A Joint Theory of Sovereign Debt and Foreign Reserves Accumulation*

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Abstract

This paper develops a unified framework for understanding sovereign debt issuance and foreign reserve accumulation in the presence of default risk, limited arbitrage, and incomplete markets. It explains why emerging economies exhibit a secular increase in sovereign debt and foreign reserves alongside a declining share of foreign-currency debt. It links these trends to the procyclical co-movement of debt and reserves and to positive, volatile, and correlated CIP and UIP premia. The model features a government that issues long-term debt in domestic and foreign currency and accumulates foreign reserves both to insure against default and to influence domestic-currency returns. Currency premia endogenously emerge from risk-averse foreign investors with constrained arbitrage capacity. Two polar cases clarify the mechanisms: a safe-haven and a dollarized-default economy. Quantitatively, the model matches the aforementioned empirical facts, showing that default risk is the primary driver of reserve accumulation, with exchange rate management playing a secondary role.

Keywords: sovereign debt, foreign reserve, currency denomination, limited arbitrage, default, foreign exchange interventions.

JEL Classification: C73, D52, E61, F34, F41, G15, H63

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1 Introduction

Over the past decades, emerging economies have simultaneously issued sovereign debt and accumulated historically large stocks of foreign reserves. At first glance, this pattern appears puzzling. If governments borrow on international markets, why do they decide to acquire foreign assets rather than reducing outstanding liabilities? The puzzle is sharpened by the fact that reserve accumulation is most pronounced in countries facing borrowing constraints, default risk, and volatile capital flows – i.e. precisely those for which external debt is most costly. Understanding why sovereigns borrow and save at the same time, and how this joint behavior interacts with nominal exchange rates and debt composition, is the central motivation of this paper.

Two broad motivations are typically invoked to rationalize the accumulation of foreign reserves. The first is precautionary. In economies subject to sovereign default, foreign reserves provide insurance against sudden stops and self-fulfilling debt crises. By holding liquid foreign assets, governments can smooth consumption in low-income states, reduce the likelihood of default, and improve borrowing terms. The second motivation relates to exchange rate management. Through sterilized foreign exchange interventions – i.e. issuing domestic-currency liabilities while accumulating foreign assets – governments can influence the nominal exchange rate and the return on domestic-currency debt. This channel is particularly relevant in environments with limited arbitrage and deviations from uncovered (UIP) and covered interest parity (CIP), where balance-sheet effects and currency premia matter for sovereign borrowing decisions.

While both motives are widely discussed in isolation, existing frameworks rarely integrate them into a unified theory of sovereign debt and reserve accumulation. Moreover, the interaction between default risk, debt denomination, reserve policy, and exchange rate premia remains largely unexplored. This paper develops a tractable yet rich framework that jointly determines sovereign borrowing, reserve accumulation, exchange rates, and currency premia, and uses it to interpret empirical regularities in emerging economies.

I begin this inquiry by establishing new empirical facts on foreign reserves and sovereign debt for a a panel of 18 emerging economies over the period 2000Q1–2025Q1. Using data on sovereign debt and foreign reserves from the IMF, together with measures of currency denomination from Arslanalp and Tsuda (2012), foreign exchange intervention from Adler et al. (2021), deviations from CIP from Du and Schreger (2016), deviations from UIP and credit default swap (CDS) spreads from Bloomberg, the paper documents four key empirical facts that motivate the theoretical framework.

The first fact concerns long-run trends in sovereign balance sheets. Emerging economies have experienced a secular increase in both sovereign debt and foreign reserves, alongside a sharp decline in the share of foreign-currency debt. On average, foreign reserves have increased by roughly 50% as a share of GDP since the early 2000s, reaching levels far above those observed in advanced economies. Sovereign debt has also risen, though more gradually, while its composition has shifted markedly toward domestic-currency denomination. This joint evolution suggests that reserve accumulation is not merely a by-product of reduced borrowing needs, but an integral component of sovereign financial policy.

The second fact highlights the cyclical behavior of debt and reserves. Changes in foreign reserves, domestic-currency debt, and foreign-currency debt are positively correlated with GDP growth and currency appreciations, and negatively correlated with default risk. In other words, during good times governments tend to both borrow more and accumulate more reserves. This pattern is inconsistent with simple buffer-stock views of reserves, but consistent with the model of Bianchi et al. (2018) in which reserves allow governments to reallocate resources across states with different borrowing costs. Why domestic and foreign-currency debt co-move remain however largely undocumented.

The third and fourth facts concerns currency premia. First, deviations from both CIP and UIP are positive on average, highly volatile, and positively correlated with each other. This implies that foreign investors earn positive excess returns on both hedged and unhedged positions in emerging-market currencies, pointing to the presence of risk compensation and limits to arbitrage in international capital markets. Panel regressions show that domestic factors such as default risk, foreign exchange intervention, and domestic monetary policy play a dominant role, especially for UIP premia. Global factors such as dollar funding conditions and financial intermediary balance-sheet capacity are important for CIP premia but have limited explanatory power for UIP deviations. These findings suggest that sovereign balance-sheet policies and exchange rate management are tightly linked to currency premia faced by foreign investors.

These empirical regularities motivate a model in which sovereign debt issuance, reserve accumulation, exchange rate dynamics, and currency premia are jointly determined. The paper develops an infinite-horizon small open economy model with default risk, incomplete markets, and limited arbitrage in currency markets. A benevolent government takes decisions on behalf of the small open economy and can issue one-period foreign reserves as well as long-term debt denominated either in domestic or foreign currency. In the spirit of Eaton and Gersovitz (1981), the government's income is stochastic, so there is value to accessing financial markets, but it cannot commit to repay, which affects the terms of that access. Foreign investors are risk-averse and act as marginal investors in both domestic and foreign-currency debt markets. Following Gabaix and Maggiori (2015), their ability to take positions in domestic-currency assets is constrained by limited commitment which gives rise to positive expected excess returns on domestic-currency debt. Foreign investors can hedge exchange rate risk, allowing the distinction between CIP and UIP premia as in Bacchetta et al. (2025). Finally, the model can accommodate both fixed and floating exchange rate regimes.

A key feature of the model is the endogenous determination of the nominal exchange rate. The real return on domestic-currency debt depends partly on government policies through sterilized interventions and the default decision. By issuing domestic-currency debt and accumulating foreign reserves or by defaulting, the government affects the exchange rate and the compensation required by foreign investors. This mechanism links reserve accumulation directly to currency premia and debt composition. The equilibrium is characterized as a Markov perfect equilibrium. The interaction of default risk, limited arbitrage, and exchange rate policy shapes the government's optimal portfolio of liabilities and assets.

To clarify the forces at work, the paper studies three benchmark economies. The first is a safe-haven economy, in which default risk is absent. In this case, sovereign debt is risk-free and foreign reserves have no precautionary value. Reserve accumulation can only serve exchange rate management purposes. Limited arbitrage implies positive CIP premia whenever domestic-currency debt is issued. This case illustrates that, absent default risk, reserve accumulation is limited and driven solely by currency considerations.

The second benchmark is a dollarized default economy, in which the government can issue only foreign-currency debt. Here, exchange rate policy is irrelevant, and reserves serve purely as insurance against rollover risk. With long-term debt, reserve accumulation allows the government to transfer resources across repayment states by exploiting variation in bond prices. This environment replicates the predictions of Bianchi et al. (2018) but cannot account for the interaction between reserves and currency premia.

The general case lies between these two extremes. The government issues both domestic- and foreign-currency debt, faces default risk, and operates in a currency market with limited arbitrage. In this environment, reserve accumulation serves a dual role: it hedges default risk and enables exchange rate interventions that affect the return on domestic-currency debt. Default risk amplifies the effects of exchange rate policy, as changes in debt composition influence both the probability of default and the compensation demanded by foreign investors.

The model is solved using global methods and taste shocks. Simulations show that the benchmark economy accumulates substantial foreign reserves while maintaining moderate debt levels. Reserve accumulation is quantitatively driven primarily by default risk, with exchange rate interventions playing a secondary but non-negligible role. The model reproduces the observed volatility and co-movement of sovereign spreads, exchange rates, and currency premia. Both CIP and UIP premia are positive on average, volatile, and positively correlated. Debt and reserves rise in good times and fall when default risk increases, matching the cyclical patterns documented in the data. Counterfactual experiments show that exchange rate regimes and arbitrage constraints critically shape debt composition and reserve policy. In particular, under a fully floating exchange rate regime reserves and domestic-currency accumulation are more pronounced than under a fully fixed exchange rate regime.

Overall, the paper provides a unified framework for understanding how sovereign debt issuance and foreign reserve accumulation interact with default risk, exchange rate policy, and currency premia. By integrating these elements into a single model, it offers new insights into the financial strategies of emerging economies and the determinants of international currency returns.

2 Related Literature

This paper contributes to the literature on sovereign debt and foreign reserves accumulation. Most studies extend the canonical sovereign debt model of Eaton and Gersovitz (1981), Aguiar and Gopinath (2006) and Arellano (2008) with foreign reserve accumulation.[1] Using one-period debt and assets, Alfaro and Kanczuk (2009) show that foreign reserves accumulation shifts resources from repayment states to default states. Quantitatively however this channel is negligible and the models predict literally no accumulation of reserves. Using long-term debt and one-period assets, Bianchi et al. (2018) show that foreign reserves accumulation transfers resources across repayment states.[2] Unlike the previous study, this hedging motive is quantitatively important. Building on Cole and Kehoe (2000), Barbosa-Alves et al. (2024) study reserve accumulation as a way to hedge against self-fulfilling debt crises. Modelling self-fulfilling debt crises as in Aguiar et al. (2020), Corsetti and Maeng (2025) show that accumulating reserves and one-period debt is desirable because it rules out an inefficient low-bond-prices equilibrium. Angeletos (2002), Buera and Nicolini (2004), Dovis (2019) and Wicht (2025) show that one can replicate the return of Arrow securities with bonds of multiple maturities. For this, the government may need to accumulate assets at some points. Quantitative predictions are at odds with the data with holding of bonds in the magnitude of several multiples of GDP. I complement this literature by adding one motive for reserve accumulation: exchange rate intervention. I find that default risk is the primary driver of reserve accumulation, with exchange rate risk playing a secondary role.

[1] See also Aguiar and Amador (2014), Aguiar et al. (2016) and Aguiar and Amador (2021).

