

# Safe Assets in Emerging Market Economies

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This version: February 15, 2024

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## Abstract

Do local-currency sovereign bonds in emerging markets work as safe assets? I estimate convenience yields arising from their safety/liquidity from both the perspective of a global and domestic investor. In a sample of 9 middle-income EMEs, I find a large convenience yield robust to both measures. The main difference with the convenience yield of U.S. Treasuries is that the global investors' convenience yield drops during episodes of high global uncertainty. I analyze two exogenous shocks to EMEs (the Taper Tantrum and Covid-19) and find that the drop in the convenience yield is not explained by the increase in credit risk or the risk premium but by a switch in investors' preferences towards a global safe asset. Results are consistent with a model of a small open economy facing endogenous borrowing constraints and where a foreign and a local sovereign bond serve as collateral (although with different qualities) and thus carry a convenience yield. I use the model to characterize the effect of safety shocks and to show that the response of the local convenience yield to the global financial cycle increases the EME's volatility.

**JEL Codes:** E43, F30, G12.

**Keywords:** convenience yields, sovereign bonds, emerging markets.

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# 1 Introduction

Investors may not only consider the yield of a bond but also might derive non-pecuniary benefits from their liquidity and safety. How much investors value these non-pecuniary benefits is captured by the “convenience yield”, and these assets are commonly known as “safe assets”. There is ample evidence of convenience yields on sovereign bonds in advanced economies. Is this true also in emerging market economies (EMEs)? In the past 20 years, their governments have deepened the local currency bond markets, they have substantially improved their credit ratings, and local currency debt now represents the lion’s share of outstanding bonds in EMEs (BIS, 2020). Do local-currency sovereign bonds in emerging market economies (EMEs) share this safe asset status in their local economy? This paper is the first attempt to estimate convenience yields of local-currency sovereign bonds in 9 middle-income EMEs, draw the differences with advanced economies, and explore their implications for the dynamics of macroeconomic variables.

Krishnamurthy and Vissing-Jorgensen (2012) quantify this convenience yield for U.S. Treasuries relative to comparable dollar assets. This safe asset status affects equilibrium interest rates, expands the fiscal capacity of the government, and is a transmission channel for the central bank’s large-scale asset purchases<sup>1</sup>. This paper emphasizes that, in emerging markets, government bonds can be a local safe asset, but they might compete with other global sources of safety. Recently, Kekre and Lenel (2021) showed that shocks to safety/liquidity demand accounted for 25% of output volatility in the U.S. and 6% of output volatility in the rest of the world. It is important to emphasize that, to be a safe asset, it is unnecessary to have (near) zero default or liquidity risk (which does not hold for emerging economies). All that is required is lower risk than alternatives and investors with a special demand for this lower risk.

The convenience yields I will estimate could come from safety or liquidity services. Safety and liquidity, however, are different concepts. Liquidity refers to the ease with which investors can sell assets for cash. According to Gorton (2017), safety refers to an asset valued at face value without expensive and prolonged analysis. Thus, safe assets will generally be liquid, and liquid assets will be safe. The difficulty in empirically disentangling them is compounded in EMEs due to the lack of data compared to the U.S.

In the first part of the paper, I estimate the convenience yield of EME local-currency sovereign bonds. I set up a simple asset pricing model allowing convenience assets with time-varying credit risk, assets denominated in different currencies, and two types of investors. The first one resembles a domestic investor. I assume a domestic investor (1) decides a portfolio of assets in domestic currency and (2) measures her returns in the domestic currency. This investor compares the local-currency sovereign bond to a domestic private local-currency asset with the same maturity that

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<sup>1</sup>See Del Negro et al. (2017a), Lenel et al. (2019), Jiang et al. (2022), Krishnamurthy and Vissing-Jorgensen (2011)

does not provide as much safety and liquidity services, such as a term deposit on a local commercial bank. As shown in Krishnamurthy and Vissing-Jorgensen (2012), the spread between the two assets measures the safety/liquidity premium on the local-currency sovereign bond. Reliable daily data for domestic private local-currency assets is available for fewer EMEs and shorter maturities (1-year term deposits, certificate of deposits, or unsecured interbank term loans, which I compare with 1-year local-currency sovereign bonds).

The second estimate comes from the perspective of a global investor. I assume an international investor (1) decides on a portfolio of assets in domestic and foreign currency and (2) measures her returns in dollars. This estimate is relevant as foreign investors have increased their participation in EME local-currency sovereign bonds in recent years (see current trends in Appendix A). I assume this investor can access a synthetic dollar bond (a local-currency EME sovereign bond with its cash flows swapped into dollars) against non-Treasury-safe dollar bonds (such as highly rated U.S. corporate or U.S. agency bonds). EME sovereign bonds will have either higher credit ratings or higher liquidity than some of these assets, justifying the existence of a convenience yield. Since both bonds are in dollars, the spread does not include currency risk, which allows me to build on the methodology used by Du and Schreger (2016) and Du et al. (2018). I show that the deviation in the covered interest parity (CIP) condition, in this case, is the sum of (1) the differential default risk, (2) regulatory risk, or the risk of losses produced by regulations imposed by the EME government (such as taxes on capital outflows or currency convertibility restrictions), (3) the covariance of the local currency with these risks, and (4) the differential convenience yield. After accounting for the first three, I obtain the latter as a residual. Data is available for nine EMEs, and I consider assets with 5-year maturity.

I find a sizable convenience yield for EME local-currency sovereign bonds, which is robust to the measure used. The dollar measure shows an average of almost 30 basis points, and the domestic measure gives a larger average of 59 basis points. I then characterize the dynamics of the EME local-currency convenience yields along two dimensions. First, along the local financial cycle, results show that convenience yields are increasing in the level of the monetary policy rate, reflecting the “money-like” properties of these sovereign bonds, similar to the findings of Nagel (2016) and Diamond and Van Tassel (2023) for advanced economies; and decrease in the supply of government debt, reflecting a downward-sloping demand curve for safety, as in Krishnamurthy and Vissing-Jorgensen (2012). Second, along the global financial cycle, whose primary determinant is global risk appetite and drives capital inflows. Results show that, unlike U.S. Treasuries, the global investors’ convenience yield drops during high global uncertainty episodes as measured by the VIX index.

To gain further insight, I analyze two exogenous adverse shocks to EMEs: the Taper Tantrum (which signaled the end of dollar liquidity supply via the end of the Fed’s large-scale asset purchases) and the Covid pandemic (which triggered a global flight to safety). While the dollar convenience

yield increased amid scarcer liquidity during the Taper Tantrum, it significantly dropped against the flight to safety in March 2020. Surprisingly, this drop was not mechanically driven by the rise in credit risk or higher risk premia but by a switch in investors' preferences away from EME bonds.

In the second part of the paper, I set up a model to characterize the macroeconomic implications. I take the small open economy (SOE) limit of the two-country model (US and EME), which allows for the interaction between the global and the local safe assets. There is a freely traded dollar bond, and households can borrow up to the market value of their holdings of U.S. sovereign bonds and EME sovereign bonds. Therefore, both sovereign bonds will carry a convenience yield with respect to the international dollar bond because households, if their collateral constraint binds, will pay a premium to enlarge their borrowing capacity. However, the U.S. sovereign bond is a better collateral than the EME sovereign bond. The convenience yield of the EME sovereign bond resembles the global investors' convenience yield of the empirical section of the paper.

In the SOE limit of the model, the U.S. acts as a closed economy. The EME is subject to a shock to global demand for safety: a negative productivity shock in the U.S. that increases U.S. households' demand for collateral to smooth consumption, coupled with an increase in the collateral quality of the U.S. sovereign bond. This could be analogous to increased demand for dollar-safe assets coming from higher global uncertainty or a global flight to safety episode. Although the shock originates in the U.S. economy, the model matches the negative response of the EME convenience yields and thus helps to characterize the effects of safety shocks on small open economies.

In the model, the drop in the convenience yield is accommodated through an increase in the yield of the local sovereign bond, which can hurt fiscal policy. The quantitative exercise shows that safety shocks increase the volatility of the local sovereign bond rate and explain around 2% of output volatility and 9% of consumption volatility in the small open economy. These effects are relevant when compared to the quantitative role of shocks to risk premia and country spreads in small open economies (Uribe & Yue, 2006; Mendoza, 2010; Farhi & Werning, 2012), accounting for 10% of the effect of risk premium shocks and almost 20% of the impact of country spreads shocks on local economic activity.

**Related Literature.** The empirical literature is ample in the study of the safety of U.S. Treasuries against comparable dollar private debt (Krishnamurthy & Vissing-Jorgensen, 2012; Greenwood, Hanson & Stein, 2015; Del Negro et al., 2017a) and against sovereign bonds of other advanced countries (Du et al., 2018; Jiang et al., 2021). Engel (2016), Jiang, Krishnamurthy, & Lustig (2021), and Engel & Wu (2023) find that increases in non-pecuniary benefits related to safety or liquidity drive an appreciation of the currency in advanced economies and can help to explain some exchange rate puzzles. This paper is the first attempt to apply this empirical work to pricing local-currency sovereign bonds in emerging markets.

Diamond & Van Tassel (2023) estimate convenience yields using domestic assets for G10 countries, which has similarities with the domestic investor's convenience yield I estimate. My analysis

of sovereign bonds in emerging markets is more comprehensive since I also provide a convenience yield from the perspective of foreign investors (who have become significant participants in domestic sovereign debt markets in developing countries). In addition, I provide a model to understand the differences to advanced economies and analyze the implications for macroeconomic variables.

This paper also relates to recent empirical analyses of the currency composition of EMEs' sovereign debt. Unlike during the 1990s, today, local-currency sovereign debt represents the lion's share of outstanding debt in EMEs, driven by increasing foreign participation (Bénétrix et al., 2019; Du & Schreger, 2022; Onen et al., 2023). Stronger institutions and policies, lower inflation, and currency risk are possible explanations (Ottonello & Perez, 2019; Hale et al., 2020; Engel & Park, 2022). I take the outstanding local-currency debt as a given and analyze its pricing by domestic and global investors.

Theoretically, my approach is novel as it is the first to build on the small open economy model and analyze the interaction of two competing safe assets (local and foreign bonds). Unlike my approach, the safe asset literature has focused on the international role of dollar debt as a global safe asset (Brunnermeier & Sannikov, 2019; Jiang, Krishnamurthy & Lustig, 2019; and Kekre & Lenel, 2021). Well-known small open economy models do not introduce a role for safe assets (for example, Uribe & Yue, 2006; Mendoza, 2010; Farhi & Werning, 2012). My contribution is to show that safety-driven capital flows are relevant for advanced and developing economies.

Finally, by documenting the existence of domestic safe assets and their interaction with the U.S. Treasury, this paper contributes to the literature on safe assets shortages (Caballero, Farhi & Gourinchas, 2016, 2017). Recently, Mendoza & Quadrini (2023) quantified how the reliance on U.S. debt as the sole source of safety has increased global financial instability. The line of work of my paper could contribute to the questions of what is required to expand the supply of global safe assets or reduce the global demand for U.S. safe assets.

