

The negative slope of the debt frontiers (as opposed to a slope of zero) suggests that the model supports accumulation of debt in both instruments, so that there is active portfolio rebalancing between FC and LC debt as the reference consumption level is attained. Second, the debt frontier shifts out when there is a liquidity crisis. However, when we specifically compare equilibrium portfolio choices under different risk tolerance levels of peso lenders, we find that the debt issuance portfolio under weaker risk tolerance is to the north-west of that when risk tolerance is strong. This suggests that, since cost of peso debt rises during risk-off episodes, and the sovereign is expected

[16]Net debt issuance in the baseline economy is defined as $b^{F'} - (1-\delta)b^F + b^{L'}$ as there is no initial stock of peso debt at the time of announcement, whereas in the dollarized economy, it is defined as $\tilde{b}^{F'} - (1-\delta)b^F$. Market value of these issuances is then denoted by $q^F(b^{F'} - (1-\delta)b^F) + q^L b^{L'}$ and $\tilde{q}^F(\tilde{b}^{F'} - (1-\delta)b^F)$, in which $\tilde{q}^F$ and $\tilde{b}^{F'}$ correspond to the issuance price and gross bond issuance in the dollarized economy.

to inflate real peso debt burdens away, the sovereign is compelled to tilt the currency structure of its debt towards hard-currency when global liquidity is scarce.

Numerical decision rules confirm that the sovereign displays a stronger currency depreciation bias as outstanding peso debt increases. The right panel of Figure 5 plots the decision rule for currency depreciation (in annualized percentage terms) as a function of outstanding peso debt and the two risk tolerance levels, while fixing the outstanding level of dollar debt at its mean over simulations. In line with our discussion in Section 3.3, optimal exchange-rate policy calls for a higher depreciation rate of currency when the stock of peso debt is larger. We also observe that currency depreciation policy function shifts up slightly when risk tolerance towards peso debt is stronger, since it is cheaper to issue peso debt under ample global liquidity.

We conclude with the observation that the cyclicality of currency depreciation policy interacts with sovereign default risk. The discussion in Section 3.3 suggested that currency depreciation might be weakly increasing in income when the responsiveness of LC bond price to income increases. To illustrate the nonmonotonicity in the co-movement between currency depreciation and income, we include Figure 6 in which we plot currency depreciation policy as a function of endowment, while fixing outstanding FC and LC stocks of debt at their average over simulations (solid lines). The dashed lines on the other hand, correspond to a higher outstanding peso debt, all else equal. For thinner lines (on the left), the numerically approximated endowment elasticity of LC bond price is greater than one. For the thicker lines, the same elasticity is less than one. Confirming our analytical insights, when the elasticity of LC bond price with respect to income is large, currency depreciation increases with income and hence, is procyclical.

This finding is intuitive as when the sovereign faces a very steep bond price menu as a function of output, marginal benefit of reducing debt burdens via inflation rapidly declines with lower income, not justifying further real distortions from inflating the economy away. On the other hand, when income elasticity of LC bond price is smaller, inflation policy is downward sloping in income. This is because in this region, the incremental increase in marginal output costs of higher inflation dominates the incremental increase in its marginal benefit. Note also that irrespective of the cyclicality of the exchange-rate, an increase in LC debt shifts the currency depreciation schedule upwards as the outstanding debt burden to inflate away gets larger.