[2] Note that Arellano and Ramanarayanan (2012), Niepelt (2014) and Hatchondo et al. (2017) also analyze short-term and long-term bonds jointly but do not allow for assets accumulation.

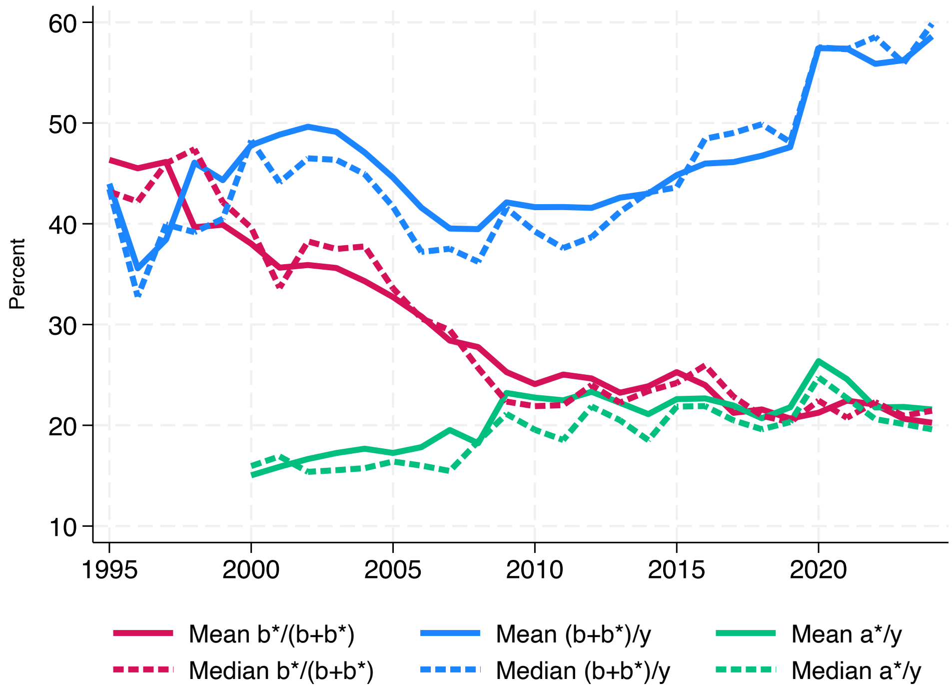
The paper also contributes to the literature on the CIP and UIP deviations. I use the CIP premium from Du and Schreger (2016) who calculate it using long-term government bonds and cross-currency swaps. Unlike Cerutti et al. (2021) and Cerutti and Zhou (2023), I find a pronouced sensitivity of the CIP premium on both domestic and global factors. Regarding the UIP premium, Kalemli-Özcan and Varela (2025) study the differences across UIP in emerging and advanced economies, while I focus on the latter. In theoretical models, CIP and UIP premia have often been analyzed separatly. Cavallino (2019), Basu et al. (2020), Fang and Liu (2021), Maggiori (2021) and Itskhoki and Mukhin (2021) focus on the latter, while Amador et al. (2019) and Fanelli and Straub (2021) analyze the former. Bacchetta et al. (2025) analyze both CIP and UIP deviations focusing on safe haven countries such as Japan and Switzerland. They consider a two-period model with an exogenous government sector, while I develop an infinite-horizon model with an endogenous sovereign debt accumulation. Quantitatively, the model generates large and variable CIP and UIP premia in line with the findings of Alvarez et al. (2009).

Finally, the paper contributes to the literature on incomplete markets and the determination of the nominal exchange rate. Benigno et al. (2016) analyze the use of capital control under costly exchange rate policy. In my analysis, exchange rate policy is costly as it affects the return of domestic-currency debt which in turns influences the issuance of such debt. This framework allows the analysis of debt accumulation with the exchange rate as in Benigno and Romei (2014). The determination of the nominal interest rate is solely determined by the limited arbitrage condition of foreign lenders following Gabaix and Maggiori (2015) without any nominal frictions. Fanelli and Straub (2021) adopt a similar setting but focus on the cost of foreign exchange intervention as Bacchetta et al. (2025). Using a more comprehensive general equilibrium model, Itskhoki and Mukhin (2021) also use limitation in arbitrage to generate UIP deviations. My contribution is therefore to extend the reduced-form determination of nominal exchange rate in the context of joint sovereign debt and foreign reserve accumulation.

3 Empirical Motivation

This section examines empirical trends in sovereign debt and foreign reserve accumulation and its relationship with the CIP and the UIP premia across 18 emerging economies relative to the USA from 2000Q1 to 2025Q1.

I denote foreign reserves by a^*, domestic-currency sovereign debt by b, foreign-currency debt by b^* and GDP by y. Data for these variables come from the IMF. CIP premia come from Du and Schreger (2016) and I construct UIP premia using Bloomberg data on exchange rate consensus forecasts. Data on foreign exchange intervention come from Adler et al. (2021) and on currency denomination of debt from Arslanalp and Tsuda (2012). The Appendix A gives more details about the data.



Note: The figure depicts the evolution of the mean and the median government total debt $(b + b^*)$ relative to GDP (y), foreign-currency debt (b^*) relative to total debt $(b + b^*)$ and foreign reserves (a^*) relative to GDP (y) in selected emerging economies. See Appendix A for more details.

Figure 1: Evolution of Reserves and Debt

The first empirical fact relates to secular trends of sovereign debt and foreign currency reserves accumulation in emerging economies. Three comments are in order. First, foreign reserves raised by almost 50%. While the average (median) is 15% (16%) of GDP in 2000, it raises to 22% (20%) in 2024 as one can see in Figure 1. In comparison, G10 economies accumulates on average twice less. For instance, foreign reserves in Germany and the USA represent less than 1% of GDP. Exceptions exist such as Denmark, Japan, Norway and Switzerland, though. Second, sovereign debt follows a similar trend albeit at a slower pace. In 1995 the average (median) indebtedness in the sample is 44% (43%) of GDP, while it amounts to 59% (60%) in 2024. This indebtedness remains below the one of most G10 economies. Third, the observed upward trend in sovereign debt is accompanied with a reduction in the share of foreign-currency debt. From 1995 to 2024, the average (median) share goes from 46% (43%) to 20% (21%). Figures B.1, B.2, B.3 and Tables B.2, B.3 in Appendix B give a detailed country-by-country overview.

Fact I. *There has been a secular increase in sovereign debt and foreign reserves accompanied by a declining share of foreign currency sovereign debt.*

Table 1: Correlations with Debt and Foreign Reserves

	Δs, Δa^*	Δs, Δb	Δs, Δb^*	Δy,Δa^*	Δy,Δb	Δy,Δb^*	CDS,Δa^*	CDS,Δb	CDS,Δb^*
Brazil	-0.37	0.01	-0.08	0.42	0.06	0.15	-0.47	-0.25	-0.26
Chile	-0.46	-0.15	-0.16	0.40	0.28	0.29	0.12	-0.01	-0.00
China	-0.29	0.29	0.23	0.20	-0.29	-0.25	-0.74	0.04	-0.15
Colombia	-0.54	0.17	0.15	0.47	-0.14	-0.12	-0.35	-0.37	-0.38
Hungary	-0.34	-0.50	-0.51	0.21	0.47	0.49	-0.27	-0.40	-0.41
Indonesia	-0.62	-0.39	-0.40	0.55	0.30	0.31	0.03	-0.32	-0.33
Israel	-0.30	.	.	0.19	.	.	0.17	.	.
India	-0.20	-0.38	-0.43	0.04	0.28	0.33	0.38	-0.82	-0.81
Korea	-0.27	.	.	0.23	.	.	0.18	.	.
Mexico	-0.35	-0.05	-0.07	0.26	0.00	0.02	-0.20	-0.27	-0.28
Malaysia	-0.47	-0.19	-0.27	0.44	0.16	0.23	-0.49	-0.01	-0.01
Peru	-0.48	0.46	0.46	0.54	-0.38	-0.38	-0.01	-0.30	-0.30
Philippines	-0.73	-0.34	-0.35	0.53	0.03	0.04	0.31	-0.23	-0.23
Poland	0.04	-0.54	-0.55	-0.01	0.49	0.50	-0.26	-0.44	-0.44
Russia	-0.38	-0.08	-0.09	0.48	-0.07	-0.07	-0.50	-0.52	-0.50
Thailand	-0.58	0.08	0.10	0.55	0.10	0.02	0.06	0.55	0.53
Turkey	-0.33	-0.38	-0.38	0.65	0.30	0.30	-0.09	0.11	0.11
South Africa	-0.42	0.15	0.11	0.54	-0.07	-0.02	-0.10	-0.02	-0.02
Mean	-0.39	-0.13	-0.16	0.37	0.11	0.13	-0.12	-0.21	-0.22
Median	-0.37	-0.15	-0.16	0.42	0.10	0.15	-0.10	-0.27	-0.28

Note: Variable b corresponds to the general government domestic-currency debt, b^* to the general government foreign-currency debt, a^* to foreign reserves, CDS to the 5-year credit default swap spread. CIP and UIP premia are at the 12 months maturity.

The second empirical fact relates to the correlation between sovereign debt and foreign reserves in emerging economies. As one can see in Table 1, the sign of the correlation is the same whether one looks at foreign reserves, domestic-currency or foreign-currency debt. Correlations are negative for the change in nominal exchange rate, positive for the nominal GDP growth and negative for the 5-year CDS spread. This means that during good times, countries simultaneously borrow and save more, a point already made by Bianchi et al. (2018) for foreign reserves and total debt. Looking at debt with different currency denomination, the table additionally shows that they co-move in the same direction.