The paper proceeds as follows. Section 2 explains the calculation of convenience yields. Section 3 undertakes a formal empirical analysis based on panel regressions and event studies. Section 4 presents the model, and Section 5 the macroeconomic implications. Section 6 then concludes.

## **2 Estimation of EME Local-Currency Convenience Yields**

### **2.1 A Simple Asset Pricing Model**

To provide a framework for deriving and estimating convenience yields, I extend the theoretical model in Krishnamurthy and Vissing-Jorgensen (2012). The new elements include (1) an asset that can have both a convenience yield and time-varying credit risk, (2) different types of investors, where the “type” refers to the assets available and the currency they measure their returns in, and (3) convenience assets denominated in different currencies.

I will consider two investors “types”. The first is a “domestic” investor that compares returns of only domestic assets and measures returns in the domestic currency of the EME. The second is a “global” or foreign investor that measures returns in dollars and compares the local-currency sovereign bond with a non-Treasury safe dollar bond (an agency or a highly-rated corporate bond).

For any of these investors, the framework modifies a standard representative agent model to include a term to capture that agents derive utility directly from holding a “convenience” asset (Sidrauski, 1967; Krishnamurthy and Vissing-Jorgensen, 2012). A representative investor maximizes

$$E \sum_{t=1}^{\infty} \beta^t u(c_t + \nu(\theta_t^i, \text{GDP}_t^i)) \quad (1)$$

where  $i \in \{d, f\}$  for domestic investor or foreign investor, respectively.  $c_t$  is consumption from an endowment stream, and the second term represents “convenience” benefits of holding bonds that provide safety or liquidity services,  $\theta_t^i$ . The assets that enter into  $\theta_t^i$  will be specified later for each investor type. The agent’s income is  $\text{GDP}_t^i$ , measured in real terms. Problem (1) shows that both investors differ in the assets held in their portfolio and in the endowment stream they receive,  $\text{GDP}_t^i$ , that will determine their risk-free rate and their pricing kernel.

The function  $\nu(\cdot)$  is a reduced-form way of capturing non-pecuniary benefits from the safety and liquidity of certain bonds. For example, the benefits of holding a liquid asset that eases transactions (as collateral) or from having an asset that promises stable nominal returns. I will not empirically distinguish between safety and liquidity benefits in this paper. These assets could be money, sovereign bonds, or private assets that share, to some extent, these characteristics (like insured bank deposits, central bank reserves, or corporate bonds of highly rated companies).

Assume that the convenience function is homogeneous of degree one in  $\text{GDP}_t^i$  and  $\theta_t^i$ . Thus define  $v(\frac{\theta_t^i}{\text{GDP}_t^i})\text{GDP}_t^i \equiv \nu(\theta_t^i, \text{GDP}_t^i)$ . Assume that the convenience function is increasing in  $\theta_t^i/\text{GDP}_t^i$ , but the marginal convenience benefit is decreasing in  $\theta_t^i/\text{GDP}_t^i$ , and  $\lim_{\theta_t^i/\text{GDP}_t^i \rightarrow \infty} v'(\theta_t^i/\text{GDP}_t^i) = 0$ .

The Euler equation for holdings of a convenience asset,  $\theta_t^i$ , gives the following expression for its price,  $P_t$  (to simplify, assume no default risk, which will be introduced later):

$$P_t = E_t[M_{t+1}P_{t+1}\Lambda_t^i]$$

where  $M_{t+1} = \beta \frac{u'(C_{t+1})}{u'(C_t)} \frac{Q_t}{Q_{t+1}}$  is the pricing kernel and  $Q_t$  is the price level.  $\Lambda_t^i \equiv 1/(1 - v'(\theta_t^i/\text{GDP}_t^i))$  captures the marginal benefits investor  $i$  derives from these bonds. A positive marginal value of convenience by investor  $i$ ,  $v'(\cdot)$ , raises  $\Lambda_t^i$ , and therefore raises the price of the bond,  $P_t$ .

### 2.1.1 Domestic convenience yield

Consider a domestic investor,  $i = d$ , with the alternative of investing in a domestic sovereign bond (with some level of default risk) and a domestic private asset but with higher risk and thus lower convenience services, for example, a term deposit on a local commercial bank.

The portfolio of convenience assets of this domestic investor is given by:

$$\theta_t^d = \theta_t^M + \kappa_t^{T,d} \theta_t^T + \kappa_t^{P,d} \theta_t^P \quad (2)$$

where  $\theta_t^M$ ,  $\theta_t^T$ , and  $\theta_t^P$  correspond to holdings of money (as the most liquid domestic asset), sovereign bonds, and alternative private substitutes, respectively. The latter two are of the same maturity.  $\kappa_t^{T,d}$  and  $\kappa_t^{P,d}$  represent the investor's  $d$  relative preference for the convenience service of assets other than money. Both are assumed to be less than one. Time variation in  $\kappa_t^{T,d}$  and  $\kappa_t^{P,d}$  could come from changes in their safe asset status: if, in certain states of the world, investors switch preferences to the safety and liquidity services of other assets, beyond what would be explained by variations in credit risk premia.

**Proposition 1.** *The spread between the yield of a local-currency domestic private asset,  $y_t^P$ , and the yield of a local-currency sovereign bond,  $y_t^T$ , of the same maturity, can be decomposed as follows:*

$$y_t^P - y_t^T \approx (\lambda_t^{T,d} - \lambda_t^{P,d}) + (l_t^P - l_t^T) + (\xi_t^{T,d} - \xi_t^{P,d}) \quad (3)$$

where  $\lambda_t^{T,d}$  measures the marginal safety/liquidity services the domestic investor ( $d$ ) derives from the sovereign bond (the convenience yield),  $\lambda_t^{T,d} \approx \kappa_t^{T,d} v'(\theta_t^d / \text{GDP}_t^d)$ , and  $\lambda_t^{P,d} \approx \kappa_t^{P,d} v'(\theta_t^d / \text{GDP}_t^d)$ ;  $l_t^P$  and  $l_t^T$  are, for each asset, the expected default plus a risk premium associated with the covariance between default and the stochastic discount factor; and  $\xi_t^{T,d}$ ,  $\xi_t^{P,d}$  are the covariances between credit risk and the convenience yield.

*Proof:* see the Appendix.

The domestic measure of the convenience yield of local-currency sovereign bonds is given by:

$$CY_t^d = \lambda_t^{T,d} - \lambda_t^{P,d} = (\kappa_t^{T,d} - \kappa_t^{P,d}) v'(\theta_t^d / \text{GDP}_t^d) \quad (4)$$

Equation 4 shows that what I call the “domestic convenience yield” is really a *differential* convenience yield because I allow the domestic private asset to provide some (but lower) convenience benefits. Henceforth, whenever I mention the “domestic convenience yield”, I will refer to this differential convenience yield.

The term  $\xi_t^{T,d}$  is an important one, and it is not present in the model of Krishnamurthy and Vissing-Jorgensen (2012). Since investors will derive no safety benefits from an asset with higher credit risk, it is likely that states of the world of higher credit risk coincide with states of lower convenience yields. Thus, the covariance between credit risk and the convenience yield will be

negative,  $\xi_t^{T,d} < 0$ . Not accounting for this will overestimate the actual convenience yield of the bond. To correctly capture  $CY_t^d$  in the data, I will have to control for measures of credit risk.

What increases the convenience yield on sovereign bonds,  $CY_t^d$ , according to the model? First, a lower supply of government debt,  $\theta_t^T/\text{GDP}_t^d$  or a lower supply of substitutes,  $\theta_t^P/\text{GDP}_t^d$ . Second, if sovereign bonds provide the same liquidity services as money, then a lower supply of  $\theta_t^M/\text{GDP}_t^d$  will also increase in the convenience yield. Third, variations in the relative convenience service. For example, losing the safe asset status (switch in investors preferences towards other safe assets) can reduce  $\kappa_t^{T,d}$ .

How will I recover  $CY_t^d$  in the data? I will take data on spreads between the two types of assets,  $y_t^P - y_t^T$ , as a measure of the convenience yield of local-currency sovereign bonds. Although Proposition 1 shows that this spread also includes differential default risk and its covariance with convenience yields, in Section 3 I will show that  $y_t^P - y_t^T$  is driven by the domestic convenience yield. This is the same empirical strategy used by Krishnamurthy and Vissing-Jorgensen (2012).

Reliable, daily data for domestic private local-currency assets is available for fewer EMEs: Chile, Colombia, Mexico, Indonesia, South Africa, and Turkey. In lack of data for highly-rated domestic corporate bonds of longer maturities, I use yields on assets with 1-year maturity, such as term deposits, certificate of deposits, or unsecured interbank term loans, which I compare with 1-year local-currency sovereign bonds. Term and certificate deposits have roughly the same credit risk as government debt (local banks hold most local-currency government debt) but cannot be redeemed before maturity, and therefore, spreads using these assets will measure mainly a liquidity premium. 1-year interbank loans are mostly liquid (central banks in EMEs have developed these markets in the past two decades) but are unsecured, and thus, spreads that use these assets will measure mainly a safety premium.

The Appendix describes the data sources for each country.

### 2.1.2 Dollar investor's convenience yield

Consider a foreign investor,  $i = f$ , that measures her returns in dollars and whose portfolio of convenience assets is given by:

$$\theta_t^f = \theta_t^{\$M} + \kappa_t^{T,f} \theta_t^T + \kappa_t^{US,f} \theta_t^{US} \quad (5)$$

where  $\theta_t^{\$M}$  correspond to money and near-money assets such as U.S. Treasuries;  $\theta_t^T$  correspond to synthetic dollar bonds: a local-currency sovereign EME bond with all the cash flows swapped into dollars via a forward contract;  $\theta_t^{US}$  correspond to holdings of non-Treasury safe dollar bond such as a highly rated U.S. corporate bond or a U.S. agency bond. The latter two are of the same maturity.  $\kappa_t^{T,f}$  captures the relative convenience service investor  $f$  derives from local-currency sovereign bonds of EMEs. As in the previous subsection, time variation in  $\kappa_t^{T,f}$  could come from



changes in investors' preference for certain assets during, for example, a flight to quality episode.

The following two Propositions explain the decomposition of the yields of  $\theta_t^{US}$  and  $\theta_t^T$  from the perspective of this foreign investor.

**Proposition 2.** *The yield in period  $t$  on a non-Treasury safe dollar bond,  $y_t^{US}$ , can be decomposed as follows:*

$$y_t^{US} \approx y_{rf,t}^{US} - \lambda_t^{US,f} + l_t^{US} - \xi_t^{US,f} \quad (6)$$

where  $y_{rf,t}^{US}$  is the dollar risk-free rate;  $\lambda_t^{US,f}$  measures the marginal safety/liquidity services the dollar investor ( $f$ ) derives from this US bond (the convenience yield);  $l_t^{US}$  is the expected default plus a default risk premium, and  $\xi_t^{US,f}$  is the covariance between default risk and the convenience yield.