5.2 The investor base is pivotal in explaining domestic-currency debt shares

This section illustrates the importance of taking into account empirically relevant heterogeneities in the investor base of EME sovereign debt in explaining the currency structure of public debt in these countries. To that end, we consider an alternative parameterization of our quantitative model in which peso lenders are as risk averse as dollar investors at all times. That is, $l_t = l^L$ so that $\alpha(l_t) = \bar{\alpha}\ \forall t$. This would imply symmetric pricing kernels for all lenders with

$$m^F_{t,t+1} = m^L_{t,t+1} = \exp\left[-\left(r^* + \bar{\alpha}\varepsilon_{t+1} + \frac{\bar{\alpha}^2\sigma^2_\varepsilon}{2}\right)\right]. \tag{31}$$

The third column of Table 2 reports key empirical moments for this economy with higher risk aversion towards peso debt, in which we leave all other model parameters unchanged. The key feature of this economy is that it produces a much lower domestic currency debt share than the baseline economy (6% as opposed to 46%) while producing a total debt-to-GDP ratio and dollar spreads that resemble the latter. The scarcity of peso debt in equilibrium is directly linked with the inability of the sovereign to pre-commit to low currency depreciation rates. Lenders realize that expected real payoffs from peso debt are vulnerable to discretionary currency depreciations as opposed to dollar debt payoffs. This causes the discounting on domestic debt prices to be systematically larger than FC debt (see bond pricing menus (17) and (18)), which in turn hinders the revenue generation ability of the sovereign from peso debt issuance. Therefore, the economy gets closer to an "original sin" state (in the Eichengreen et al. (2005) sense) as an endogenous equilibrium outcome. Finally, as a reflection of lower domestic-currency debt issuance, annual inflation declines by 100 basis points in this economy relative to the baseline specification. This is because with less LC debt, consumption smoothing benefits from inflation fall short of its distortionary output costs.

A compelling question is why lenders purchase peso debt at all, if its repayments carry currency risk as opposed to dollar debt. The answer lies within the nature of default, the hedging properties of domestic currency denominated debt and the existence of debt recovery. Firstly, since defaults are not selective, the dynamics of credit risk on both debt instruments co-move. Hence, the sovereign issues just the right amount of peso debt to ensure that it reduces the likelihood of outright defaults at the expense of incurring output costs of inflation. Secondly, a nonzero debt-recovery upon default constrains how low bond prices can go, limiting the adverse effect of currency depreciation on bond prices and making peso denominated bonds slightly more amenable than otherwise.

Losing the domestic-currency debt and inflation levers has a profound effect on business cycle implications of the model. Specifically, the economy with lower LC debt produces less volatile debt-to-GDP ratios and inflation, while at the same time producing higher volatility in bond spreads. In addition, inflation becomes less countercyclical and the negative co-movement between both debt instruments in the baseline economy disappears (see the second and third panels of Table 2). These findings are essentially linked with the inability of the sovereign in using LC debt and inflation as tools to provide fiscal relief in episodes of less favourable macroeconomic fundamentals.

5.3 The importance of distortions created by currency depreciations

We uncover that costs of inflation act as a partial commitment device akin to a successfully applied inflation targeting regime, which contributed to factors that have allowed the EME sovereigns to issue more LC debt in the last two decades. In other words, this helps mitigate the inflationary bias. This finding emerges from checking the robustness of our results to the intensity of inflation costs, which prevent the sovereign from choosing arbitrarily large currency depreciation rates in the baseline model. Particularly, we reduce the output cost parameter of currency depreciations by half (with $\theta = 2$) while leaving the rest of model parameters unchanged. The fourth column of Table 2 reports that lenders realize as output costs of inflation created by currency depreciations are reduced, the sovereign would have a stronger tendency to inflate its debt away. As a result, equilibrium in this case supports a LC debt share that is 17 percentage points lower than the baseline economy. This decline in the prevalence of peso debt is mainly linked with the increased discounting of domestic-currency payoff streams by peso lenders with the expectation that the inflation bias would be stronger under lower inflation costs.[17]

In terms of volatilities as well as output correlations, the reduced inflation cost specification produces similar results vis-à-vis the baseline economy, with the main departure of lower volatility of both debt-to-GDP ratios and a slightly more volatile trajectory for inflation over the business cycle. Therefore, between the currency management and exchange-rate policy levers, the sovereign

[17] When inflation costs are further increased arbitrarily, the portfolio collapses to peso debt due to the elimination of the currency risk. In this case, peso and hard currency debt essentially become perfect substitutes.

resorts to the more active use of currency depreciations in this economy, which also helps reduce consumption volatility relative to the baseline specification with higher inflation costs.