Fact II. *Foreign reserves, domestic-currency and foreign-currency sovereign debt tend to increase when domestic currency appreciates, GDP increases or default risk decreases.*

The next few empirical facts relate the CIP and the UIP premia in emerging economies. The CIP premium is computed according to

$$i_{j,m,t} - i^*_{m,t} - (f_{j,m,t} - S_{j,t}), \tag{1}$$

where $i_{j,m,t}$ is the m-year nominal sovereign bond yield in country j, $i^*_{m,t}$ is the m-year nominal government bond yield in the USA, $F_{j,m,t} = \exp(f_{j,m,t})$ is the m-year outright forward exchange rate of country's j currency against the USD and $S_{j,t}$ is the spot exchange rate at time t. Similarly, the UIP premium is computed according to

$$i_{j,m,t} - i^*_{m,t} - (\mathbb{E}(S_{j,t+m}) - S_{j,t}), \tag{2}$$

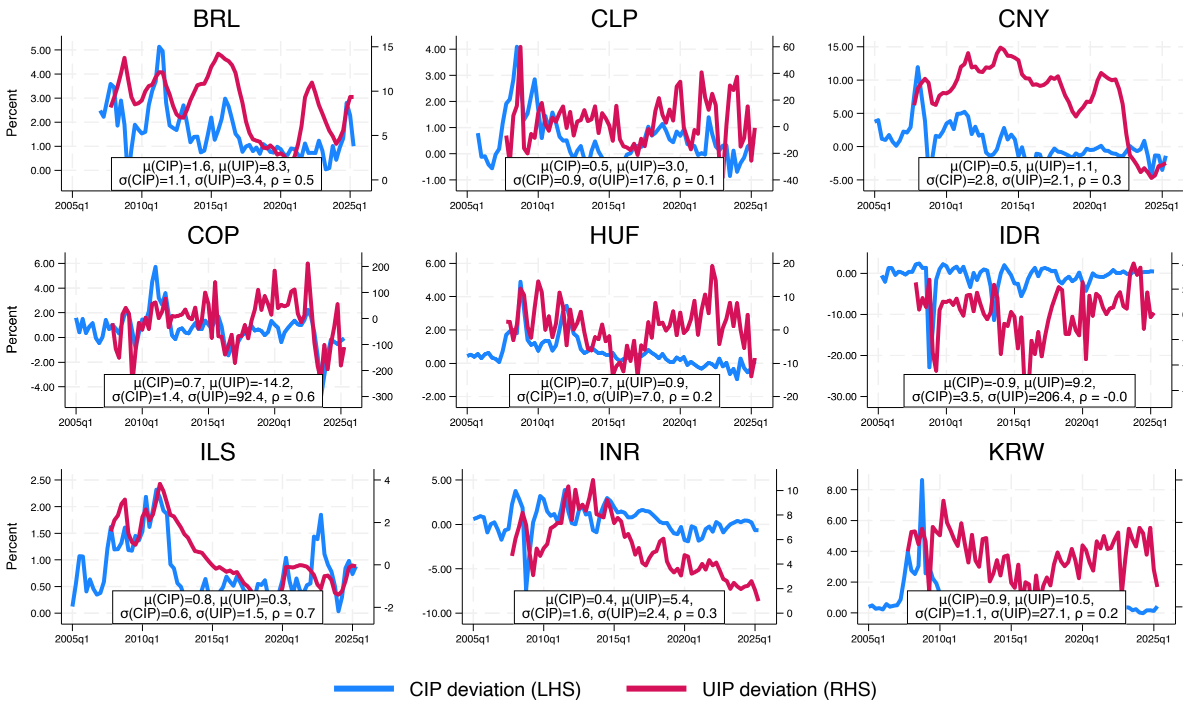
where $\mathbb{E}(S_{j,t+m})$ denotes the expectation of exchange rate at $t+m$.

The third empirical fact relates to the sign, magnitude and the correlation of the CIP and UIP premia. Figure 2 depicts the two premia for the currencies in the sample. Four comments are in order. First, except for a few cases, CIP and UIP premia are always positive. This implies that for US investors both the hedged and the unhedged returns in these currency exceed the direct USD return. Equivalently, the synthetic borrowing cost using USD is smaller than the direct funding cost in domestic currency. Second, the UIP premium is almost always greater than the CIP premium. Third, the CIP and UIP premia are volatile with a standard deviation often exceeding the mean value. Fourth, for most currencies, the two premia correlate positively with each other with a mean (median) of 0.28 (0.39). This indicates that there are common factors influencing these premia.

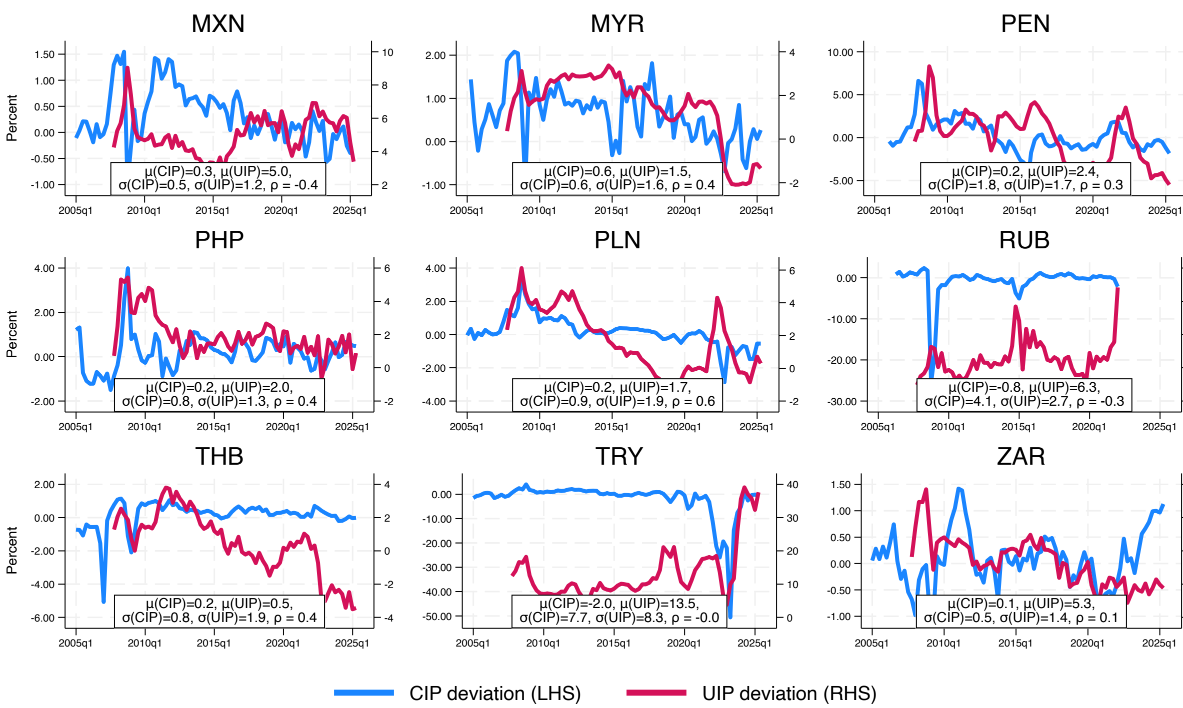
Fact III. *Both the CIP and UIP premia are positive, volatile, and positively correlated. Notably, the UIP premium exceeds the CIP premium in magnitude.*

The fourth empirical fact concerns the main drivers of the CIP and UIP premia. I first assess which component of each premium is quantitatively more important, and then evaluate the role of domestic and global factors. As shown in equations (1) and (2), both premia are defined as the difference between the interest rate differential and the exchange rate adjustment. Using a within-variance decomposition, I find that fluctuations in the exchange rate account for the larger share of variation in both the CIP and UIP premia.

To investigate the domestic and global determinants of the CIP and UIP premia, I estimate a series of panel regressions. Table 2 reports the results where the dependent variable in columns (1) and (4) is the CIP premium, while the remaining columns decompose this deviation into the interest rate differential $i - i^*$ and the forward premium $f - s$. Table 3 follows a similar structure for the UIP premium. All specifications include maturity-by-currency fixed effects to control for persistent heterogeneity across currencies and maturities. The first three columns omit time fixed effects and therefore exploit both cross-sectional and time-series variation, whereas the last three columns additionally include time fixed effects, absorbing common global shocks and isolating differential cross-sectional responses over time.



(a)



(b)

Note: The figure depicts the CIP and UIP premia at the 1-year maturity for selected emerging economies computed according to (1) and (2), respectively. The variables μ, σ and ρ correspond to the mean, the standard deviation and the correlation, respectively.

Figure 2: CIP and UIP Premia

Table 2: CIP Regressions

	(1) CIP	(2) $i - i^*$	(3) $f - s$	(4) CIP	(5) $i - i^*$	(6) $f - s$
CDS Spread	0.15***	0.00***	0.00***	0.22***	0.01***	0.01***
	[0.05]	[0.00]	[0.00]	[0.06]	[0.00]	[0.00]
FX Intervention	3.83***	0.02**	-0.02	3.92***	-0.01	-0.06***
	[1.36]	[0.01]	[0.02]	[1.33]	[0.01]	[0.02]
Central Bank Policy Rate	-3.09***	0.56***	0.60***	-2.86***	0.57***	0.61***
	[1.00]	[0.02]	[0.03]	[0.99]	[0.02]	[0.02]
USD Convenience Yield	16.71***	0.28***	0.14***			
	[2.71]	[0.04]	[0.04]			
USD Liquidity Premium	36.61***	-0.83***	-1.11***			
	[9.84]	[0.10]	[0.12]			
US B&D Capital Ratio	-3352.44***	17.95***	54.29***			
	[281.87]	[3.40]	[3.68]			
Federal Funds Effective Rate	4.57***	-0.49***	-0.55***			
	[1.69]	[0.03]	[0.03]			
Volatility Index	1.20***	-0.01***	-0.02***			
	[0.30]	[0.00]	[0.00]			
Constant	222.46***	0.73***	-1.73***	68.12***	0.29***	-0.45***
	[16.48]	[0.20]	[0.22]	[7.46]	[0.11]	[0.13]
Maturity × Currency FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	Yes	Yes	Yes
Observations	4156	4156	4156	4156	4156	4156
Adjusted R^2	0.49	0.91	0.88	0.52	0.93	0.89
Adjusted R^2 within	0.26	0.75	0.69	0.02	0.74	0.69

Note: *** $p < .01$, ** $p < .05$, * $p < .10$. Robust standard errors in brackets.

Local factors are strongly and robustly associated with CIP and UIP premia. Higher sovereign credit risk, proxied by CDS spreads, is consistently linked to larger premia, with positive and highly statistically significant coefficients across all specifications. Foreign exchange interventions are also associated with wider premia, and this effect remains quantitatively similar and statistically significant after the inclusion of time fixed effects. The effect seems to pass through the exchange rate adjustment rather than the interest rate differential. Domestic monetary policy conditions are relevant as well: higher central bank policy rates are associated with significantly smaller CIP and UIP premia. Overall, these findings indicate that domestic factors play a substantial role in shaping CIP and UIP premia.