Equation (6) highlights that the larger the convenience yield  $\lambda_t^{US,f}$ , the lower the yield on the bond: the investor is willing to accept a lower return,  $y_t^{US}$ , in exchange for the safety/liquidity services the bond provides. The terms  $l_t^{US}$  and  $\xi_t^{US,f}$  have the same interpretation as in the previous subsection.

**Proposition 3.** *The yield on the synthetic dollar bond can be calculated as the yield of the local-currency bond of an EME,  $y_t^T$ , minus the forward premium between the local currency and the dollar,  $\rho_t = \log F_{t+1} - \log S_t$ , where  $F_{t+1}$  and  $S_t$  are the forward and spot exchange rates, respectively, both expressed as units of local currency per dollar.*

*The total yield on the synthetic bond,  $y_t^T - \rho_t$ , can be decomposed as:*

$$y_t^T - \rho_t \approx y_{rf,t}^{US} - \lambda_t^{T,f} + (l_t^T - q_t^T) + (k_t - p_t) - \xi_t^{T,f} - \psi_t^{T,f} \quad (7)$$

where  $y_{rf,t}^{US}$  is the dollar risk-free rate;  $\lambda_t^{T,f}$  is the convenience yield the investor  $f$  derives from the sovereign bond of the EME;  $l_t^T - q_t^T$  is the expected loss upon default,  $l_t^T$ , net of the covariance between default and currency risk,  $q_t^T$ ;  $k_t - p_t$  are the expected losses upon the imposition of regulations,  $k_t$ , net of the covariance between the risk of regulations and currency risk,  $p_t$ ; and  $\xi_t^{T,f}$  and  $\psi_t^{T,f}$  the covariance of default risk and the convenience yield, and the covariance between the convenience yield and capital control risk, respectively.

The dollar convenience yield on local-currency sovereign bonds of EMEs, which is a *differential* convenience yield, can be written as:

$$CY_t^f = \lambda_t^{T,f} - \lambda_t^{US,f} = (\kappa_t^{T,f} - \kappa_t^{US,f})v'(\theta_t^f/\text{GDP}_t^f) \quad (8)$$

If EME sovereign bonds share the liquidity services provided by money, a lower supply of dollar liquid assets such as dollar money or U.S. Treasuries will increase the dollar convenience yield on EME sovereign bonds through  $v'(\theta_t^f/\text{GDP}_t^f)$ . In addition, a higher default risk of EME sovereign

bonds mechanically lowers the convenience yield, since investors will derive lower benefits if there is higher risk. Losing the safe asset status during a flight-to-quality episode would also reduce  $\kappa_t^{T,f}$ , lowering the convenience yield.

Propositions 2 and 3 give the yields of two bonds denominated in dollars. Therefore, the spread between the two does not contain currency risk:

$$\underbrace{y_t^{US} - (y_t^T - \rho_{j,t})}_{\text{Spread}} = \underbrace{\lambda_t^{T,f} - \lambda_t^{US,f}}_{\text{Diff. Convenience yield}} + \underbrace{(l_t^{US} - l_t^T)}_{\text{Differential default risk}} - \underbrace{k_t}_{\text{Regulatory risk}} + \underbrace{(q_t^T + p_t + (\xi_t^{T,f} - \xi_t^{US,f}) + \psi_t^{T,f})}_{\text{Covariances}} \quad (9)$$

The term  $k_t$  captures the risk of regulations imposed by the local government that can inflict additional losses upon investors: taxes on capital outflows, currency convertibility restrictions, and any other forms of capital controls. These are relevant as most of the foreign participation in local-currency sovereign bonds has been through domestic markets under domestic law. Both the default risk and  $k_t$  are net of their covariance with currency risk,  $q_t^T$  and  $p_t$ , respectively. Intuitively, when dollar investors invest in local-currency EME sovereign bonds, default or capital controls cause an additional, indirect loss on them. They not only receive less local currency back, but those cash flows are now worth less if the currency depreciates upon these events. The yield on the synthetic bond does not capture the latter, as currency risk is being hedged. Therefore, the synthetic bond yield underestimates the loss risk upon these events.

The new term  $\psi_t^{T,f}$  captures the covariance between the convenience yield and the risk of capital controls. Since higher regulatory risk will lower the non-pecuniary benefits earned by foreign investors, it is likely that states of the world with higher capital control risk coincide with states of lower convenience yields. Thus, the covariance between regulatory risk and the convenience yield will be negative. Similar to the case of  $\xi_t^{T,f}$ , not accounting for this will overestimate the actual convenience yield of the bond. To correctly capture  $CY_t^f$  in the data, I will have to control for measures of credit risk

How will I recover  $CY_t^f$  in the data? Data is available for the spread between the two bonds. Then, I will gather data on differential credit risk (through CDS spreads), regulatory risk plus covariances (explained below), and any residual left will be attributable to  $\lambda_t^{T,f} - \lambda_t^{US,f}$ .

The main challenge is finding a proxy for the regulatory risk variables and the covariances in the right-hand side of Equation (9). I rely on the spread between the swapped local-currency bond and the bond denominated in foreign currency issued offshore. The latter is generally issued under international law and, therefore, not subject to the unilateral imposition of capital controls and other regulations.

**Proposition 4.** Let  $\Phi_t^{FC}$  denote the spread between the yield of the synthetic bond,  $y_t^T - \rho_t$ , and

the yield of the sovereign bond of the same EME issued in dollars,  $y_t^{FC}$ . Then,

$$\begin{aligned}\Phi_t^{FC} &\equiv y_t^T - \rho_t - y_t^{FC} \\ &\approx (\lambda_t^{FC,f} - \lambda_t^{T,f}) + (l_t^T - l_t^{FC} - q_t^T) + (k_t - p_t) + (\xi_t^{FC,f} - \xi_t^{T,f}) - \psi_t^{T,f}\end{aligned}\tag{10}$$

where  $\lambda_t^{FC,f}$  and  $l_t^{FC}$  are the convenience yield and the default risk of the sovereign bond issued in dollars, respectively.

The expression  $\Phi_t^{FC}$  will be approximately equal to the term on regulatory risk plus covariances in (9). However, it also adds two new terms that could make it a bad proxy. First, the differential credit risk between foreign and local currency bonds. I will assume that  $l_t^{FC} \approx l_t^T$  because, as discussed in Du and Schreger (2016), recent history in emerging markets does not give a clear higher probability of defaults in either currency, and this is particularly true for the countries in my sample.

Second, the differential convenience yield between foreign currency bonds and swapped local currency bonds,  $\lambda_t^{FC,f} - \lambda_t^{T,f} \equiv \tau_{\text{aut}}$ . Both convenience yields are in dollars and could be different if the two bonds have either different credit risks (already ruled out) or different liquidity. As for liquidity, forward contracts used in the swapped local-currency bond have significantly larger bid-ask spreads and lower trading volume than bonds. Since investors in the swapped local currency bonds have short positions in the less liquid swap market, overall they have better liquidity than holding bonds denominated in foreign currency. I will proxy the differential convenience yield with the liquidity risk in currency swaps, measured by their bid-ask spread.

The result in Proposition 4 can be substituted in Equation (9), then move the differential convenience yield to the left-hand side and obtain the following:

$$\lambda_t^{T,f} - \lambda_t^{US,f} = y_t^{US} - (y_t^T - \rho_t) + (l_t^T - l_t^{US}) + \Phi_t^{FC} - \tau_t + (\xi_t^{US,f} - \xi_t^{FC,f})\tag{11}$$

On the left-hand side, I have the desired convenience yield of EME sovereign bonds against non-Treasury-safe dollar bonds. The Appendix describes all data sources for bond yields, forward premia, credit risk, and  $\Phi_t^{FC}$  on the right-hand side of Equation (11).  $\tau_t$  corresponds to the liquidity risk in currency swaps. To account for  $\xi_t^{US,f} - \xi_t^{FC,f}$ , I will show in Section 3 that  $\lambda_t^{T,f} - \lambda_t^{US,f}$  on the left-hand side is not driven by risk premia, recession, or political risk.

What are the non-Treasury dollar bonds,  $y_t^{US}$ , in the data? Three series are available. First, the 5-year yield on Resolution Funding Corporation (Refcorp) bonds. As suggested by Longstaff (2004), Refcorp bonds are effectively guaranteed by the U.S. government and are subject to the same taxation, but are not as liquid as Treasuries. The other two are the ICE Bank of America index for AAA and BBB-rated corporate bonds in the US. They track the performance of US dollar-denominated investment grade-rated corporate debt publicly issued in the US domestic market, including all maturities over one year.

How do these dollar assets compare with the local-currency sovereign bonds in EMEs regarding safety and liquidity? The Refcorp and AAA-rated corporate bonds have higher credit ratings than the nine EMEs considered. According to Moody's, credit ratings are Baa1 on average, ranging from A1 (for Chile) to B3 (for Turkey). Thus, it is likely that the convenience yield estimated through these two spreads includes mostly a liquidity premium, not a premium for their safety. However, most of these countries' credit ratings are above the BBB-rated corporate bonds, so the convenience yields calculated using this index might capture both a safety and a liquidity premium.

The nine countries for which I estimate the dollar convenience yield are Brazil, Chile, Colombia, Indonesia, Mexico, Peru, the Philippines, South Africa, and Turkey. This selection is based solely on data availability.

The Appendix discusses standard features and financial frictions of EME financial markets that could potentially affect the estimation of the convenience yield according to Equation (11): the issuance of Eurobonds (local-currency sovereign bonds issued under international law and thus not subject to regulatory risk), and the possibility of market segmentation between foreign vs. local investors.

## 2.2 Analysis

Table 1 shows summary statistics for the two measures of the local-currency convenience yield of sovereign bonds. These are calculated at the daily frequency. Columns 1-3 provide moments for the dollar investors convenience yield ( $\lambda_t^{T,f} - \lambda_t^{US,f}$  in Equation (11)), and Columns 4-6 do the same for the domestic convenience yield ( $y_t^P - y_t^T$  in Equation (2)). The last column shows the correlation between the two measures.

Overall, both measures show positive and sizable averages. The domestic convenience yield measure shows a larger mean than the dollar investor's convenience yield. Column 7 shows that the correlation between the two measures is positive and significant. Chile and Mexico have the largest average dollar convenience yield among the nine countries. Notice that the correlation between the two measures is not significantly different from zero in Turkey. However, Column 2 shows that local-currency sovereign bonds in Turkey enjoy almost no convenience yield from the dollar-investor perspective. This is consistent with evidence that Turkey has the lowest foreign investors' participation in local-currency sovereign bonds among these nine EMEs (according to BIS data), which has dropped sharply in recent years.