6 Conclusion

EMEs have been praised by getting out of the original sin trap and issuing domestic-currency denominated sovereign debt to be purchased by foreign investors, which mitigates the currency risk faced by public finances in these countries. Nonetheless, recent work has emphasized the risk of going back to square one for EMEs as an increased share of foreign holdings in LC government debt exposes these countries to large bond sell-offs that coincide with abrupt reversals in the global risk sentiment. These sell-offs reinvigorated debates about trade-offs of mitigating inflationary bias as governments may not issue debt in their domestic currencies when they need it the most. We quantitatively accounted for this trade-off and reached to the conclusion that the lever to reduce real debt burdens via discretionary exchange-rate depreciations continues to help avert a sovereign default and to facilitate debt sustainability even though issuing domestic-currency sovereign debt is increasingly limited for EMEs when global liquidity is scarce. We also find that debt sustainability benefits of actively managing the currency composition of sovereign debt outweigh inflationary distortions of exchange-rate depreciations and boosts welfare. Our work fills a gap in the literature by highlighting the pivotal role of lenders in explaining the currency structure of sovereign debt and sheds light on the commendable experience of many EMEs in enduring the COVID-19 shock without a major debt event.

Our framework can be used to explore defaults that are selective on currency denomination, the dynamic relationship between monetary policy credibility and currency management of sovereign debt and trade-offs faced by a sovereign in transferring the currency risk to domestic or foreign lenders. We leave those compelling extensions that are beyond the scope of this paper to future research.

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Table 1: Parameter values

	Parameter	Value
Discount factor	β	0.92
Risk aversion of households	σ	2
Income autocorrelation coefficient	ρ	0.65
Standard deviation of innovations	σ_ϵ	0.0283
Mean log income	$\bar{y}$	$(-1/2)\sigma_\epsilon^2$
Debt duration	δ	0.2845
Risk-free rate	r^*	0.04
Coupon payment	κ	0.312
Probability of re-entry after default	ψ	0.6667
Debt recovery rate	ω	0.63
Inflation target	π^*	0.03
Transition probability of lower LC risk tolerance	p_{HL}^0	0.38
Transition probability of lower LC risk tolerance	p_{HL}^1	38
Transition probability of higher LC risk tolerance	p_{LH}	1
Risk aversion of peso investors	$\underline{\alpha}$	1
Jointly calibrated in the baseline economy		
Output cost of default	d_0	-1.45
Output cost of default	d_1	1.6
Inflation cost intensity	θ	4
Risk aversion of dollar investors	$\bar{\alpha}$	6.25

Table 2: Data vs. model economies

	(1)	(2)	(3)	(4)
			Higher	Lower
		Baseline	risk aversion	inflation
	Data	economy	to peso debt	costs
Long-term debt statistics[a] (%)				
Debt-to-GDP	30.3	31.2	29.1	30.6
Share of LC debt	48.0	46.5	5.7	29.4
$r^F - r^{*F}$	2.2	2.2	2.0	2.2
$r^L - r^{*L}$	0.5	1.5	1.9	1.5
Inflation	4.1	4.2	3.1	4.2
Volatilities (%)[b]				
$\sigma(c)/\sigma(y)$	1.1	1.5	1.0	1.4
$\sigma(tb/y)$	0.8	2.0	0.4	1.6
$\sigma(r^F - r^{*F})$	0.5	1.0	1.0	1.0
$\sigma(r^L - r^{*L})$	0.4	0.8	0.9	0.8
$\sigma(\pi)$	0.9	0.3	0.0	0.4
$\sigma(b^F/y)$	2.9	3.2	1.0	2.4
$\sigma(b^L/y)$	3.2	4.4	0.4	3.2
Correlations[b]				
$\rho(c, y)$	0.8	0.9	1.0	0.9
$\rho(tb/y, y)$	-0.1	-0.6	-0.3	-0.5
$\rho(r^F - r^{*F}, y)$	-0.5	-0.9	-0.9	-0.9
$\rho(r^L - r^{*L}, y)$	-0.2	-0.9	-0.9	-0.2
$\rho(\pi, y)$	-0.1	-0.2	-0.1	-0.2
$\rho(b^F/y, y)$	-0.0	0.0	-0.9	-0.1
$\rho(b^L/y, y)$	-0.1	-0.3	-0.1	-0.2
$\rho(b^F/y, b^L/y)$	-0.9	-0.9	0.4	-0.7