Global financial conditions significantly influence the CIP premium, though their impact on the UIP premium is more limited. Indicators of USD funding stress, such as the USD convenience yield and the USD liquidity premium, enter with positive and highly significant coefficients, consistent with tighter global dollar conditions widening CIP premia. Similar to Kalemli-Özcan and Varela (2025), effects on the UIP premium are not significant. Intermediary balance sheet capacity, measured by US brokers and dealers capital ratio, is negatively related to CIP premium, underscoring the importance of arbitrage constraints. The opposite holds for UIP deviation highlighting the importance of risk appetite. Moreover, higher Federal funds rates and elevated global market volatility are both associated with significantly

Table 3: UIP Regressions

	(1) UIP	(2) $i - i^*$	(3) $\mathbb{E}(s') - s$	(4) UIP	(5) $i - i^*$	(6) $\mathbb{E}(s') - s$
CDS Spread	46.82***	0.00***	-0.46***	70.83***	0.01***	-0.70***
	[15.74]	[0.00]	[0.16]	[21.71]	[0.00]	[0.22]
FX Intervention	308.36***	0.02	-3.07***	367.59***	-0.04**	-3.72***
	[115.03]	[0.02]	[1.15]	[132.55]	[0.02]	[1.33]
Central Bank Policy Rate	-248.15**	0.73***	3.21***	-211.52**	0.75***	2.87***
	[104.02]	[0.03]	[1.03]	[100.94]	[0.03]	[1.01]
USD Convenience Yield	248.26	0.45***	-2.03			
	[426.60]	[0.07]	[4.25]			
USD Liquidity Premium	-1472.63	-1.16***	13.57			
	[1554.68]	[0.20]	[15.50]			
US B&D Capital Ratio	105233.46**	20.96***	-1031.38**			
	[49629.51]	[6.56]	[494.97]			
Federal Funds Effective Rate	338.56	-0.66***	-4.04			
	[251.35]	[0.05]	[2.50]			
Volatility Index	-65.64	-0.03***	0.62			
	[61.16]	[0.01]	[0.61]			
Constant	-4765.32*	0.52	48.17*	-2176.44	-0.52***	21.24
	[2659.31]	[0.37]	[26.53]	[1346.77]	[0.16]	[13.44]
Maturity × Currency FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	Yes	Yes	Yes
Observations	984	984	984	984	984	984
Adjusted R^2	0.65	0.93	0.65	0.66	0.94	0.66
Adjusted R^2 within	0.12	0.83	0.12	0.11	0.83	0.11

Note: *** $p < .01$, ** $p < .05$, * $p < .10$. Robust standard errors in brackets.

larger CIP premium. The effect is however not significant for UIP premium.

Fact IV. *While domestic and global factors influence CIP premia, UIP premia are driven by domestic factors such as default risk, foreign exchange intervention and monetary policy.*

Having established new empirical facts, the following sections aim at building a model of joint sovereign debt and foreign reserves accumulation capable of rationalizing them.

4 The Model

Consider a small open economy in infinite discrete time $t = \{0, 1, \dots\}$ with a single homogenous good and no production. The government of this economy is benevolent, receives a stochastic endowment and trades with a continuum of foreign investors which represent the marginal investor in both domestic and foreign markets.

There is an uncertain state ψ taking value on the compact set Ψ with an *i.i.d.* distribution. Denote by i and i^* the domestic and foreign risk-free one-period nominal interest rate, respectively. For simplicity, the two interest rates are time invariant. The spot price of foreign currency in terms of domestic currency is given by S_t in period t and the forward rate priced in period t for period $t+1$ is F_t. The price of goods in foreign currency is normalised to 1 and purchasing power parity (PPP) holds. This also means that the domestic inflation rate at time t is $1+\pi_t \equiv \frac{S_t}{S_{t-1}}$. Inflation is composed of an endogenous part $\overline{\pi}$ and an exogenous part $\hat{\pi}(\psi)$ with $\alpha \in [0,1]$ such that

$$\pi = \alpha\overline{\pi} + (1-\alpha)\hat{\pi}(\psi).$$

The case $\alpha = 0$ can be interpreted as a fully flexible exchange rate regime, while $\alpha = 1$ corresponds to a fixed exchange rate regime. The real return of foreign and domestic-currency debt are $R^* = 1 + r^* = 1 + i^*$ and $R(\pi) = 1 + r(\pi) = \frac{1+i}{1+\pi}$, respectively.

Foreign investors are risk averse and discount the future with a stochastic discount factor $\Lambda^*(\psi)$ which is normalized such that $\mathbb{E}(\Lambda^*(\psi)R^*) = 1$. Foreign investors have zero net position in both domestic and foreign currencies and fund themselves by borrowing in foreign currency. They have access to the forward exchange rate market to hedge their domestic currency position. The government cannot access this market. Foreign investors have limited commitment in the domestic currency market that translates into limited financial risk-bearing capacity. Each period, after taking positions but before the shock is realized, they can divert a fraction of the funds invested in domestic currency.

The government receives an endowment $y(\psi)$ every period and discounts the future at rate $\beta < \frac{1}{R^*}$. Preference over consumption is represented by $\mathbb{E}\sum_{t=0}^{\infty}\beta^t u(c_t)$ where $c_t \geq 0$ denotes the consumption at time t. The instantaneous utility function $u(\cdot)$ is continuous, strictly increasing and strictly concave. The government cannot commit to repay foreign investors. In case of default, it suffers from permanent autarky and an output penalty denoted by $\varkappa(\psi) \geq 0$.

The government can issue debt in either domestic or foreign currencies and can accumulate foreign reserves. Expressed in foreign currency, the domestic-currency debt $b \leq 0$ and foreign-currency debt $b^* \leq 0$ have a unit price q. The former pays in domestic rate i and the latter in foreign rate i^*. Both types of debt have long-term maturities modelled as a geometrically decaying coupon structure similar to Hatchondo and Martinez (2009) and Chatterjee and Eyigungor (2012). More precisely, a fraction $1-\delta$ of the debt matures every period and the remaining fraction δ is rolled over. If $\delta = 0$ the debt is one period and if $\delta = 1$ it is a perpetuity. Besides debt, the government has access to a one-period risk-free foreign reserve assets $a^* \geq 0$ at unit price of 1 given that $\mathbb{E}(\Lambda^*(\psi)(1+i^*)) = 1$.

I restrict my attention to Markov equilibria with state vector (ψ, π, b, b^*, a^*). The timing of actions is the same as in Eaton and Gersovitz (1981). At the beginning of each period,

ψ realizes and the government decides whether to default. Conditional on no default, it can issue new domestic debt b', foreign debt $b^{*\prime}$ and foreign reserves $a^{*\prime}$. In default, there is no debt issuance while foreign reserves accumulation remains possible.

4.1 Domestic Government

Given the current value of the shock, the inflation rate and the outstanding stock of debt and reserves, the overall beginning of the period value is given by

$$W(\psi, \pi, b, b^*, a^*) = \max \Big\{ V^R(\psi, \pi, b, b^*, a^*), V^A(\psi, a^*) \Big\}, \tag{3}$$

where $V^R(\psi, \pi, b, b^*, a^*)$ corresponds to the value in repayment and $V^A(\psi, a)$ to the value in default. I denote by $D_t(\psi, \pi, b, b^*, a^*)$ the default policy which takes value one when $V^A(\psi, a) > V^R(\psi, \pi, b, b^*, a^*)$ and zero otherwise. Under default, the government cannot issue new debt and suffers from an output penalty $\varkappa$. The value is then given by

$$V^A(\psi, a^*) = \max_{a^{*\prime} \geq 0} \Big\{ u\left(y(\psi) - \varkappa(\psi) + R^* a^* - a^{*\prime}\right) + \beta \mathbb{E} V^A(\psi', a^{*\prime}) \Big\}.$$

The government continues to accumulate foreign reserves but cannot ever re-access the debt markets. This assumption is later relaxed in the quantitative section. The government value under repayment is given by

$$\begin{aligned} V^R(\psi, \pi, b, b^*, a^*) = &\max_{\pi', B' = (b', b^{*\prime}, a^{*\prime})} \Big\{ u\left(c\right) + \beta \mathbb{E} W(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}) \Big\} \\ \text{s.t.} \quad & c + q(B') \left[b^{*\prime} + b' - \delta b^* - \overline{\delta} b \right] + a^{*\prime} = y(\psi) + (R(\pi) - \overline{\delta}) b + (R^* - \delta) b^* + R^* a^* \\ & b' \leq 0, \; b^{*\prime} \leq 0, \; a^{*\prime} \geq 0, \; \overline{\delta} \equiv \frac{\delta}{1+\pi}, \; \pi'(\psi') = \alpha \overline{\pi}' + (1-\alpha) \hat{\pi}(\psi'), \end{aligned} \tag{4}$$

where the inflation policy by $\overline{\pi}' = \Pi(b', b'^*, a'^*)$ is specified in the next section. The optimal debt and reserves policy vector is denoted by $B' = B(\psi, \pi, b, b^*, a^*)$. The cost of issuing domestic and foreign-currency debt are dissimilar. While it is true that domestic and foreign-currency debt face the same default risk, they do not have the same return in repayment. In other words, the difference comes from the wedge between the foreign real interest rate $(R^* - \delta + \delta q)$ and the domestic real interest rate $(R(\pi) - \overline{\delta} + \overline{\delta} q)$.

Regarding foreign reserves, three are three motives for accumulation. First, the government can transfer resources from the repayment state to the default state. This is because a^* is consumed in both repayment and default. Quantitatively however this channel turns out to be unimportant as shown by Alfaro and Kanczuk (2009) and Bianchi et al. (2018).

The second advantage of accumulating foreign reserves is that the government can transfer resources across repayment states. For this, observe that the value of *outstanding* debt in repayment is

$$(R(\pi) - \bar{\delta})b + (R^* - \delta)b^* + q(B(\psi, \pi, b, b^*, a^*)) \left(\bar{\delta} b + \delta b^*\right),$$

which depends on ψ through the bond policy function. When returns are high, it is very costly to repay outstanding debt. Hence, issuing debt to buy foreign reserves provides higher payoffs in states in which the bond return is low. As a result, foreign reserves enable the government to transfer resources from states with low borrowing costs (high debt prices) to states with high borrowing costs (low debt prices).