Figure 1 shows the evolution of the dollar-investor's convenience yield computed for the 5-year maturity. First, notice that, for most countries, local-currency convenience yield drops sharply during crises (the 2008 financial crisis and the Covid pandemic in 2020). In those episodes, the convenience yields turned significantly negative. Negative values must be interpreted as EME sovereign bonds providing less safety and liquidity than non-Treasury U.S. dollar debt. Second,

Table 1: Summary Statistics

Country	Dollar-investor's CY			Domestic CY			(7) Corr
	(1) Sample starts	(2) Mean	(3) Std	(4) Sample starts	(5) Mean	(6) Std	
Brazil	June 2010	28.62	30.31	n.a.	n.a.	n.a.	-
Chile	April 2011	45.98	26.61	May 2010	60.63	33.42	0.3253***
Colombia	December 2007	16.76	26.34	June 2005	53.72	64.76	0.4749***
Indonesia	February 2015	27.82	15.71	February 2003	85.03	56.74	0.2582***
Mexico	December 2007	44.42	24.27	July 2011	19.26	14.1	0.5076***
Peru	December 2007	29.42	27.00	n.a.	n.a.	n.a.	-
Philippines	December 2007	18.40	31.72	n.a.	n.a.	n.a.	-
South Africa	December 2013	27.10	35.57	April 2000	66.6	47.24	0.1581***
Turkey	December 2007	-4.27	27.11	October 2006	73.45	101.17	0.0167
United States	February 2006	46.44	12.79				

Notes: Daily frequency. The sample ends on March 9, 2021. Mean and std are calculated from 1/1/2010 onward. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

there was a widespread increase in local-currency convenience yields around 2014-2016, followed by a persistent decline. Third, not all countries have been affected by the Covid crisis similarly. Significant drops in local-currency convenience yields happened in Mexico, Peru, Chile, Indonesia, the Philippines, and South Africa, while Brazil did not experience a significant reduction.

In the Appendix, I perform additional analysis on the evolution of the EME convenience yield computed against the convenience yield of the U.S. Treasury (the “U.S. Treasury premium” as calculated in Du, Im, and Schreger (2018) for G10 countries).

Figure 2 shows the evolution of the domestic convenience yield for the 1-year sovereign bond. They usually increase in times of crisis (Chile in 2020, South Africa in 2008) with a few exceptions (Indonesia in 2008 and Mexico in 2020).

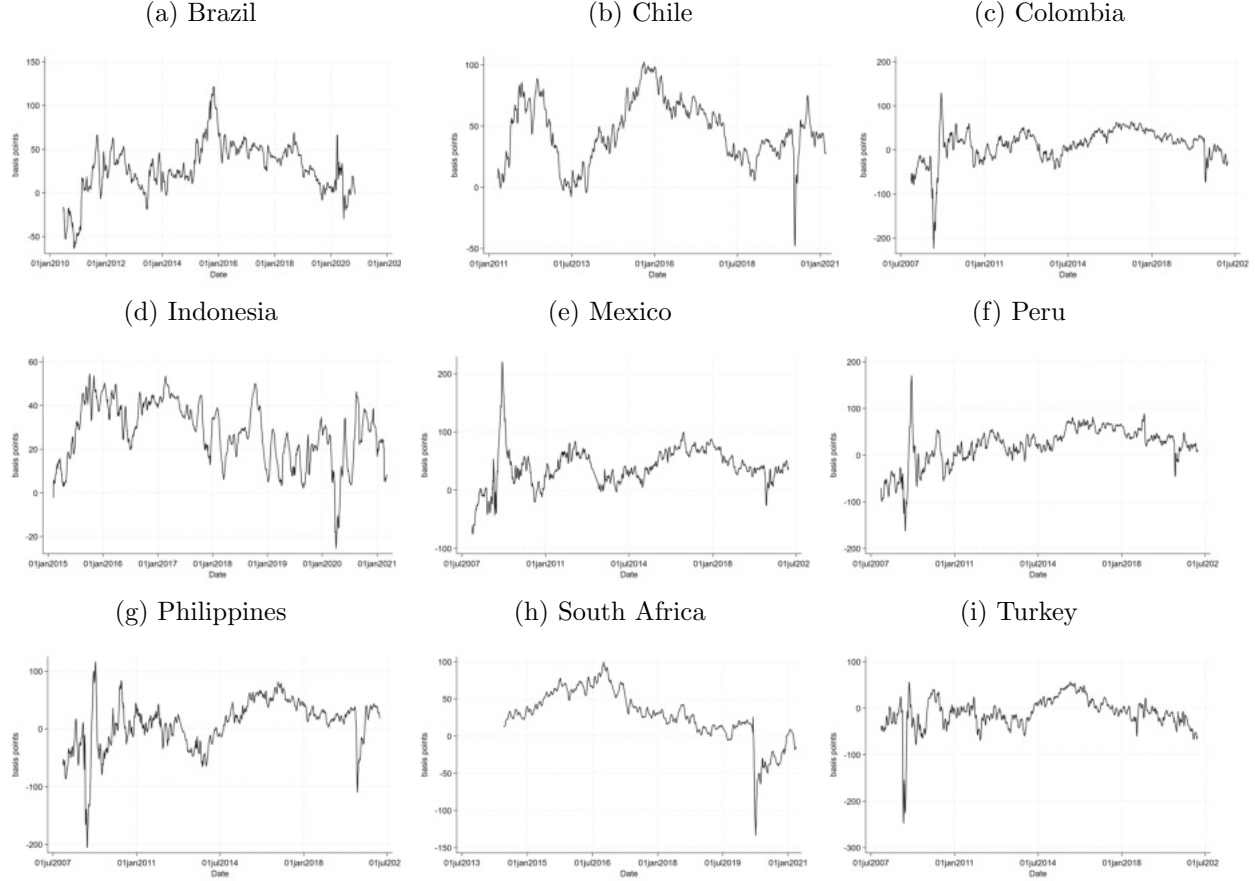
### 3 Empirical Analysis

#### 3.1 The Role of Safety/Liquidity Services

This section provides empirical evidence that the estimated convenience yields capture non-pecuniary services related to safety/liquidity services. I follow Krishnamurthy and Vissing-Jorgensen (2012), Greenwood et al. (2015), and Nagel (2016) and set up the following regression:

$$cy_{i,t} = \beta_1(\text{Gov. debt supply/GDP})_{t-1} + \beta_2 i_{t-1}^{MP} + \beta_3 i_t^{US} + \beta_4 X_t + c_i + \tau_t + \epsilon_{i,t} \quad (12)$$

Figure 1: Dollar-Investor's Convenience Yield on 5-Year Local-Currency Sovereign Bonds

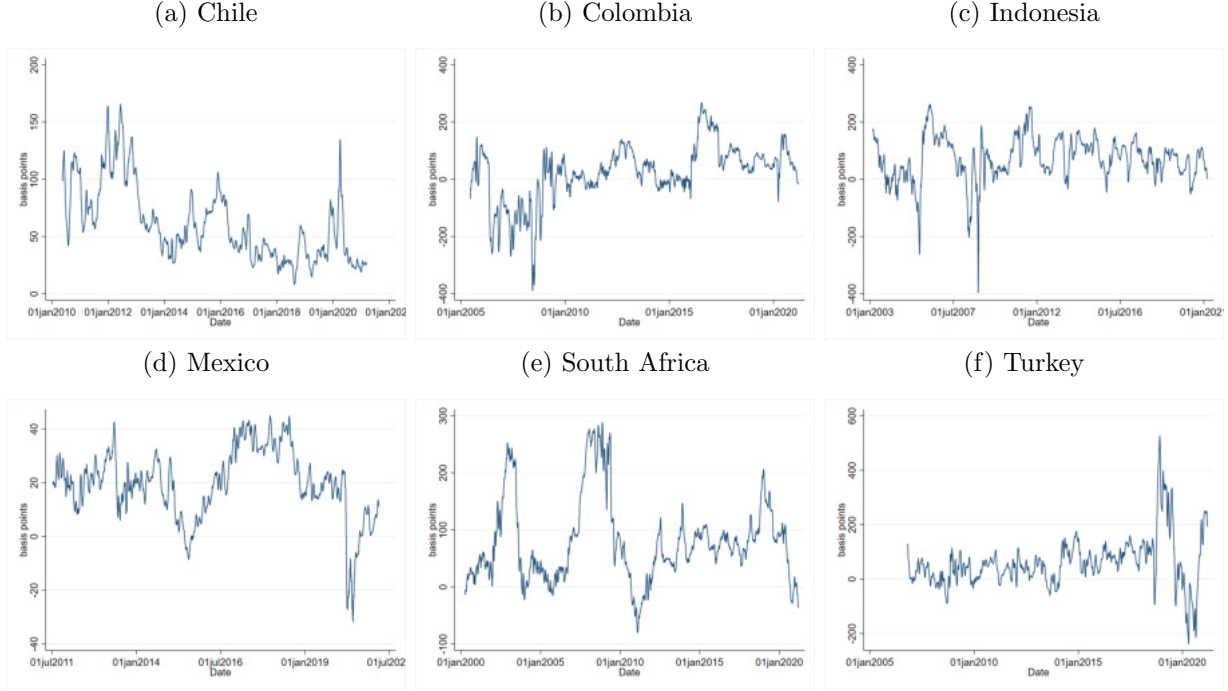


Notes: Figure shows the 14-day moving average of the dollar-convenience yield for each country.

where  $i$  is currency/country,  $t$  is time, and  $cy_{i,t}$  is either the dollar investors' or the domestic convenience yield. The variable  $(\text{Gov. debt supply}/\text{GDP})_t$  is the outstanding supply of "safe assets". I added the local-currency sovereign debt and U.S. government debt supply. Both quantities are net of central bank holdings. For the domestic convenience yield, this is a proxy for  $\theta_t^T/\text{GDP}_t^d$  in the model's Equations (2) and (4), and for the dollar convenience yield, a proxy for  $\theta_t^M/\text{GDP}_t^f$  in (5) and (8). If there is a demand for safety and liquidity from investors, the coefficient  $\beta_1$  represents the slope of the demand curve for safe assets and should, therefore, be negative.

The variables  $i^{MP}$  and  $i_t^{US}$  correspond to the level of the monetary policy rate in each EME and the U.S., respectively. This represents the price of the most liquid asset in the economy: money or its near substitutes, such as central bank reserves or private liquid deposits. In terms of the model above, this is a proxy for  $\theta_t^M$  and  $\theta_t^{\$M}$ . Interest rate hikes drain the supply of money assets, driving up their price. As explained in Nagel (2016) and Diamond and Van Tassel (2023), if government debt shares the money properties of very liquid assets, then its convenience yield should respond positively to the price of liquidity, i.e., the level of the monetary policy rate.

Figure 2: Domestic Convenience Yield on 1-Year Local-Currency Sovereign Bonds



Notes: Figure shows the 14-day moving average of the domestic convenience yield for each country.

Lastly,  $X_t$  refers to relevant control variables. Given that, according to Proposition 1, the measure of the domestic convenience yield ( $y_t^P - y_t^T$ ) might include a component of credit risk or risk premia, I control for proxies of these risk variables to show that they do not drive the results. For the dollar convenience yield, these controls are important to make sure that the residual differential convenience yield does not capture any covariance of the convenience yield with credit risk (the  $\xi_t$ 's in the previous section).

The independent variables are lagged one month to avoid endogeneity and reverse causality as much as possible (I include other ways to address endogeneity in the Appendix). The variables  $c_i$  and  $\tau_t$  are country and time-fixed effects, respectively, that allow control for time and country-specific factors. I double-clustered the standard errors across year and country.