[a] Long-term statistics are annualized.
[b] $\sigma(j)$ denotes the standard deviation of a variable j. $\rho(j,k)$ denotes the correlation coefficient between variables j and k. Standard deviation of output in the model emerges as $\sigma(y) = 0.028$.

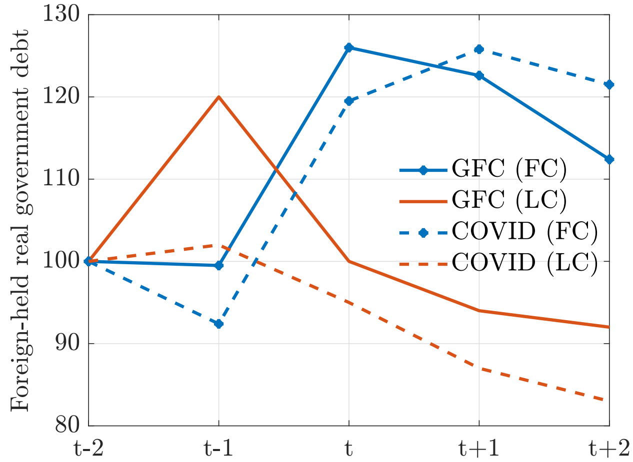

Figure 1: Evolution of foreign-held central government debt securities of Mexico in real units. Real series are obtained using the GDP deflator. Lines with(out) diamonds correspond to debt denominated in foreign (local) currency. Solid and dashed lines correspond to the Global Financial Crisis and the COVID-19 crisis episodes, respectively. Time t on the horizontal axis denotes the quarter for each stress episode, in which monthly realizations of the volatility index VIX was five standard deviations above its historical mean. For comparability across stress episodes and currency denominations, real debt stocks are normalized to 100 in quarter $t-2$. Data sources are the IMF Sovereign Debt Investor Base for Emerging Markets database, OECD Economic Outlook 109 database, Refinitiv and authors' calculations.

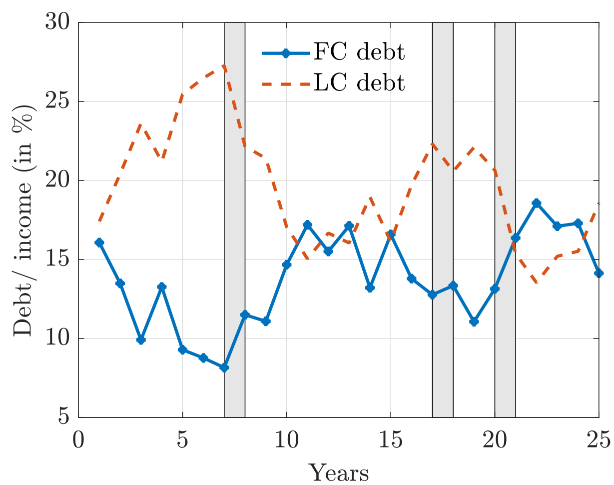

Figure 2: Evolution of dollar (FC) and peso (LC) debt-to-income ratios implied by model simulations. Shaded areas denote stress episodes that lead to increased risk aversion towards peso debt.