There is a third advantage of accumulating foreign reserves: the determination of the nominal exchange rate. This channel appears in the dependency of the real return of domestic currency $R(\pi'(\psi'))$ on $\pi'(\psi')$. The next section makes this dependency explicit when deriving the foreign investors problem.

4.2 Foreign Investors

Foreign investors value their expected profit with a stochastic discount factor $\Lambda^*(\psi)$. They represent the marginal investors in the economy and have zero net position in both domestic and foreign currencies. When investing in domestic currency, they can hedge part of their position with forward contracts in quantity f'.

When operating in the foreign currency market, foreign investors make zero net expected profit and have no limitations in their capacity to take on risks. The bond price is given by

$$q(b', b^{*\prime}, a^{*\prime}) = \mathbb{E}\left[\Lambda^*(\psi)(1 - D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))\left(R^* - \delta + \delta q(B''))\right],$$

where $\pi'(\psi') = \alpha\Pi(b', b^{*\prime}, a^{*\prime}) + (1-\alpha)\hat{\pi}(\psi')$ and $B'' = B(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime})$. Under repayment, foreign lenders receive the fraction of debt maturing, $(1-\delta)R^*$, the interest payment for the share of debt that is rolled-over, $\delta(R^* - 1)$, and the value of the outstanding debt in the next period, $\delta q(B'')$. The assumption of *i.i.d.* shocks and the restriction to Markovian equilibria make the bond price is independent of ψ. Additionally observe that this bond price collapses to 1 when there is no default and no dilution risk under the assumption that $\mathbb{E}(\Lambda^*(\psi)R^*) = 1$.

Operations on the domestic currency market imply that foreign investors must convert foreign currency into domestic currency. The return in foreign currency is random. To limit the extent of expected profit of foreign investors, I introduce limited arbitrage capacity.

Following Gabaix and Maggiori (2015), each period, after taking positions but before the shock ψ' realized, foreign investors can divert a fraction $\Gamma|b'|$ of the portfolio b'.[3] Since creditors, when lending to the foreign investors, correctly anticipate this incentive, foreign investors are subject the following participation constraint

$$I^* \geq \Gamma(-b')^2, \tag{5}$$

where I^* denotes the foreign investors value in the domestic market. Given the zero net position, their value in the domestic market is given by

$$\begin{aligned} I^* =& \mathbb{E}\left[\Lambda^*(\psi)\Big(- b'\left((1 - D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))\left[1 + i - \delta + \delta q(B'')\right]\frac{1}{1 + \pi'(\psi')} - R^*\right)\right] \\ & + b'(q(b', b^{*\prime}, a^{*\prime}) - 1). \end{aligned}$$

The maximization problem of foreign lenders is therefore

$$\begin{aligned} \max_{\{b', f'\}} & \left\{\mathbb{E}\left[\Lambda^*(\psi)\Bigg(- b'\left((1 - D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))\left[1 + i - \delta + \delta q(B'')\right]\frac{1}{1 + \pi'(\psi')} - R^*\right)\right.\right. \\ & \left.\left.\qquad - f'\left(\frac{1}{S'} - \frac{1}{F}\right)\Bigg)\right] + b'(q(b', b^{*\prime}, a^{*\prime}) - 1)\right\} \\ \text{s.t.} & \qquad (5),\ b' \leq 0,\ f' \geq 0. \end{aligned}$$

As the objective function linearly depends on b' and the constraint (5) quadratically, the constraint always binds. This implies that the amount of domestic debt directly impacts the excess return in domestic currency. More precisely, a larger $-b'$ increases $\frac{1+i}{1+\pi'(\psi')}$ given that R^* is exogenous. The reason is that foreign lenders must earn larger expected profit to take on a greater position in domestic currency. In other words, the government can issue domestic-currency debt only if the foreign lenders expect a positive profit. This is consistent with Fact III. Given that one part of the inflation rate is exogenous, one can write

$$R(\pi'(\psi')) \equiv R(\psi', b', b^{*\prime}, a^{*\prime}) = \frac{1 + i}{1 + \alpha\overline{\pi}(b', b^{*\prime}, a^{*\prime}) + (1 - \alpha)\hat{\pi}(\psi')}.$$

I have assumed that the nominal interest rate remains fixed. This is without loss of generality as a change in this rate has no real effects given the absence of nominal rigidities. Thus, the domestic government can affect the exchange rate by issuing debt to buy foreign reserves.

[3] In case of such diversion, the recovery rate of the initial position $|b'|$ is equal to $1 - \Gamma|b'|$. Creditors can recover a value of $\max(1 - \Gamma|b'|, 0)|b'|$.

Given that foreign lenders can hedge their position against foreign exchange risks, I can define the CIP premium as the excess return of an *hedged* position in domestic currency held by foreign investors. Formally,

$$Z^*(D) = (1-D)(1+i-\delta+\delta q)\frac{S}{F} - R^*.$$

Equivalently the UIP premium corresponds to the *unhedged* excess return which is given by

$$X^*(D) = (1-D)(1+i-\delta+\delta q)\frac{S}{S'} - R^*.$$

5 Three Economies

To better understand the different components of the model, I consider two polar cases: a safe-heaven economy characterized by the absence of default risk and a dollarized default economy characterized by the absence of domestic currency market. Afterwards I analyze the general case lying in between these two extremes.

5.1 Safe-Haven Economy

A safe-heaven economy consists of an economy without default risk. For this, one assumes that $\varkappa \to \infty$. This together with the fact that $\mathbb{E}(\Lambda^*(\psi)R^*) = 1$ implies $q(B) = 1$ for all B. Given this, the maturity becomes irrelevant and it holds that

$$\mathbb{E}\left[\Lambda^*(\psi)X^*(0)\right] = -\Gamma b'. \tag{6}$$

Moreover, the CIP and the UP premia take the textbook form

$$Z^*(0) = (1+i)\frac{S}{F} - R^* \quad \text{and} \quad X^*(0) = (1+i)\frac{S}{S'} - R^*.$$

Similar to Bacchetta et al. (2025), the relationship between CIP and UIP deviations are given by the first-order condition with respect to f'

$$\mathbb{E}\left[\Lambda^*(\psi)X^*(0)\right] = Z^*(0),$$

which can be rewritten as

$$\mathbb{E}\left[X^*(0)\right] + \frac{\operatorname{cov}(\Lambda^*(\psi), X^*(0))}{\mathbb{E}\Lambda^*(\psi)} = Z^*(0). \tag{7}$$

Hence the CIP and UIP deviations diverge by a covariance term. This combined with (6) leads to $Z^*(0) = -\Gamma b'$. Hence, while the UIP premium can be negative, the CIP premium must stay positive for the domestic government to issue domestic-currency debt. In the special case in which $\alpha = 1$, $\pi'(\psi') = \overline{\pi}'$ and therefore there is no exchange risk implying that $S' = F/R^*$ and $X^*(0) = Z^*(0)$.

Regarding the issuance of domestic and foreign-currency debt, the first-order conditions of (4) with respect to $b^{*\prime}$ and b' read

$$\begin{aligned} u_c(c) =& \beta\mathbb{E}\left[u_c(c')\right] R^*, \\ u_c(c) =& \beta\mathbb{E}\left[u_c(c')\left(R(\pi'(\psi')) + \frac{\partial R(\pi'(\psi'))}{\partial b'} b'\right)\right]. \end{aligned}$$

The two issuance have the same marginal benefit but diverge in their marginal cost. The derivative of the domestic bond return comes from the fact that the government cannot commit to a specific bond policy and therefore cannot commit to a specific nominal exchange rate policy. Combining the two expressions together, I obtain

$$\beta\mathbb{E}\left[\frac{u_c(c')}{u_c(c)}\left(X^*(0) + \frac{\partial R(\pi'(\psi'))}{\partial b'} b'\right)\right] = 0.$$

Since $\frac{\partial R(\pi'(\psi'))}{\partial b'} \leq 0$ and $b' \leq 0$, whenever $\mathbb{E}\left[X^*(0)\right] \leq 0$, it is optimal for the government to issue debt in domestic currency only. This is because the unhedged real return in domestic currency is lower than the return in foreign currency. Note that for this to hold, it should be that the covariance in (7) is sufficiently negative.

5.2 Dollarized-Default Economy

A dollarized default economy consists of an economy without domestic currency market. The main difference with respect to the previous case is that there is default risk (i.e. $\varkappa < \infty$) and the whole issuance of debt is denominated in foreign currency. This corresponds to the model of Bianchi et al. (2018).

In the absence of domestic currency market, the foreign lenders problem is standard. Returns are simply defined by the discounted future default risk. The government value under repayment is given by

$$V^R(\psi, b^*, a^*) = \max_{b^{*\prime}, a^{*\prime}} \left\{ u\left(c\right) + \beta \mathbb{E} W(\psi', b^{*\prime}, a^{*\prime}) \right\} \tag{8}$$

$$\text{s.t.} \quad c + q(b^{*\prime}, a^{*\prime}) \left[b^{*\prime} - \delta b^*\right] + a^{*\prime} = y(\psi) + (R^* - \delta)b^* + R^* a^*$$

$$b^{*\prime} \leq 0, \;\; a^{*\prime} \geq 0.$$

This implies that the government can transfer resources across repayment states only if $\delta > 0$. In the case in which $\delta = 0$, the value of *outstanding* debt in repayment is $R^* b^*$ which is independent on the realization of ψ. Thus, having more or less foreign reserves does not affect the utility in repayment across ψ. In opposition, for $\delta > 0$, the value of *outstanding* debt in repayment becomes $[R^* - \delta + \delta q(B(\psi, b^*, a^*))]b^*$ which depends on ψ through the bond policy function. With long-term debt, the value of outstanding bond depends on the current bond price which enables to transfer resources across repayment states.