Table 2 shows the results. Columns 1 and 4 show that both measures respond positively to the level of the monetary policy rate. As explained above, this is the sign one expects if EME local-currency convenience yields arise from liquidity-related benefits: a higher monetary policy rate is related to a lower supply of money-related assets, increasing the convenience yield on other near-money assets, such as government debt. The local monetary policy rate has a more significant effect on the domestic convenience yield. In contrast, the U.S. monetary policy rate significantly impacts the dollar convenience yield. This can be explained by how both convenience yields are estimated: the former measures returns in local currency, while the latter measures returns in

Table 2: Determinants of Convenience Yields

	Dep. var.: dollar CY			Dep. var.: domestic CY		
	(1)	(2)	(3)	(4)	(5)	(6)
Local MP rate <sub>t-1</sub>	0.867 (0.509)	1.209 (0.741)	0.482 (0.485)	10.51*** (1.486)	8.468*** (3.182)	10.46*** (1.464)
U.S. MP rate <sub>t-1</sub>	11.66*** (3.269)	7.878** (3.144)	9.501** (4.701)	1.649 (9.517)	-6.917 (13.30)	2.033 (9.394)
$\log(\frac{\text{Local gov debt}}{GDP_{local}})_{t-1}$	14.33* (8.018)	11.07 (7.719)	-0.727 (10.507)	-31.73*** (10.50)	-31.65*** (9.284)	-31.79*** (10.51)
$\log(\frac{\text{U.S. gov debt}}{GDP_{US}})_{t-1}$	-131.0*** (39.74)	-132.2*** (36.78)	-152.8*** (56.49)	119.4 (87.53)	97.37 (104.3)	119.1 (87.60)
slope <sub>local,t-1</sub>		1.350 (1.611)			-9.233 (7.818)	
slope <sub>US,t-1</sub>		-3.407 (3.683)			-9.810 (11.97)	
Output gap <sub>t-1</sub>			16.68** (6.559)			-7.285 (11.12)
Constant	-297.0*** (71.78)	-300.3*** (64.91)	-317.9*** (105.1)	20.2 (127.9)	24.91 (140)	19.75 (128.0)
Observations	1,137	1,103	833	955	906	955
R-squared	0.670	0.681	0.699	0.324	0.338	0.324

Notes: Data are at monthly frequency. All columns include country and year-fixed effects. Standard errors are double-clustered by country and year. Start dates vary among countries but end in March 2021 for all. U.S. debt and EME local-currency debt-to-GDP variables are net of the central bank's holdings. The output gap is measured as the 12-month log difference in industrial production (OECD series, data available for Brazil, Chile, Colombia, Mexico, Indonesia, South Africa, and Turkey). \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

dollars.

Regarding the supply variable, in Columns 1 and 4, the supply of government debt negatively affects the convenience yield. Similar to the coefficients for the monetary policy rate, the supply of local-currency bonds has a significant adverse effect on the domestic convenience yield, and the supply of U.S. government debt has a negative impact on the dollar-investor's convenience yield. This suggests that both measures of convenience yields correctly capture the relevant currencies for each investor: a larger supply of local-currency government bonds affects more the convenience yield that measures returns in the local currency and analogously for the dollar investor.



The negative coefficient on the relative supply of U.S. Treasuries is a crucial result. As explained above, if the measures of local-currency convenience yield capture demand for safety and liquidity, then the estimated coefficient represents the slope of the demand for safe assets and, therefore, should be negative.

Default and liquidity risk and the risk premia investors charge are important components of bond spreads, especially in EMEs. Columns 2 and 5 include the yield curve’s slope as a further control. The slope of the yield curve is known to predict the excess returns on stocks, and it is a commonly used risk factor when estimating risk premia in bond markets (Campbell and Shiller, 1991; see Baumeister (2023) for a comprehensive review). For example, if investors are more risk-averse in a recession, they will demand a higher risk premium to hold the sovereign bond or its private substitutes. Thus, the slope of the yield curve serves as a measure of variation in the risk premium component of the bond spread, that is, the terms involving the covariances of convenience yields in Section 2. In addition, to the extent that default and liquidity risk are likely to vary with the business cycle, the slope variable can furthermore help control for the expected risks in the yield spread.

I measure the slope as the spread between the 10-year sovereign bond yield and the 3-month yield in the domestic currency. I include the domestic slope and the slope in the US. The estimated coefficients for the supply of debt and the monetary policy rate are robust to the inclusion of the slope variable, although it reduces the magnitude of the estimated coefficient of the monetary policy rate. This suggests that results are not driven by the risk premia investors charge on EME debt and that the estimated convenience yields are correctly capturing the non-pecuniary benefits of safety and liquidity.

In Columns 3 and 6, I add the output gap as an alternative control for the state of the local business cycle. The dollar convenience yield is moderately procyclical, meaning that for global investors, the local sovereign bond provides lower safety and liquidity services during domestic recessions. This result is interesting as it contrasts with evidence for the convenience yield of sovereign debt in the U.S. (Caramp and Singh, 2021).

Results in Table 2 are robust to including a time trend (that controls for trends in the dependent variable) and to having the lagged dependent variable on the right-hand side (not shown). Since right-hand side variables are lagged one period, autocorrelation in local-currency convenience yields can bias their coefficients. Inclusion of the lagged-dependent variable controls for endogeneity that may arise from the persistence of the dependent variable. Since the data are at the monthly frequency and span more than ten years, adding the lagged dependent variable is unlikely to give rise to the Nickell (1981) bias.

### 3.2 EME Local-Currency Convenience Yield and the Global Financial Cycle

In this section, I extend the analysis above to study the dynamics of the local-currency convenience yield along global variables. To do this, I rely on the insights from the literature on the global financial cycle (Rey, 2013; Miranda-Agrippino and Rey, 2021). This literature has documented significant co-movements in asset prices, capital inflows, and credit growth across regions and countries and has identified global risk appetite as the main driver. Miranda-Agrippino and Rey (2021) document that the VIX strongly correlates with a global factor that explains about a quarter of the variance in risky asset prices and about 35% of the variance in gross capital flows. This evidence supports the wide acceptance of the VIX as a measure of global uncertainty and the main driver of the global financial cycle. The following exercise can, therefore, be seen as an effort to extend this literature by analyzing the co-movements of the price of safety and liquidity across countries, which has not been studied so far.

In the following regressions, I interpret the VIX as an indicator of global uncertainty or an indicator of a flight to dollar safety. These episodes often lead to revisions by investors, and the safety status of a particular asset can change for any given level or risk of the asset. In terms of the simple model in Section 2.1, the VIX index can be represented by the parameter  $\kappa_t^{T,f}$ . It might capture a time-varying preference for certain convenience assets over others, so its effect could be positive or negative.

Table 3 shows the results. In Column 1, the coefficient on the VIX is negative and statistically significant for the dollar-investor convenience yield. This is a striking result as it is the opposite of the response of convenience yields in advanced economies. This suggests that the safety status of local-currency sovereign bonds decreases during periods of high-risk aversion. In the U.S., a rise in the VIX increases the convenience yield on its debt, driving dollar rates down and creating liquidity shortages. Notice that the federal funds rate loses its significance and becomes very imprecisely estimated. The federal funds rate and the VIX vary only at the time series dimension (they do not vary at the cross-section dimension).

As mentioned above, in terms of the model of Section 2.1, the VIX captures the effect of  $\kappa_t^{T,f}$ . In Column 2, I control for the slope of the yield curve, again as a measure of risk premia. Although its introduction reduces the magnitude of the estimated coefficient on the VIX, the effect of the VIX is robust. This suggests that the drop in the dollar convenience yield comes from losing its “safe asset” status in investors’ preferences.

Next, in Column 3, I control for capital inflows. This allows me to analyze their effect on the local-currency convenience yield and also works as a robustness check for the effect of the VIX (as it strongly correlates with gross capital flows). If the coefficient of the VIX index keeps its significance after controlling for capital inflows, this would confirm that global uncertainty has a negative effect on its own. I added capital inflows disaggregated by the sector they are directed to

Table 3: Convenience Yields and the Global Financial Cycle

	Dep. var.: dollar CY				Dep. var.: domestic CY			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Local MP rate <sub>t-1</sub>	0.683 (0.527)	0.545 (0.759)	0.403 (0.747)	2.261*** (0.747)	10.29*** (1.544)	8.374** (3.214)	9.068*** (3.099)	6.372*** (1.947)
U.S. MP rate <sub>t-1</sub>	3.229 (2.822)	-0.826 (3.074)	-0.729 (2.952)	4.225 (4.259)	0.640 (9.046)	-8.264 (13.52)	-10.28 (13.09)	0.681 (11.66)
$\log(\frac{\text{Local gov debt}}{GDP_{local}})_{t-1}$	15.07* (8.015)	11.24 (7.664)	10.28 (7.430)	6.996 (9.242)	-32.09*** (10.54)	-31.80*** (9.355)	-31.88*** (9.511)	-40.72*** (10.89)
$\log(\frac{\text{U.S. gov debt}}{GDP_{US}})_{t-1}$	-139.2*** (36.71)	-139.7*** (35.72)	-127.4*** (32.80)	-121.90*** (41.89)	55.67 (77.64)	26.56 (90.70)	22.50 (90.09)	65.86 (84.13)
vix <sub>t-1</sub>	-1.015*** (0.299)	-0.857*** (0.260)	-0.860*** (0.255)	-1.123*** (0.407)	0.744 (0.485)	0.508 (0.588)	0.562 (0.579)	0.710 (0.525)
slope <sub>local,t-1</sub>		1.694 (1.583)	1.403 (1.564)			-9.064 (7.796)	-8.738 (7.615)	
slope <sub>US,t-1</sub>		-7.325* (4.154)	-7.578* (3.953)			-9.215 (12.61)	-7.945 (12.25)	
$(\frac{GovdebtInflow}{GDP})_{t-1}$			-1.508 (1.221)				3.781 (4.408)	
$(\frac{BankdebtInflow}{GDP})_{t-1}$			-3.043*** (0.984)				7.100** (3.530)	
$(\frac{CorpdebtInflow}{GDP})_{t-1}$			1.954** (0.877)				3.291 (3.132)	
Terms of trade				-157.3 (102.16)				-300.8 (346.5)
Diff. Inflation				-1.147 (0.784)				7.921*** (1.857)
Democratic risk				-8.291** (3.729)				-11.72 (9.003)
Constant	-250.4*** (62.97)	-258.9*** (61.1)	-239.4*** (56.62)	471.1 (478.0)	-58.14 (152.1)	-71.35 (168.6)	-81.74 (164.7)	1377.1 (1568.0)
Observations	1,137	1,103	1,103	1,012	955	906	906	871
R-squared	0.692	0.697	0.705	0.713	0.325	0.338	0.352	0.428

Notes: Data are at monthly frequency. All columns include country and year-fixed effects. Standard errors are double-clustered by country and year. Start dates vary among countries but end in March 2021 for all. Capital inflows-to-GDP variables are standardized by the mean and standard deviation of each country. “Diff. inflation” is the yearly inflation rate in each country minus yearly inflation in the United States. “Democratic risk” measures political accountability (International Country Risk Guide, April 2019 version), and it is standardized by the mean and standard deviation of each country (higher values reflect higher risk). \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

(government, bank, or corporate debt), using data from Adjiev et al. (forthcoming). The VIX kept its negative effect on the local bond convenience yield, which confirms the direct negative effect of global uncertainty (independent of capital inflows). Further interpreting the coefficients of each inflow sector independently isn’t straightforward because the data does not report the currency denomination of these inflows.