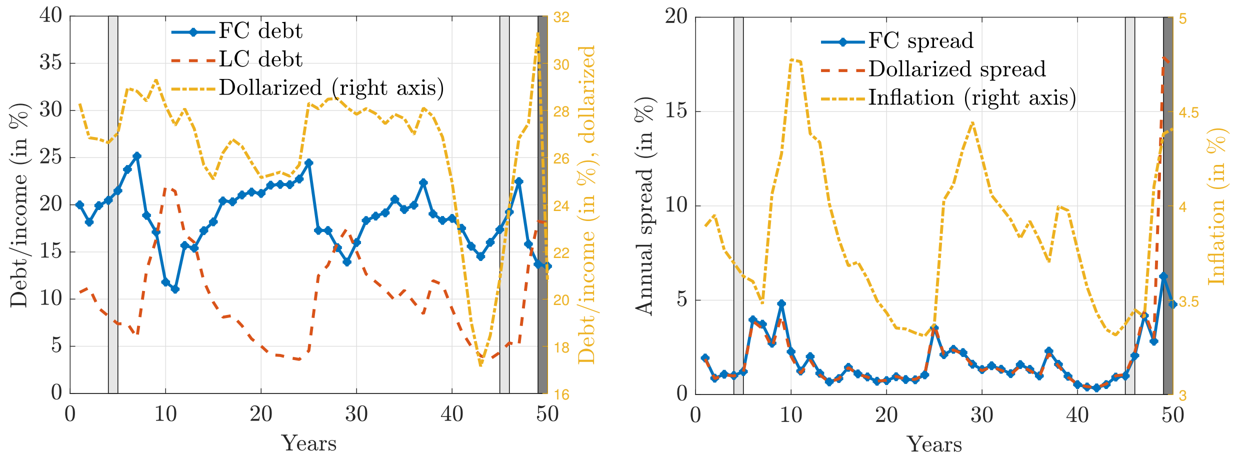

Figure 3: The left panel shows the evolution of the FC and LC debt-to-income ratios in the baseline economy and the FC debt-to-income ratio of the counterfactual economy which is financially dollarized (plotted against the right axis), all in percentages. The right panel shows the evolution of annualized FC debt spreads (solid lines) and currency depreciation rate in the baseline economy (fine-dashed lines plotted against the right axis) and FC debt spreads in the dollarized economy (dashed lines) implied by the trajectory of endowment shocks used in the left panel. Shaded areas denote low global liquidity episodes with increased risk aversion towards peso debt. In the dark-shaded region, both global liquidity is low and macroeconomic fundamentals are exceptionally weak.