Given the default risk, the bond price is not necessarily equal to 1 implying a different inter-temporal condition than in the previous case. More precisely, the first-order conditions of (8) with respect to $b^{*\prime}$ is

$$u_c(c) \left[q(b^{*\prime}, a^{*\prime}) + \frac{\partial q(b^{*\prime}, a^{*\prime})}{\partial b^{*\prime}} (b^{*\prime} - \delta b) \right] = \beta \mathbb{E} \left[u_c(c')(1 - D(\psi', b^{*\prime}, a^{*\prime})) \left(R^* - \delta + \delta q(b^{*\prime\prime}, a^{\prime\prime *})\right) \right].$$

The derivative of the bond price is due to the impossibility for the government to commit to repay. Bond issuance affects the bond returns through the default risk. There is however no exchange rate risk meaning that the accumulation of reserve is solely associated to the hedging of default risks.

5.3 In-Between Economy

The general case consists of the economy in between the two extremes presented previously. There is both a domestic and foreign currency market as well as default risk (i.e. $\varkappa < \infty$). The foreign lenders binding constraint (5) is given by

$$\mathbb{E} \left[\Lambda^*(\psi) X^*(D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime})) \right] - (q(b', b^{*\prime}, a^{*\prime}) - 1) = -\Gamma b'.$$

The term within the expectation corresponds to the expected unhedged excess return of domestic-currency debt, while $q(b', b^{*\prime}, a^{*\prime}) - 1$ corresponds to the excess return on foreign-currency debt.

The combination of the default risk, the risk aversion of foreign lenders and the limited arbitrage generates a specific dynamic for the domestic-currency debt. Remember the special case in which $\alpha = 1$. In the safe-haven economy, CIP and UIP premia simply equate each other. This is not necessarily the case here as foreign lenders discount future default risk. Hence, it is the combination of both default risk and exchange rate risk that shape the issuance of domestic-currency debt.

In the safe-haven economy, a larger $-b'$ has to be compensated by a larger return $R(\pi'(\psi'))$. With the default risk, this effect is further amplified by the fact that a larger domestic-currency debt increases $D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime})$ for all $\psi' \in \Psi$. This requires an even larger compensation. Given that a larger $-b'^{*}$ and a lager a^* have the same effect on the default policy, the same argument holds true.

Furthermore, the first-order condition of the foreign lenders problem with respect to f' leads to the following expression

$$\mathbb{E}\left[\Lambda^*(\psi) X^*(D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))\right] = \mathbb{E}\left[\Lambda^*(\psi) Z^*(D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))\right].$$

Expectation is taken on both sides given the default risk next period. The expression can be rewritten as

$$\begin{aligned}&\mathbb{E}\left[X^*(D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))\right] + \frac{\operatorname{cov}(\Lambda^*(\psi), X^*(D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))}{\mathbb{E}\Lambda^*(\psi)} \\ &= \mathbb{E}\left[Z^*(D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))\right] + \frac{\operatorname{cov}(\Lambda^*(\psi), Z^*(D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))}{\mathbb{E}\Lambda^*(\psi)}\end{aligned}$$

Fact III states that $\mathbb{E}[X^*(D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))] > \mathbb{E}[Z^*(D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))]$ implying that $\operatorname{cov}(\Lambda^*(\psi), X^*(D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))) < \operatorname{cov}(\Lambda^*(\psi), Z^*(D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime})))$.

With default risk, the bond price is not necessarily equal to 1 due to the default risk. The first-order condition of (4) with respect to $b^{*\prime}$ gives

$$\begin{aligned}&u_c(c)\left[q(B') + \frac{\partial q(B')}{\partial b^{*\prime}}\left(b^{*\prime} + b' - \delta b^* - \overline{\delta} b\right)\right] = \\ &\beta \mathbb{E}\left[u_c(c')(1 - D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))\left(R^* + \frac{\partial R(\pi'(\psi'))}{\partial b^{*\prime}} b'\right)\right],\end{aligned}$$

which is very similar to the one in the dollarized economy except for the derivative of the domestic-currency debt return. This additional term is due to the fact that the issuance of foreign-currency debt affects the default risk and therefore the return on domestic-currency debt. As before, the derivative of the bond price is due to the impossibility for the government to commit to repay. The first-order conditions respect to b' is

$$u_c(c)\left[q(B') + \frac{\partial q(B')}{\partial b'}\left(b^{*\prime} + b' - \delta b^* - \overline{\delta} b\right)\right] =$$
$$\beta\mathbb{E}\left[u_c(c')(1 - D(\psi', \pi'(\psi'), b', b^{*\prime}, a^{*\prime}))\left(R(\pi'(\psi')) + \frac{\partial R(\pi'(\psi'))}{\partial b'}b'\right)\right].$$

Unlike the safe-haven economy, both the marginal benefit and the marginal cost of issuance diverge between the two types of debt. A one-unit increase in domestic-currency debt does not have the same impact on the bond price q and the return R as a one-unit increase in foreign-currency debt. The reason is that the two types of debt have different returns and therefore different effect on the incentive to default. Combining the two expressions, one obtains the following equation

$$\beta\mathbb{E}\left[\frac{u_c(c')}{u_c(c)}\left(X^*(D) + \frac{\partial R(\pi'(\psi'))}{\partial b'}b' - \frac{\partial R(\pi'(\psi'))}{\partial b'^*}b'\right)\right] = \left(\frac{\partial q(B')}{\partial b'} - \frac{\partial q(B')}{\partial b'^*}\right)\left(b^{*\prime} + b' - \delta b^* - \overline{\delta} b\right).$$

The expression depends on the sensitivity of the bond price and the domestic-currency return with respect to b'^* and b'. These are key in determining the optimal debt structure but are analytically intractable. The next section therefore offers a quantitative exploration.

6 Quantitative Analysis

This section first exposes the parametrization of the model and continues with a study of the debt and foreign reserves dynamic. It finishes with counterfactual analyses on different exchange rate regimes.

6.1 Parametrization

The quantitative version of the model integrates the standard features in the literature: stochastic market re-entry and persistent shocks. Due to the presence of multiple types of debt with long-term maturity, I introduce taste shocks to the default and the issuance decision to solve the model.[4] Table 4 depicts the different parameters of the model. In future versions, the parametrization will also be adapted to a proper calibration with moments matching for the sample countries.

The borrower's utility function takes the constant relative risk aversion (CRRA) form $u(c) = \frac{c^{1-\varpi_b}}{1-\varpi_b}$ with the standard value of $\varpi_b = 2$ in the literature. The foreign and domestic

[4]See Chatterjee and Eyigungor (2012), Mihalache (2020), Dvorkin et al. (2021), Mateos-Planas et al. (2024) and Mateos-Planas et al. (2023).

Table 4: Parameters

Parameter	Value	Description
ϖ_b	2	CRRA parameter for borrower
ϖ_l	2	CRRA parameter for foreign lenders
β	0.965	Discount factor borrower
i^*	0.02	Foreign risk-free interest rate
i	0.02	Domestic risk-free interest rate
δ	0.9	Averga debt maturity
Γ	0.1	Arbitrage constraint
α	0.5	Control nominal exchange rate
κ	0.8	Default output penalty
θ	0.2	Market re-entry probability
ρ_y	0.9	Autocorrelation output
σ_u	0.017	Standard deviation output
ρ_s	0.6	Autocorrelation exchange rate
σ_v	0.067	Standard deviation exchange rate
ω	0.015	Taste shock variance
ϕ	0.1	Taste shock correlation

risk-free rates are both 2% and $\beta = 0.965$. The stochastic endowment follows a log-normal AR(1) process $\log y_t = \rho_y \log y_{t-1} + u_t$ with $u \sim N(0, \sigma_u^2)$. Based on the estimation of Arellano and Ramanarayanan (2012) for Brazil, $\rho_y = 0.9$ and $\sigma_u = 0.017$. The stochastic endowment is discretized into a 7-state Markov chain following Tauchen (1986). The output penalty upon default is given by $\varkappa(\psi) = \max\{0, y(\psi) - \kappa\mathbb{E}[y(\psi)]\}$ following Arellano (2008).

Regarding the exchange rate change, I also assume an AR(1) process $\Delta S_t = \rho_s \Delta S_{t-1} + v_t$. Estimation from Brazil gives $\rho_s = 0.6$ and $\sigma_v = 0.067$. I additionally consider $\alpha = 0.5$, which corresponds to the case in-between the fully floating and the fully fixed exchange rate regime.

Regarding debt, I set $\delta = 0.9$ to match the an average maturity of 10 years. I subsequently select $\Gamma = 0.1$ and assume the following stochastic discount factor for foreign investors

$$\Lambda^*(\psi) = \frac{1}{R^*}\frac{\tilde{\Lambda}^*(\psi)}{\mathbb{E}[\tilde{\Lambda}^*(\psi)]},$$

where $\tilde{\Lambda}^*(\psi) = \left(\frac{y(\psi)}{\mathbb{E}[y(\psi)]}\right)^{\varpi_l}$ takes the CRRA form and is decreasing in income (i.e. bad states are priced highly). Notice that I normlalize the stochastic discount factor such that $\mathbb{E}[\Lambda^*(\psi)R*] = 1$.

6.2 Sovereign debt and foreign reserves

In this section, I present the results of the parametrization. To gain the most insight into the quantitative results, I compare the three economies of Section 5 back to back. Table 5 depicts the outcome of the model for the different specifications. Each economy is simulated 2000 times for 600 periods and the first 200 periods are discarded to make sure that the initial conditions do not matter.

Table 5: Results under Benchmark Parameters

Moments	In-Between	Safe-Haven	Dollarized-Default
1. Mean (μ)			
a^*/y	0.18	0.08	0.12
$-b^*/y$	0.39	0.51	0.63
$-b/y$	0.20	0.11	-
$b^*/(b+b^*)$	0.53	0.83	-
Spread	0.03	0.00	0.03
S^-/S	0.03	0.01	-
CIP	0.01	0.00	-
UIP	0.09	0.02	-
2. Standard deviation (σ)			
Spread	0.02	0.00	0.02
S^-/S	0.01	0.02	-
CIP	0.17	0.06	-
UIP	0.21	0.09	-
3. Correlation (ρ)			
a^*, y	0.37	0.22	0.37
b^*, y	0.23	-0.16	0.23
b, y	0.10	-0.26	-
a^*, S^-/S	0.25	0.01	-
b^*, S^-/S	0.42	0.50	-
b, S^-/S	0.48	0.03	-
a^*, Spread	-0.18	-	-0.22
b^*,Spread	-0.01	-	-0.04
b, Spread	-0.06	-	-
CIP, UIP	0.87	1.00	-

Note: The outcome comes from the simulation of 2000 economies for 600 periods and the first 200 periods are discarded to make sure that the initial conditions do not matter. All reported variables are in level.