Finally, in Column 4, I include the terms of trade for each country, measured as the commodity

price index of exports over the equivalent for imports, and two secular factors with lower frequency variation. The terms of trade control for a global factor highly correlated with commodity indices and international trade, explaining 31% of the variance of fluctuations in private liquidity worldwide (Miranda-Agrippino and Rey, 2021). For the secular variables, I added the differential yearly inflation in each country with respect to the United States and the differential index in democratic accountability, taken from the dataset of the International Country Risk Guide (standardized, so higher values mean higher political risk). It is natural to expect that EMEs with better institutions, governance, and higher investor confidence would enjoy a higher local currency convenience yield. Results are robust to the inclusion of these variables.

Columns 5 to 8 replicate the analysis for the domestic convenience yield. Overall, the global financial cycle has a negligible effect on domestic investors' valuation. This result suggests that the composition of the investor base (between domestic and foreigners) is relevant for sovereign debt valuation.

The results in this subsection are also robust to including a time trend and the lagged dependent variable as a regressor.

### 3.3 Analysis of Two Exogenous Shocks

This subsection tries to better understand the reason why the dollar convenience yield drops when there is higher global uncertainty. I do this by analyzing the response to two identifiable exogenous shocks to EMEs: the Taper Tantrum and the Covid pandemic. These are widely accepted as exogenous and unanticipated adverse shocks to EMEs. The Taper Tantrum started with Fed Chairman Ben Bernanke's speech in May 2013, which signaled the end of the Fed's large-scale asset purchases and, thus, a future reduction in the supply of dollar liquidity. The Covid-19 episode likely represents many shocks; therefore, I will focus my analysis on the early months of the pandemic (March-June 2020). Both episodes involved increased risk and a capital inflow reversal for EMEs. Still, one difference is that, unlike the first months of the Covid shock, the Taper Tantrum did not trigger a flight to safety episode (understood as global investors buying U.S. Treasuries because of their safety). This can be seen in the response of the VIX index (which did not increase).

I run a regression with the dollar-investor convenience yield on the left-hand side and interact the shocks with the explanatory variables of the previous sections. The interacted coefficients capture any change in the sensitivity of convenience yields to the different determinants and will shed light on which variables most likely drive the responses during these episodes. Results show that the response of the dollar convenience yield is quite different in the two episodes, driven in each case by different explanatory variables. Compared to Table 3, I introduce the supply of debt as the relative supply of U.S. Treasuries over local debt, which allows for a less noisy estimation of the supply coefficient.

Table 4 shows the results. Column 1 shows that the Taper Tantrum had a positive and significant effect. In Column 2, the coefficient of the interaction between the shock and the local monetary policy rate is positive and statistically significant. This variable proxies for the price of money and near-money assets. As explained before, a higher monetary policy rate is associated with a higher price of liquidity. The positive sign of the interaction term suggests that the convenience yield increased due to the demand for liquidity during the episode. Recall that during the Taper Tantrum, there was no flight to safety but scarcer liquidity that plausibly drove up the convenience yield of sovereign bonds. As Column 2 shows, this effect is not driven by the rise in risk premia, as captured by the slope of the local yield curve.

In contrast, Column 3 shows that the Covid shock significantly reduced the local-currency convenience yield by almost 19 basis points. In Column 4 the interaction of the shock with the relative supply of U.S. Treasuries is significantly negative, suggesting the slope of the demand for this global safe asset became significantly steeper. This is consistent with a global flight to the safety of U.S. Treasuries and with global investors preferring this safe asset over the local sovereign bond.

Column 4 suggests that what drives the drop in convenience yield (or the loss of safety status) is not the rise in credit risk or risk premia charged by global investors during this type of episode but a switch in preferences towards other sources of safety/liquidity. This provides further evidence that demand for safety is a relevant driver of capital flows, not only for advanced economies but also for emerging economies.

Are there other mechanisms that could be at play? A common alternative explanation rests on a financial repression mechanism. The government might want to force the local banks to hold its bonds, especially during downturns. However, if financial repression drives down local yields and is likely to be enforced during recessions, it would show up in the data as a countercyclical convenience yield. Another one is inflation risk since economic activity in EMEs is more likely to face adverse supply shocks. However, this and other risks are already part of the decomposition of local convenience yields in Section 2.

Of course, the insights highlighted in this section still leave questions open. Suppose it is true that the preference for alternative global safe assets drives the local-currency convenience yield. In that case, it still needs to be explained what precise feature of the local-currency sovereign bond makes it less preferred than the alternatives during global shocks involving a flight to safety. This question goes beyond this paper’s scope but represents a venue for future research.

### 3.4 Summary of Empirical Analysis

Let me briefly summarize the key takeaways from this and the previous section. Data on deviations of covered interest parity conditions and local asset spreads show investors are willing to pay a

Table 4: Effect of Taper Tantrum and Covid-19 Shocks

Dep. var: $cy_{i,t}$	(1)	(2)	(3)	(4)
Non-interacted regressors	Yes	Yes	Yes	Yes
$TT_{t-1}$	4.875*** (1.348)	2.972 (2.778)		
$MP\ rate_{t-1} \times TT$		2.030*** (0.524)		
$\log(\frac{US\ debt\ to\ GDP}{Local\ Debt\ to\ GDP})_{t-1} \times TT$		0.682* (0.366)		
$vix_{t-1} \times TT$		-0.783** (0.379)		
$slope_{local,t-1} \times TT$		0.413 (1.551)		
$Covid-19_{t-1}$			-18.92*** (5.908)	-21.84*** (5.517)
$MP\ rate_{t-1} \times Covid-19$				-1.830 (1.513)
$\log(\frac{US\ debt\ to\ GDP}{Debt\ to\ GDP})_{t-1} \times Covid-19$				-2.358*** (0.601)
$vix_{t-1} \times Covid-19$				0.570* (0.288)
$slope_{local,t-1} \times Covid-19$				3.108 (1.930)
Constant	46.92** (18.32)	49.41*** (18.55)	47.11** (18.60)	51.79** (19.70)
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Lagged dep. var.	Yes	Yes	Yes	Yes
Observations	1,091	1,091	1,091	1,091
R-squared	0.838	0.839	0.841	0.846

Notes: See Table 3.  $TT$  is a dummy variable taking the value one from May to December 2013. Covid-19 is a dummy variable taking the value one from March to June 2020. All columns include country and year fixed effects \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

safety/liquidity premium on EMEs' local-currency sovereign bonds. However, this does not make them equivalent to a U.S. Treasury or an advanced economy. The main difference is that their

local-currency convenience yield is procyclical with respect to the global financial cycle, suggesting that their value as safe assets drops during episodes of increased global uncertainty measured by the VIX index. A comparison between the Taper Tantrum and the Covid shock suggests that the reason is not driven by higher credit risk or a higher risk premium, but by loss of safety status based on investors' preferences.

In the Appendix, I ran a series of robustness tests for Sections 3.1-3.3. First, I ran the same regressions but with credit risk (measured as the differential CDS spread) as a dependent variable, which is another CIP deviation component. If my decomposition in Section 2 accurately disentangled local-currency bond premiums from default risk, then the determinants should differ. The results of that exercise confirm this. Contrastingly with convenience yields, credit risk does not respond to the supply of debt. Second, I also addressed the concern that my results might be driven by periods of high illiquidity and mispricing of EME assets (sovereign bonds, CDS contracts, or interest rate swaps). I reran the regressions by dropping the 2008 and 2020 crises to capture only "normal" periods. The results suggest that the role of safety and liquidity demand as a source of EMEs' convenience yields is robust to this smaller sample.

## 4 Model

The model aims to (1) characterize the effects of shocks to demand for safety on small open economies, matching the empirical responses of the local convenience yields, and (2) quantify the role of safety demand on SOE's business cycles.

Time is discrete and runs to infinity:  $t = 0, 1, 2, \dots$  I refer to the two countries in the model as the EME (home) and the US (foreign). There is a financial friction: U.S. households can borrow up to a fraction of their holdings of U.S. Treasuries and EME local-currency sovereign bonds. Therefore, when the constraint binds, they pay a premium (or "convenience yield") for both sovereign bonds.

The EME is populated by a continuum of identical households distributed on the interval  $[0, n)$  with preferences defined over a consumption basket of traded goods. The US is populated by a continuum of households distributed on the interval  $(n, 1]$ , with equivalent preferences. I solve the model for the small open economy limit, this is, for  $n \rightarrow 0$  (as in De Paoli (2009) and Akinci and Queralto (2022)).

From the perspective of the EME, the model features two shocks: a standard productivity shock and a safety shock. The latter features an increase in demand for collateral joint with an increase in the collateral quality of U.S. sovereign bonds. This resembles an increase in the global demand for foreign bonds, which provide better "convenience services" than other assets. In this sense, its impact should capture the effect of the VIX index in the empirical section or the effect of a change in  $\kappa_t^{T,f}$  in the simple model of Section 2. Kekre and Lenel (2021) show that shocks to safety/liquidity demand for US Treasuries account for 25% of output volatility in the U.S. and 6%

of output volatility in the rest of the world.

#### 4.1 Households

The expected utility of a representative EME household in period  $t$  is given by

$$\mathbb{U}_t = E_t \sum_{i=0}^{\infty} \beta^i \left( \frac{C_{t+i}^{1-\gamma}}{1-\gamma} - \frac{L_{t+i}^\eta}{\eta} \right) \quad (13)$$

where  $\gamma > 0$  is the coefficient of relative risk aversion and  $1 > \beta > 0$  is the subjective discount factor.  $\mathbb{E}_t$  denotes expectations conditioned on period  $t$  information.  $L_t$  is the labor supplied to local firms.  $C_t$  is the consumption index defined over two consumption goods: an EME-produced good,  $C_{D,t}$ , and a US-produced good,  $C_{F,t}$ . I assume that the index takes the CES form, so

$$C_t = \left[ (1-\omega)^{\frac{1}{\theta}} C_{D,t}^{\frac{\theta-1}{\theta}} + \omega^{\frac{1}{\theta}} C_{F,t}^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \quad (14)$$

with elasticity parameter  $\theta$ , and share parameter  $\omega$  for the foreign good. I also assume consumption home bias:  $\omega < 1/2$ .

$P_t$  is the associated consumption price index for EME households in their local currency:

$$P_t = \left[ (1-\omega)P_{D,t}^{1-\theta} + \omega P_{F,t}^{1-\theta} \right]^{\frac{1}{1-\theta}} \quad (15)$$

where  $P_{D,t}$  and  $P_{F,t}$  are the local currency prices at which the EME households purchase EME and US goods, respectively. EME households also decide how much labor to supply to local firms and derive a nominal wage income of  $W_t L_t$  from working for EME firms.