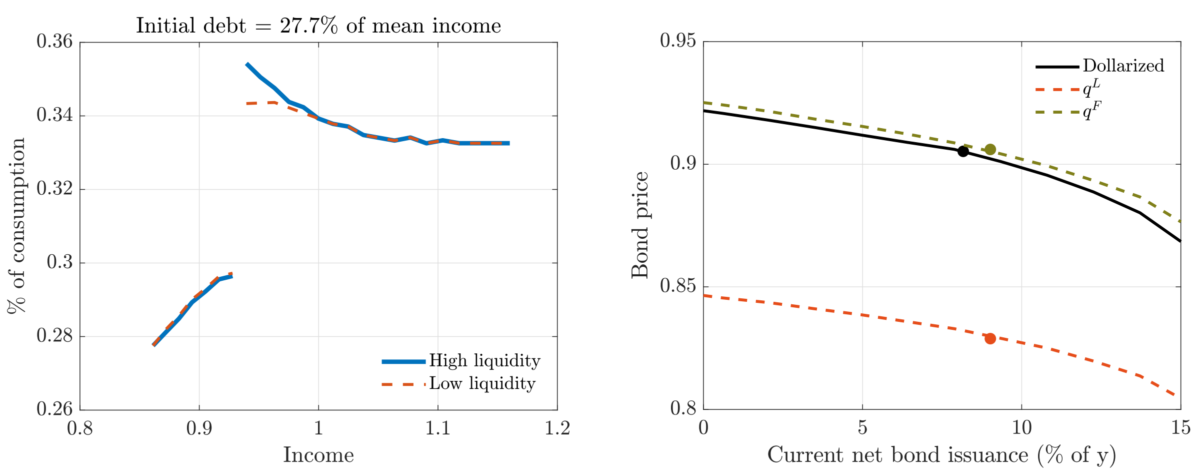

Figure 4: The left panel plots welfare gains of an unanticipated announcement regarding the switching of the economy from the dollarized economy specification to the baseline specification with hard- and peso-debt issuance. The gains are denoted in percentage consumption equivalent units and plotted as a function of initial endowment and the liquidity state, while fixing initial sovereign debt to the indebtedness of the ergodic state of the dollarized economy. The right panel plots bond pricing schedules as a function of total net debt issuance (as percent of mean endowment, normalized to 1) for the baseline (dashed lines) and the dollarized economies (solid line) under low global liquidity. The dashed line in the north is the pricing schedule for hard-currency debt issuance in the baseline economy. Thick dots on these pricing schedules correspond to equilibrium realizations.

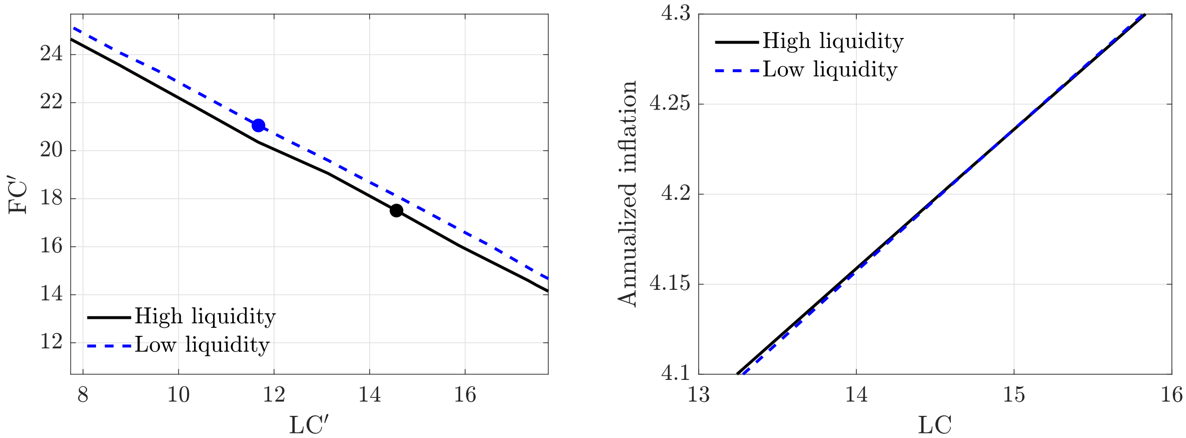

Figure 5: The panel on the left plots the debt issuance frontier (as a percent of mean income that is normalized to one) that supports a reference consumption level in the baseline model for high- and low-liquidity states. The panel on the right plots the currency depreciation policy (in annualized percentage terms) as a function of the state of liquidity and outstanding LC debt, while fixing outstanding FC debt at its average over simulations.