I analyze each moment separately across the different specifications depicted in Table 5. In terms of mean, one observes that the in-between economy primarily issue foreign-currency debt. Hence parameters have to be adapted to be consistent with Fact I.[5] The

[5]For simplicity, I took $i = i^*$ but in the data $i > i^*$ which would foster a greater domestic-currency debt accumulation as it increases the excess return of foreign investors.

share of foreign reserves relative to GDP is high averaging 18% of GDP, while the overall debt-to-GDP ratio is below 60%. In comparison, the safe-haven economy accumulates more debt and less reserves. Most of the indebtedness is denominated in foreign currency since the UIP premium is positive on average. The low level of reserves simply comes from the low level of domestic-currency debt. In comparison, the dollarized-default economy issues a larger amount of foreign reserves. This indicates that quantitatively reserves accumulation is mainly due to default risk. Foreign exchange interventions account for a smaller part of the accumulation. Finally, CIP and UIP premia are on average positive consistent with Fact III and are larger in the presence of default risk.

Regarding standard deviations, in the in-between economy, one notes that the spread displays the high volatility typical of emerging economies. Such volatility comes from the combination of the long-term maturity and the risk aversion of foreign lenders. One equally notices a pronounced volatility of the nominal exchange rate, the CIP and the UIP premium consistent with Fact III. Comparing the in-between and the safe-haven economies, one notices that the default risk is again the main driver albeit the exchange rate risk is not negligible.

In terms of correlations, in the in-between economy, one observes the co-movement of foreign reserves, foreign-currency and domestic-currency debt reported in Fact II. The positive correlation with output and the negative correlation with the default risk follow the mechanism highlighted by Bianchi et al. (2018). The borrower uses foreign reserves to transfer resources from states with low borrowing costs (high spread and low output) to states with high borrowing costs (low spread and high output). This relationship however vanishes in the safe-haven economy. Regarding the correlation with the nominal exchange rate, the mechanism is entirely driven by the limitation in arbitrage. Foreign lenders must be compensated when offering more domestic-currency debt as this entails greater risk. This channel remains in the safe-haven economy but is less pronounced in terms of magnitude. Finally, CIP and UIP premia positively correlate consistent with Fact III. Given the functional form of the foreign lenders stochastic discount factor this correlation is stronger in the safe-haven economy.

Thus the model shows features consistent with Facts I-III. To address Fact IV, one could add an additional shock that would only affect the foreign lenders stochastic discount factor. This would explain why the CIP react to global factors and the UIP less so.

6.3 Exchange Rate Regimes

In this section, I explore the implications of the exchange rate regime on the benchmark in-between economy. So far $\alpha = 0.5$ meaning that the exchange rate regime is neither fully flexible nor fully fixed. In what follows, I consider a fully fixed exchange rate regime (i.e. $\alpha = 1$) and a fully floating exchange rate regime (i.e. $\alpha = 0$). The former case means that the borrower announces the next-period nominal exchange rate S' in the current period and commit to implement it next period. There is therefore no exchange rate risk in the next period. However, this does not mean that the nominal exchange rate is fixed forever. In the next period, the borrower determines S'' and generally $S'' \neq S'$.

Table 6: Results under Alternative Exchange Rate Regimes

Moments	Benchmark	Fixed Exchange Rate	Floating Exchange Rate
1. Mean (μ)			
a^*/y	0.18	0.11	0.21
$-b^*/y$	0.39	0.39	0.41
$-b/y$	0.20	0.08	0.30
$b^*/(b+b^*)$	0.53	0.82	0.57
Spread	0.03	0.03	0.06
S^-/S	0.03	0.01	0.00
CIP	0.01	0.01	0.08
UIP	0.09	0.01	0.10
2. Standard deviation (σ)			
Spread	0.02	0.03	0.05
S^-/S	0.01	0.01	0.04
CIP	0.17	0.16	0.24
UIP	0.21	0.20	0.25
3. Correlation (ρ)			
a^*, y	0.37	0.38	0.42
b^*, y	0.23	0.08	0.20
b, y	0.10	0.21	0.36
a^*, S^-/S	0.25	0.09	0.01
b^*, S^-/S	0.42	0.59	0.84
b, S^-/S	0.48	0.49	0.10
a^*, Spread	-0.18	-0.19	-0.15
b^*,Spread	-0.01	-0.03	-0.06
b, Spread	-0.06	-0.07	-0.13
CIP, UIP	0.87	0.92	0.73

Note: The outcome comes from the simulation of 2000 economies for 600 periods and the first 200 periods are discarded to make sure that the initial conditions do not matter. All reported variables are in level.

There are two striking features related to the exchange rate regime in Table 6. First, the share of foreign-currency debt to GDP remains constant across the different regimes. It is the level of reserves and domestic-currency debt that changes. In particular, reserves accumulation is more pronounced in the floating exchange rate regime. Second, the different correlations keep the same sign across the different specifications.

In the floating exchange rate regime, the issuance of domestic-currency is not a choice anymore. The excess return on domestic currency is completely determined by the default risk and the exogenous part of the exchange rate change. As a result, the issuance of domestic-currency debt significantly increase compared to the benchmark economy similar to the volatilities.

In opposition, in the fixed exchange rate regime, the borrower entirely determines the return of the domestic-currency debt. This return is however not allowed to be state-contingent. One sees that the issuance of domestic-currency debt drops relative to the benchmark specification. The same holds true for the volatilities.

7 Conclusion

This paper develops a unified framework to study sovereign debt issuance and foreign reserve accumulation in economies facing default risk, incomplete markets, and limited arbitrage in currency markets. Motivated by new empirical evidence from emerging economies, the model integrates two distinct but interacting motives for reserve accumulation: precautionary insurance against default risk, and exchange rate management through sterilized interventions. By allowing governments to issue long-term debt in both domestic and foreign currency while accumulating foreign reserves, the framework connects sovereign balance-sheet policies to deviations from covered (CIP) and uncovered interest parity (UIP).

The analysis highlights how the interaction between default risk and exchange rate policy fundamentally shapes debt composition and reserve holdings. In a safe-haven economy without default risk, reserve accumulation serves the sole purpose of affecting the nominal exchange rate. In contrast, in a dollarized-default economy, reserves exclusively provide insurance against default. Most emerging economies lie between these extremes: default risk creates a precautionary demand for reserves, while limited arbitrage in currency markets allows governments to influence exchange rates and domestic-currency returns through reserve accumulation.

Quantitatively, the model replicates key empirical patterns observed in the data. It generates realistic levels of foreign reserves, volatile and positively correlated CIP and UIP premia, and the joint procyclicality of debt and reserves. While default risk accounts for the bulk of reserve accumulation, exchange rate interventions play a meaningful role in shaping debt denomination and currency premia. The framework also clarifies why domestic factors such as sovereign risk and foreign exchange interventions are central in explaining UIP premia, whereas global financial conditions matter more for CIP deviations.

These results suggest that reserve accumulation and debt management should be analyzed jointly rather than in isolation. Policies affecting exchange rates, debt composition, and reserve holdings interact in non-trivial ways through default incentives and limits to arbitrage. Future work could extend the framework by introducing endogenous monetary policy, richer financial intermediaries, or cross-country spillovers, thereby further exploring the role of sovereign balance sheets in the global financial system.

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Online Appendix

(Not for Publication)

A Data

This section specifies the source of data and describes how certain variables were constructed. Table A.1 summarizes the data sources and frequencies.

Table A.1: Data Sources and Frequencies

Series	Sources	Frequency
Spot exchange rate	Bloomberg, BIS	daily
Exchange rate forecasts	Bloomberg[a]	quarterly
Government bond yields	Bloomberg, Du and Schreger (2016)	daily
Forward premium	Du and Schreger (2016)	daily
Federal funds effective rate	Federal Reserve Bank of St. Louis	daily
VIX	Federal Reserve Bank of St. Louis	daily
Security Brokers and Dealers	Federal Reserve Bank of St. Louis	quarterly
Central bank policy rates	BIS	daily
Short-term interest rate	OECD	monthly
Nominal GDP	IMF WEO, OECD[b]	yearly, quarterly
Foreign currency reserves	IMF IRFC	monthly
Foreign exchange intervention	Adler et al. (2021)	monthly
General government debt	IMF WEO	yearly
General government foreign-currency debt	Arslanalp and Tsuda (2012)[c]	quarterly, yearly

[a] Consensus forecast 3m, 6m, 9m, 1y, 2y, 3y, 4y, 5y.
[b] Federal Reserve Bank of Atlanta for China, OpenDOSM for Malaysia, national statistical offices for Israel, Thailand, Peru and Philippines.
[c] At quarterly frequency foreign-currency debt is for central government.

Countries and currencies: the sample is made of 18 emerging economies currencies: Brazil (BRL), Chile (CLP), China (CNY), Colombia (COP), Hungary (HUF), India (IDR), Indonesia (INR), Israel (ILS), Korea (KRW), Malaysia (MYR), Mexico (MXN), Peru (PEN), Philippines (PHP), Poland (PLZ), Russia (RUB), South Africa (ZAR), Thailand (THB), Turkey (TRY).