In this model, EME households can trade a bond to smooth consumption, denominated in the US price index. In addition, two sovereign bonds (denominated in each country's price index) serve as collateral. The budget constraint of EME households is therefore given by

$$P_t C_t + \frac{Q_t^b}{S_t} b_t + \frac{Q_t^T}{S_t} b_t^{g*} + P_t^b b_t^g \leq \frac{P_t^*}{S_t} b_{t-1} + \frac{P_t^*}{S_t} b_{t-1}^{g*} + P_t b_{t-1}^g + W_t L_t \quad (16)$$

where  $b_t$  is the number of dollar bonds held by the EME household;  $Q_t^b$  is the nominal price of a bond (in US dollars). This bond is in zero net supply and determines the net foreign asset position of the EME.  $b_t^{g*}$  and  $b_t^g$  are the number of foreign and local government bonds, respectively, whose prices are  $Q_t^T$  and  $P_t^b$ .  $P_t^*$  is the US period- $t$  price index, and  $S_t$  denotes the period- $t$  nominal exchange rate measured as the price of EME currency in US dollars (hereafter, I use \* notation for US variables). According to this definition, a depreciation (appreciation) in the real value of the US dollar corresponds to a rise (fall) in  $S_t$ .

Dividing both sides of the budget constraint by  $P_t$ , we obtain the constraint in real terms,



$$C_t + \frac{q_t^b}{\mathcal{E}_t} b_t + \frac{q_t^T}{\mathcal{E}_t} b_t^{g*} + p_t^b b_t^g \leq \frac{1}{\mathcal{E}_t} b_{t-1} + \frac{b_{t-1}^{g*}}{\mathcal{E}_t} + b_{t-1}^g + w_t L_t \quad (17)$$

where  $q_t^b$ ,  $q_t^T$ ,  $p_t^b$ , and  $w_t$  are the corresponding real values of  $Q_t^b$ ,  $Q_t^T$ ,  $P_t^b$ , and  $W_t$ .  $\mathcal{E}_t$  is the real exchange rate defined as the relative price of the basket of goods consumed in the EME in terms of the price of a basket of goods consumed in the US,

$$\mathcal{E}_t = \frac{S_t P_t}{P_t^*} \quad (18)$$

Similarly, the US is populated by a continuum of households distributed on the interval  $(n, 1]$ . The preferences and optimization problem of the US households are identical to those of the EME household with the  $*$  notation for US variables. For example, the US consumption index is denoted by  $C_t^*$ , with  $C_{D,t}^*$  and  $C_{F,t}^*$  denoting the consumption of US and EME-produced goods by US households. The price index for US households in dollars is given by

$$P_t^* = \left( \omega^* (P_{D,t}^*)^{1-\theta} + (1 - \omega^*) (P_{F,t}^*)^{1-\theta} \right)^{\frac{1}{1-\theta}} \quad (19)$$

U.S. households can trade the dollar bond and hold both sovereign bonds. Their budget constraint is analogous to the one for EME households.

I assume that the law of one price holds for both traded goods, so  $P_{F,t}^* = S_t P_{D,t}$  and  $P_{D,t}^* = S_t P_{F,t}$ . Let  $p_{D,t}^* = P_{D,t}^*/P_t^*$  and  $p_{F,t}^* = P_{F,t}^*/P_t^*$  denote the relative prices of US and EME goods faced by US households, and  $p_{F,t} = P_{F,t}/P_t$  and  $p_{D,t} = P_{D,t}/P_t$  denote the relative prices faced by EME households. Then, by the definition of real exchange rate,  $p_{D,t}^* = \mathcal{E}_t p_{F,t}$  and  $p_{F,t}^* = \mathcal{E}_t p_{D,t}$ . From the definitions of  $P_t$  and  $P_t^*$  in (15) and (19), I obtain  $1 = \omega^* (p_{D,t}^*)^{1-\theta} + (1 - \omega^*) (p_{F,t}^*)^{1-\theta}$  and  $1 = \omega (p_{F,t})^{1-\theta} + (1 - \omega) (p_{D,t})^{1-\theta}$ . Combining these equations with the definition of real exchange rate produces the following expression:

$$\mathcal{E}_t = \left( \frac{1 - \omega^*}{1 - \omega} + \frac{(\omega^* - \omega) (p_{F,t})^{1-\theta}}{1 - \omega} \right)^{\frac{1}{\theta-1}} \quad (20)$$

According to this expression, a depreciation of the real exchange rate,  $\mathcal{E}_t$ , lowers the relative price of US goods facing EME households when there is consumption home bias,  $\omega^* > \omega$ . Home bias is the model's only source of real exchange rate fluctuation. Although the law of one price holds for all goods individually, the real exchange rate is directly related to the relative prices, which fluctuate in response to shocks in both countries. The intuition behind this result is that  $P_t$  and  $P_t^*$  are consumer-based price indexes, while home bias implies that the US (EME) preference puts higher weight on US (EME) goods than EME (US) preference does.

**Financial friction and demand for safe assets.** The world credit market is imperfect. Households guarantee their debt by offering domestic and foreign assets as collateral. The collateral

constraint takes the form of the margin requirement:

$$q_t^b b_t^* \geq -(\kappa_t^* q_t^T b_t^{g*} + \kappa_t p_t^b \mathcal{E}_t b_t^g) \quad (21)$$

for the case of the U.S. households and an analogous constraint for EME households. Thus, households can borrow internationally up to a fraction  $\kappa_t^*$  of the market value of US sovereign bonds and a fraction  $\kappa_t$  of the market value of the local sovereign bonds. The margin constraint is not derived from an optimal credit contract. Instead, the constraint is imposed directly as in the models with endogenous credit constraints examined in Kiyotaki and Moore (1997) or Aiyagari and Gertler (1999), even though a restriction like (21) can be endogenously modeled<sup>2</sup>.

A binding constraint in (21) creates a demand for safe assets (the two sovereign bonds) to be able to borrow and smooth domestic consumption. Under what conditions is (21) binding? In general, the constraint is binding when U.S. households have low financial wealth (fewer supply of safe assets) and when borrowing demand is high<sup>3</sup>.

The collateral quality of the U.S. sovereign bonds, captured by  $\kappa_t^*$ , follows an exogenous process, described later along with the other shocks. To see the implications for the pricing of bonds, take the U.S. households' first-order conditions for the foreign and the local sovereign bond, respectively:

$$q_t^T = \beta E \left[ \frac{\lambda_{t+1}^*}{\lambda_t^*} \right] + \kappa_t^* \frac{\mu_t^*}{\lambda_t^*} \quad (22)$$

$$p_t^b = \beta E \left[ \frac{\lambda_{t+1}^*}{\lambda_t^*} \right] + \kappa_t \frac{\mu_t^*}{\lambda_t^*} \quad (23)$$

where  $\lambda_t^*$  and  $\mu_t^*$  are the Lagrange multipliers for the budget and collateral constraints of the U.S. household, respectively. As usual,  $\lambda_t^*$  equals the lifetime marginal utility of  $C_t^*$ . The price of the bonds depends on the two reasons why households demand bonds. First, there is the intertemporal substitution motive. This is the typical motive in standard neoclassical models in which households demand bonds to smooth their consumption path. Second, there is a safety motive, above and beyond the intertemporal substitution motive, coming from their use as collateral. This is captured by the term  $\kappa_t \frac{\mu_t^*}{\lambda_t^*}$ , which depends on how binding the collateral constraint is ( $\mu_t$ ), the quality as collateral ( $\kappa_t$ ), and the level of consumption ( $\lambda_t$ ).

Let  $R_{t+1}^b \equiv 1/p_t^b$  and  $R_{t+1}^T \equiv 1/q_t^T$ . The expected excess return of the local sovereign bond with respect to the foreign sovereign bond is given by:

$$E[R_{t+1}^b(\mathcal{E}_{t+1}/\mathcal{E}_t) - R_{t+1}^T] = R_{t+1}^T \frac{cov(\lambda_{t+1}^*/\lambda_t^*, \mathcal{E}_{t+1}/\mathcal{E}_t)}{E[\lambda_{t+1}^*/\lambda_t^*]} + \frac{\mu_t^*(\kappa_t^* - \kappa_t)}{E[\lambda_{t+1}^*/\lambda_t^*]} \quad (24)$$

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<sup>2</sup>See Bianchi and Mendoza (2020) for a comprehensive review of the models using these type of financial constraints

<sup>3</sup>Some of these features of the demand for safe/liquid assets are also present, for example, in Mendoza and Quadrini (2023)

The expected excess return of the non-sovereign foreign bond over the local sovereign bond is given by an analogous expression (with  $R_{t+1} \equiv 1/q_t^b$ ):

$$E[R_{t+1} - (\mathcal{E}_{t+1}/\mathcal{E}_t)R_{t+1}^b] = -R_{t+1} \frac{\text{cov}(\lambda_{t+1}^*/\lambda_t^*, \mathcal{E}_{t+1}/\mathcal{E}_t)}{E[\lambda_{t+1}^*/\lambda_t^*]} + \frac{\mu_t^*(\kappa_t - 1)}{E[\lambda_{t+1}^*/\lambda_t^*]} \quad (25)$$

On the right-hand side, the first term captures the covariance of real exchange rate and consumption growth. The second term corresponds to the differential convenience yield between the two bonds, which depends on how binding the collateral constraint is,  $\mu_t$ , and the collateral quality.

Recent papers like Maggiori (2017) and Hassan and Zhang (2021) consider a currency a safe haven if it appreciates during global downturns. They are looking at the covariance in the first term of the right-hand side. In this paper, I mean something different for a safe bond. The “safety” of a bond will come from its use as collateral, which is captured by the differential convenience yield.

There is no conflict between the two approaches, as they are closely linked. Jiang, Krishnamurthy, and Lustig (2021) and Engel and Wu (2023) estimate an empirical counterpart for Equations (24) and (25) and find that increases in the convenience yield drive an appreciation of the currency. Therefore, convenience yields of dollar assets, for example, are one factor driving the dollar’s appreciation during global downturns.

The dollar-investor’s convenience yield of the empirical section is captured in the model by the second term on the right-hand side of Equation (25). Recall that the dollar investor was assumed to invest in dollar- and domestic-currency assets and to measure her returns in dollars. The term in Equation (25) captures both: it arises from comparing the local-currency sovereign bond against non-sovereign assets denominated in foreign goods using the pricing kernel of the U.S. household.

The convenience yields in the model capture the main empirical properties found in Section 3. First, the convenience yield lowers the bonds’ equilibrium yield below the level implied by the consumption smoothing demand alone. Second, it depends negatively on the supply of safe assets (a higher supply of sovereign bonds makes the collateral less binding and lowers  $\mu_t$ ) and positively on the demand for consumption smoothing, which increases the collateral value.

Equations (24) and (25) make clear that interest rate parity does not hold in this model. Deviations are proportional to the differential convenience yield. This is similar to what happens in the models of Jiang, Krishnamurthy, and Lustig (2021) and Engel and Wu (2023), where fluctuations in convenience yields produce deviations from the uncovered interest parity condition.