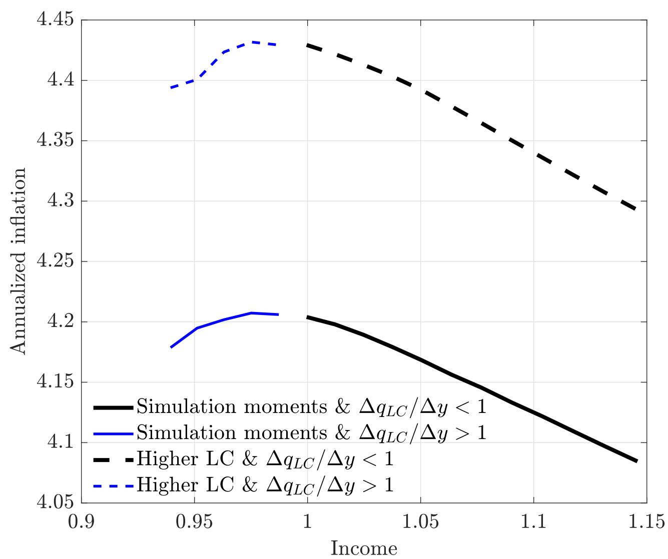

Figure 6: Currency depreciation policy (in annualized percentage terms) in the baseline model as a function of income while outstanding LC and FC denominated debt stocks are fixed at their average over simulations. The dashed lines correspond to a higher stock of outstanding LC denominated debt. For finer lines, income elasticity of LC bond price is larger than 1.

A Appendix

A.1 Response of EMEs to the COVID-19 shock

The top panel of Figure A.1 indicates that majority of the countries that had a higher domestic currency share in foreign-held sovereign debt prior to the COVID-19 crisis faced a lower increase in sovereign risk spreads during the pandemic episode. The figure implies a simple correlation coefficient of -0.38 between average spread increases and the pre-COVID levels of LC share in foreign-held sovereign debt. The bottom panel of Figure A.1 indicates that countries that had a higher domestic currency share in foreign-held sovereign debt prior to the COVID-19 crisis faced a larger exchange rate depreciation against the dollar during the pandemic episode. The figure implies a simple correlation coefficient of 0.33 between average depreciation and the pre-COVID levels of LC share in foreign-held sovereign debt. Intriguingly, for very high LC debt shares, it is likely that the original sin redux effect dominates, creating a non-linear effect on country risk premiums.

A.2 Local currency denominated synthetic risk-free bond yields

A synthetic and risk-free peso denominated bond would satisfy the condition

$$q^{*L}\left(b^{F'}, b^{L'}, y, l\right) \quad = \quad \mathbb{E}_{y',l'|y,l}\left\{m^{L}_{y,l,y'} \, \frac{(1-\delta)q^{*L'}+\kappa}{1+\pi'}\right\}, \tag{A.1}$$

as it would repay in all states of the world. Nonetheless, under no commitment to a pre-determined path for currency deprecation rates, it would still carry a currency depreciation risk premium. The pricing functional on the right-hand side of (A.1) satisfies $q^{*L'} = q^{*L}(b^{F''}, b^{L''}, y', l')$ with $b^{F''} = \hat{b^F}(b^{F'}, b^{L'}, y', l')$, $b^{L''} = \hat{b^L}(b^{F'}, b^{L'}, y', l')$ and $\pi' = \hat{\pi}(b^{F'}, b^{L'}, y', l')$ as defined in the main text. We solve for (A.1) by following an iterative procedure; using equilibrium default, borrowing and currency depreciation policy functions as it has no impact on borrowing or currency depreciation decisions. Given the synthetic risk-free pricing schedule, risk-free yields-to-maturity can be computed as $r^{*L}_t = \frac{\kappa}{q^{*L}_t} - \delta$.