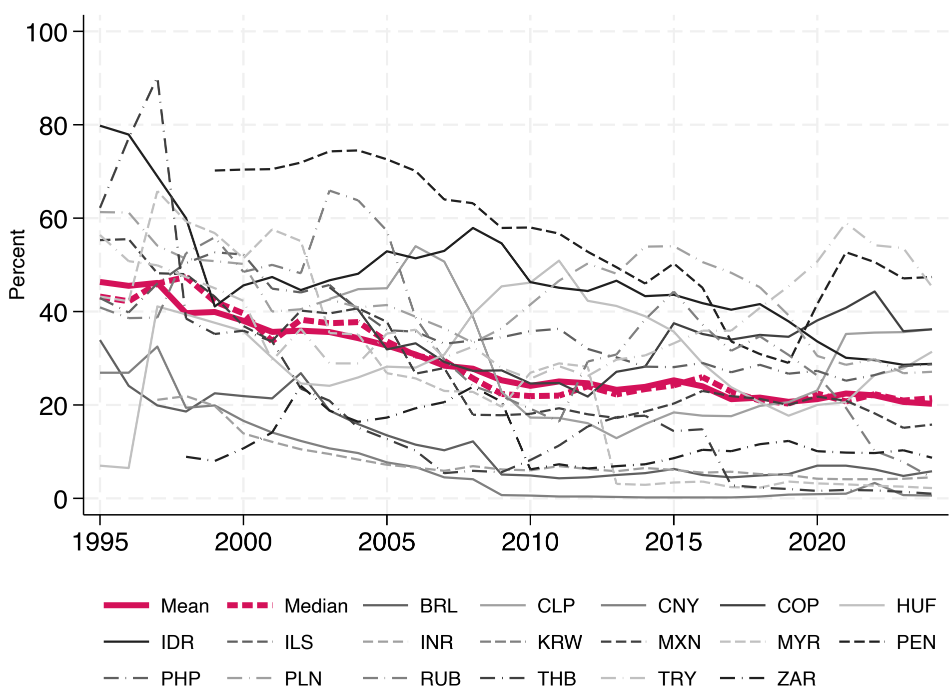
CIP and UIP deviations: daily spot exchange rate data come from Bloomberg and the BIS. Quarterly consensus exchange rate forecasts come from Bloomberg. Daily forward premium come from Du and Schreger (2016) together with the government bond yields differentials. Individual yields come from Bloomberg.

Debt and foreign reserves: monthly foreign reserves come from the IMF International Reserves and Foreign Currency Liquidity (IRFCL). Monthly data on foreign exchange intervention come from Adler et al. (2021). Yearly data on general government debt come from the IMF World Economic Outlook (WEO). Yearly data on general government foreign-currency debt come from Arslanalp and Tsuda (2012). The authors also provide central government foreign-currency debt at the quarterly frequency.

USD and US investors: USD convenience yield and liquidity premium are computed according to Kalemli-Özcan and Varela (2025). The former corresponds to the average short-term interbank interest rate differential between the US and G10 countries (i.e. Australia, Canada, Denmark, Germany, Japan, New Zealand, Norway, Sweden, Switzerland, United Kingdom). The latter represents the average gap between the short-term interbank interest rate differential and the short-term government bond yield differential between the US and G10 countries. Regarding the US brokers and dealers capital ratio, it corresponds to the ratio of total equity to total financial assets taken from Federal Reserve Bank of St. Louis.

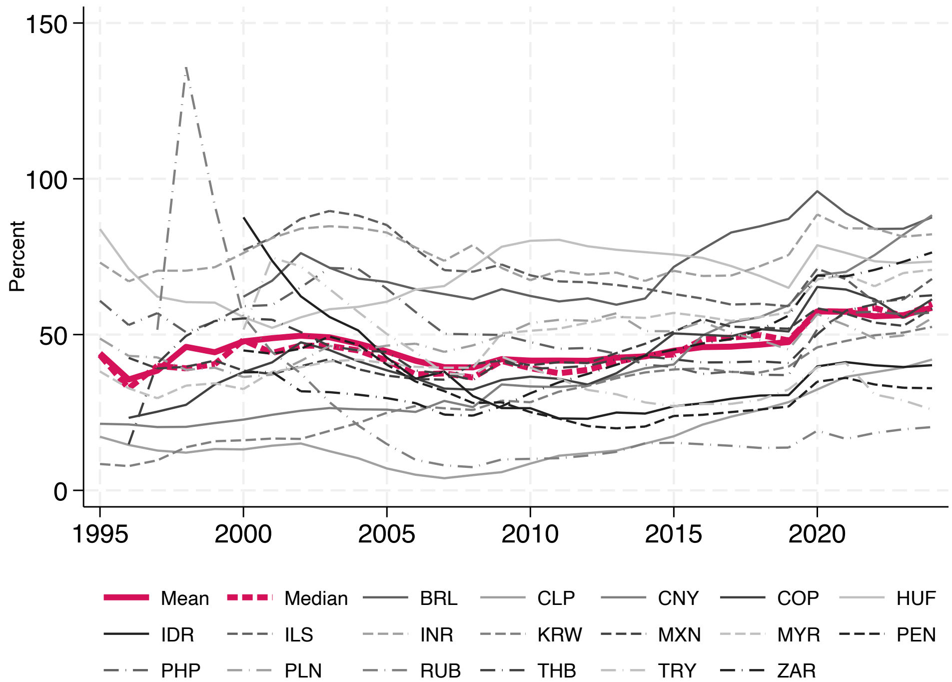
Other financial variables: VIX, federal funds effective rate are from Federal Reserve Bank of St. Louis. Central bank policy rates come from the BIS.

B Additional Tables and Figures



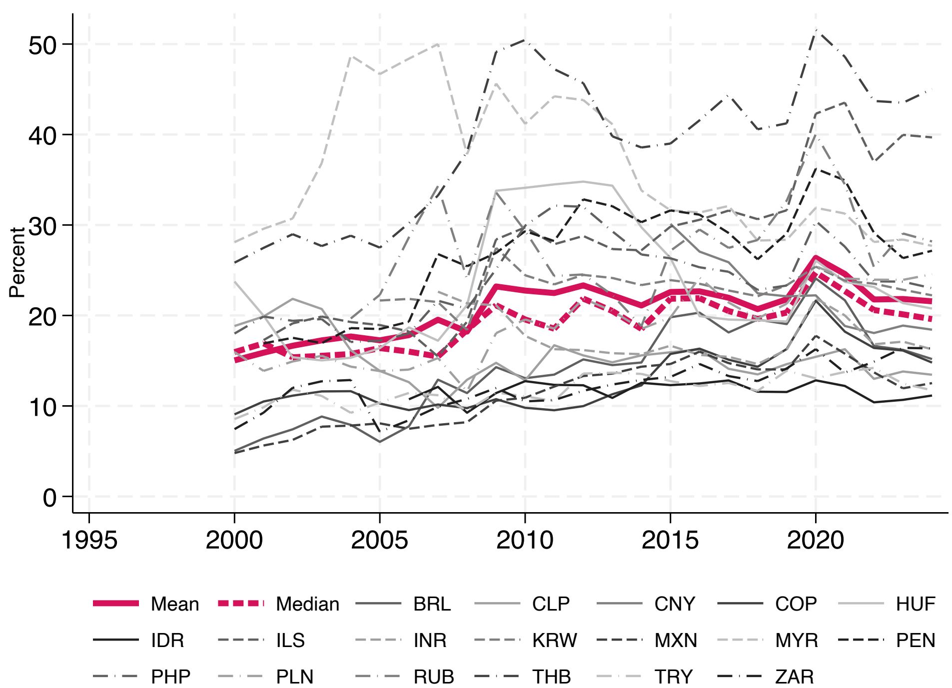
Note: The figure depicts the evolution of foreign-currency debt (b^*) relative to total debt ($b+b^*$). See Appendix A for more details.

Figure B.1: Evolution of Foreign Currency Debt Share by Country



Note: The figure depicts the evolution of total debt $(b+b^{*})$ relative to GDP (y). See Appendix A for more details.

Figure B.2: Evolution of Total Debt per GDP by Country



Note: The figure depicts the evolution of foreign reserves (a^{*}) relative to GDP (y). See Appendix A for more details.

Figure B.3: Evolution of Foreign Reserves per GDP by Country

Table B.2: Foreign Reserves and Debt in Emerging Economies

	$\mu(\frac{b^*}{b+b^*})$	$\mu(\frac{b+b^*}{y})$	$\mu(\frac{a^*}{y})$	$\sigma(\frac{b^*}{b+b^*})$	$\sigma(\frac{b+b^*}{y})$	$\sigma(\frac{a^*}{y})$
Brazil	9.53	73.53	13.99	6.56	11.89	5.32
Chile	29.00	19.21	15.33	12.97	12.55	2.73
China	3.89	45.51	22.41	5.05	22.42	4.13
Colombia	33.30	46.10	12.89	6.43	10.64	3.35
Hungary	31.40	70.03	23.36	9.08	8.61	6.61
Indonesia	43.36	38.97	11.70	8.17	15.98	0.98
Israel	.	70.68	28.07	.	9.31	8.34
India	6.69	76.75	17.64	2.48	6.60	2.54
Korea	.	34.09	23.21	.	11.73	1.79
Mexico	24.35	46.50	11.36	8.50	8.53	3.65
Malaysia	18.86	52.68	36.23	18.10	12.00	7.75
Peru	55.23	32.12	26.70	13.69	8.78	5.80
Philippines	33.53	51.84	23.92	7.14	10.32	4.60
Poland	40.84	49.54	18.99	8.29	6.15	4.10
Russia	33.15	18.77	27.81	16.45	11.52	5.26
Thailand	11.30	46.89	39.12	9.80	9.05	8.17
Turkey	36.89	39.88	11.85	9.58	14.00	1.55
South Africa	12.86	45.36	12.25	5.60	17.87	2.57
Mean	26.70	48.20	20.46	9.18	11.47	4.32
Median	31.40	46.50	18.99	8.50	10.64	4.10

Note: I denote foreign reserves by a^*, domestic-currency sovereign debt by b, foreign-currency debt by b^* and GDP by y. The variables μ, σ and ρ correspond to the mean, the standard deviation and the correlation, respectively. All variables are expressed in percent.

Table B.3: Foreign Reserves and Debt in G10 Economies

	$\mu(\frac{b+b^*}{y})$	$\mu(\frac{a^*}{y})$	$\sigma(\frac{b+b^*}{y})$	$\sigma(\frac{a^*}{y})$
Australia	30.46	4.17	16.38	1.09
Canada	88.55	4.29	14.80	0.94
Germany	67.10	5.26	6.65	1.35
Japan	208.15	21.70	36.58	6.37
New Zealand	32.64	8.70	10.69	2.07
Norway	39.28	14.67	6.85	2.62
Sweden	41.47	9.14	5.79	2.11
Switzerland	44.72	64.50	6.37	44.98
United Kingdom	72.74	4.86	26.03	1.74
Denmark	41.68	18.97	7.48	5.28
United States	94.67	0.73	24.51	0.17
Mean	68.42	14.31	14.39	6.38
Median	44.72	8.70	10.69	2.07

Note: I denote foreign reserves by a^*, domestic-currency sovereign debt by b, foreign-currency debt by b^* and GDP by y. The variables μ, σ and ρ correspond to the mean, the standard deviation and the correlation, respectively. All variables are expressed in percent.