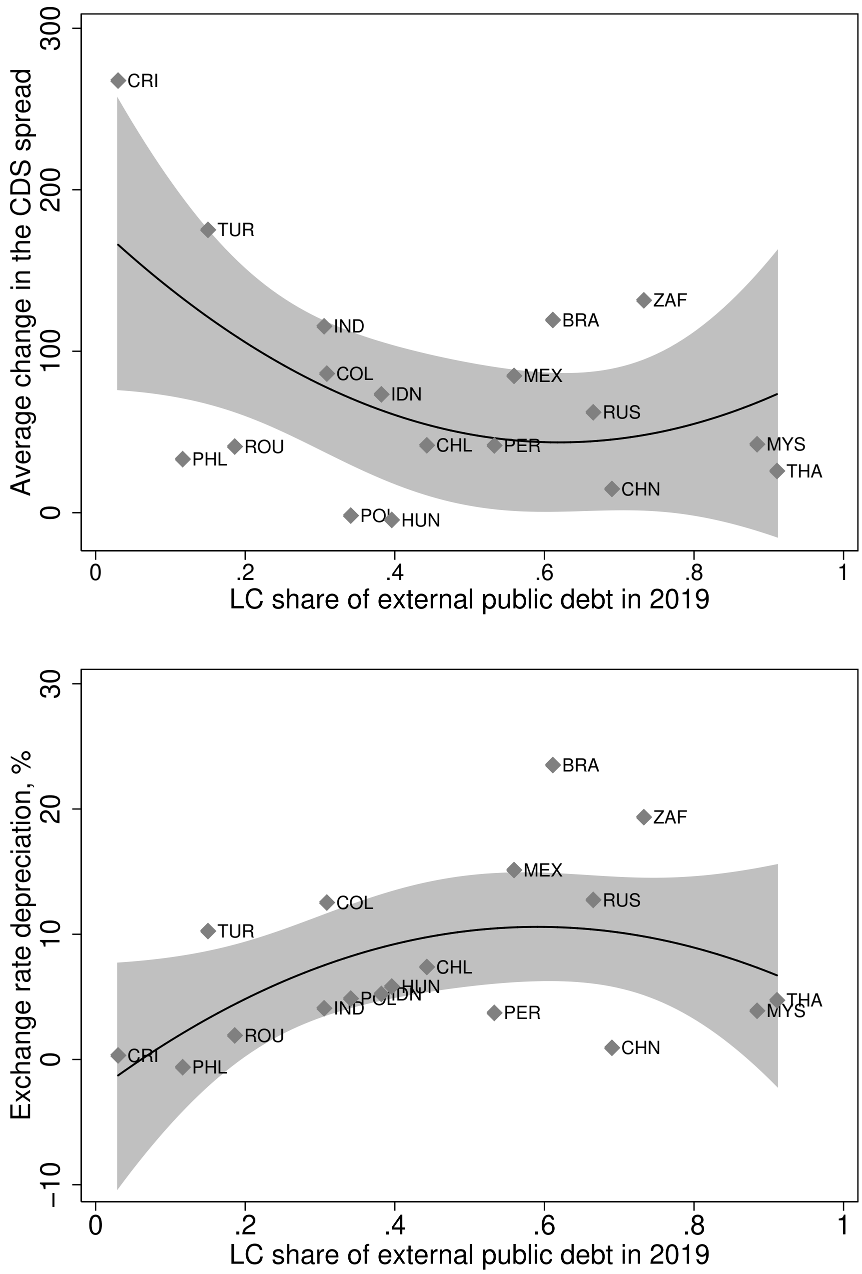

Figure A.1: The vertical axis in the top panel denotes the average CDS spread increase in countries as of August 2020 relative to the beginning of 2020. For Costa Rica and India, EMBI Global bond spreads compiled by JP Morgan are used due to data availability. The vertical axis in the bottom panel denotes the average exchange rate depreciation against dollar in countries as of August 2020 relative to the beginning of 2020. The horizontal axes denote the domestic-currency share of foreign-held sovereign debt as of 2019Q4 (2018Q4 for Costa Rica). Solid lines and the shaded areas denote a quadratic fit and a 95% confidence interval, respectively. Data sources are the IMF Sovereign Debt Investor Base for Emerging Markets dataset by Arslanalp and Tsuda (2014), Refinitiv, Factset the OECD and authors' calculations.