## 4.2 Firms

Each country has a single industry, and each sector is populated by a continuum of identical firms distributed on the interval  $[0, 1]$ . A representative US firm hires labor  $L_t^*$  to produce an output of US goods,  $Y_t^*$ , according to  $Y_t^* = F(A_t^*, L_t^*)$  where  $F$  is a constant-returns-to-scale production

function, and  $A_t^*$  denotes the state of productivity. The output of EME goods by a representative EME firm,  $Y_t$ , is given by an identical production function hiring labor  $L_t$ , with productivity  $A_t$ .

Firms in each country choose production to maximize their total value to shareholders. In particular, a representative US firm solves

$$\max_{D_{t+i}^*} \mathbb{E}_t \sum_{i=0}^{\infty} \beta^i \frac{\lambda_{t+i}^*}{\lambda_t^*} \frac{D_{t+i}^*}{P_{t+i}^*} \quad (26)$$

s.t.

$$D_t^* = P_{D,t}^* F(A_t^*, L_t^*) - W_t^* L_t^* \quad (27)$$

where  $\lambda_t^*$  is the stochastic discount factor of the firms' shareholders. The firms' shareholders are US households, so  $\lambda_t^* = C_t^{*-\gamma}$ .

The problem of a representative firm can be rewritten in real terms as

$$\max_{L_{t+i}^*} \mathbb{E}_t \sum_{i=0}^{\infty} \beta^i \frac{\lambda_{t+i}^*}{\lambda_t^*} \left\{ p_{D,t+i}^* F(A_{t+i}^*, L_{t+i}^*) - w_{t+i}^* L_{t+i}^* \right\} \quad (28)$$

Similarly, a representative EME firm solves

$$\max_{L_{t+i}} \mathbb{E}_t \sum_{i=0}^{\infty} \beta^i \frac{\lambda_{t+i}}{\lambda_t} \left\{ p_{D,t+i} F(A_{t+i}, L_{t+i}) - w_{t+i} L_{t+i} \right\} \quad (29)$$

where the stochastic discount factor is given by the marginal utility of EME households,  $\lambda_t = C_t^{-\gamma}$ .

### 4.3 Government

The government in each country collects lump-sum taxes and borrows from households. This borrowing determines the supply of US Treasuries (in the case of the US) and the supply of the EME local-currency sovereign bond. For simplicity, I assume that government debt in both countries has a 1-period maturity.

The government issues new bonds every period and adjusts the tax rate to pay for the maturing bonds from the previous period. I assume the government aims to keep the ratio of debt to GDP constant at some level  $b_{ss}^g = b_t^g / Y_t$  ( $b_{ss}^{*g} = b_t^{*g} / Y_t^*$ ) at all times. As explained in Bohn (1995), this is an example of a simple policy that stabilizes the debt-GDP ratio over time, which I consider to be representative of both countries.

The tax rate will vary to satisfy the following budget constraints:

$$\tau_t + p_t^b b_{t+1}^g = b_t^g \quad (30)$$

and

$$\tau_t^* + q_t^T b_{t+1}^{g*} = b_t^{g*} \quad (31)$$

These budget constraints imply that the supply of safe assets will be pro-cyclical. This is consistent with evidence from the US (see Caramp and Singh, 2021). For EMEs, they imply that tax revenues will be higher in states where output is higher and in states where the price of the local bond is lower. Therefore, tax revenues will be procyclical, consistent with evidence for emerging markets (Vegh and Vuletin, 2013; Frankel et al., 2013).

#### 4.4 Shocks

The EME economy is subject to two types of shocks: standard productivity shocks and safety shocks.

**Productivity shock.** I assume that production functions are Cobb-Douglas:  $F(A, L) \equiv AL^{1-\alpha}$ , with  $1 > \alpha \geq 0$ . I also assume that log productivity in the EME economy follows a stationary  $AR(1)$  process:

$$\log A_t = \rho \log A_{t-1} + \epsilon_t \quad (32)$$

with  $1 > \rho > 0$ , where  $\epsilon_t$  is an i.i.d. productivity shock.

**Safety shock.** A safety shock involves two things happening at the same time. First, a negative productivity shock in the U.S. reduces the supply of sovereign bonds by the U.S. government and increases the U.S. households' demand for collateral to smooth consumption. Second, a concurrent increase in the collateral quality of the U.S. sovereign bond,  $\kappa_t^*$ . In particular, this parameter follows an  $AR(1)$  process whose statistical moments are calibrated in the next section,

$$\log \kappa_t^* = (1 - \rho^s) \log \kappa^* + \rho^s \log \kappa_{t-1}^* + \sigma^s \epsilon_t^s \quad (33)$$

The shock increases the convenience yield of the U.S. sovereign bond because it makes the collateral constraint more binding (the U.S. household wants to borrow to smooth consumption) and because the supply of the bond drops. The drop in the supply of US sovereign bonds is a common way to achieve an exogenous increase in the demand for safe assets and is consistent with evidence of flight-to-safety episodes. Caramp and Singh (2021) show that the supply of US safe assets (including US Treasuries and private safe assets such as money market funds and private deposits) drops during recessions, explaining the countercyclicality of the US convenience yield. Gorton (2017) characterizes the 2008 crisis and the Euro debt crisis of 2012 as shocks where many assets considered safe and “information-insensitive” suddenly became “information-sensitive”, effectively reducing the supply of assets deemed safe. In the model of Kekre and Lenel (2021), where demand for safety is captured via a reduced-form bonds-in-the-utility function specification, a drop in the

supply of US government bonds has effects equivalent to an exogenous increase in the utility provided by US safe assets.

Of course, a negative productivity shock in the US can have additional effects on the EME, although, in this case, they will not affect the dynamics of the safety shock. For example, the recession in the US could decrease the demand for EME's exports. However, since I solve the model for the SOE limit where  $\omega^* \rightarrow 1$  and  $n \rightarrow 1$ , the U.S. behaves in practice as a closed economy. Therefore, there will be no effect through lower exports demand.

## 4.5 Discussion

In this section, I aimed to set up a model with the minimum number of ingredients needed to study convenience yields. For example, the model is set in real terms, leaving aside inflation, nominal rigidities, and monetary policy. While the interaction of local monetary policy with convenience yields is an interesting research question, convenience yields do not rely on nominal rigidities or other frictions.

In the model, convenience yields in bonds arise from their use as collateral. Therefore, convenience yields will be higher when there is more demand for consumption smoothing or when the supply of bonds is lower. The safety shock in the model encompasses both. As mentioned above, the convenience yield of the EME sovereign bond in the model captures the global investor's convenience yield of the empirical section. The model will show that this convenience yield will drop against a safety shock, resembling the effect of the VIX index in the empirical section. Rises in the VIX index are associated with increased global uncertainty or a flight to safety, which increases the demand for the safety of dollar assets, increasing the convenience yields in the U.S.

There are alternative ways of achieving a convenience yield in a tractable model. For example, Kekre and Lenel (2021) use a bond-in-the-utility-function specification. In that framework, the convenience yield comes from an unmodeled demand for safety, and convenience yields are exogenous. A safety shock is an exogenous increase in this wedge on the Euler equation. Del Negro et al. (2017b), for a closed-economy framework, model a convenience yield on government bonds by adding a resaleability constraint on risky equity. When an exogenous shock reduces the resaleability of equity, entrepreneurs increase their demand for government bonds, which they could sell to take idiosyncratic investment opportunities. However, to solve the model, they make constraints always binding. In contrast, in my model, the constraint occasionally binds in the ergodic set, allowing for states where convenience yields are zero.

Finally, I abstract from explicitly modeling financial intermediaries. Akinci and Queralto (2022) use the SOE limit of the two-country model to analyze the effect of US monetary policy spillovers on EMEs, but they do not feature convenience yields. The spillovers work through the incentive constraints of currency-mismatched global intermediaries, which are made binding by dollar

appreciations that follow a monetary policy hike in the US. My model could easily include local and global financial intermediaries to analyze the interaction of specific financial frictions with convenience yields.

## 4.6 Equilibrium

I study a standard sequential competitive equilibrium: in equilibrium, prices and allocations are such that allocations solve the households' and firms' optimization problems, and all markets clear in each history of shocks. Numerically, I solve for sequential competitive equilibrium with a particular recursive structure: a recursive equilibrium is a sequential competitive equilibrium in which prices and allocations are (single-valued) functions of two exogenous state variables (the productivity and the safety shock) and three endogenous state variables,  $b_t^g$ ,  $b_t^g$  and  $b_{t-1}$ . The US bond is in zero net supply, so  $b_t^* - b_t = 0$  by market clearing. Thus,  $b_{t-1}$  identifies the EME net foreign asset position at the start of period  $t$ .

A sequential competitive equilibrium consists of stochastic sequences of allocations,

$$\{C_{D,t}^*, C_{F,t}^*, \chi_t^*, b_t^*, L_t^*, C_{D,t}, C_{F,t}, \chi_t, b_t, L_t\}$$

and prices,

$$\{p_{D,t}^*, p_{F,t}^*, q_t^T, q_t^b, p_t^b, p_{D,t}, p_{F,t}, q_t, \mathcal{E}_t\}$$

such that the allocations solve households' and firms' optimization problems and markets clear. Market clearing in the two goods markets requires that

$$Y_t^* = A_t^* L_t^{1-\alpha} = C_{D,t}^* + \frac{n}{1-n} C_{F,t} \quad (34)$$

and

$$Y_t = A_t L_t^{1-\alpha} = C_{D,t} + \frac{1-n}{n} C_{F,t} \quad (35)$$

The non-sovereign bonds are in zero net supply, so  $0 = b_t + b_t^*$ . The two sovereign bonds are in positive supply, and the supply equals the sum of the two households' holdings.

I solve for the recursive equilibrium using policy-function iteration, a global method developed by Cao, Luo, and Nie (2023). The method suits dynamic stochastic general equilibrium (DSGE) models with portfolio choices. As the borrowing constraint is tied to the price of capital and the price of the local bond, a shock that reduces asset prices tightens the collateral constraint, leading to deleveraging and reductions in both investment and working capital, so the effect of the shocks gets amplified. The collateral constraint occasionally binds in the ergodic set, and the equilibrium policy and state transition functions are highly nonlinear. The algorithm in Cao et al. (2023)

Table 5: Externally Set Parameters

Parameter	Description	Value
$\beta$	Discount factor	0.98
$\gamma$	Risk aversion	2
$\eta$	Labor elasticity	1.846
$1 - \omega$	Home bias	0.7
$\theta$	Consumption elasticity	5
$1 - \alpha$	Labor share	0.64
$\rho$	Productivity persistence	0.82
$\sigma$	Productivity volatility	0.0196
$\kappa^*$	Foreign collateral	1.4
$\kappa$	Local collateral	1.05
$\rho^s$	Safety persistence	0.4
$\sigma^s$	Safety volatility	0.29

relies on simultaneous transition and policy function iteration and can capture the nonlinearities accurately.

I solve the model for the small open economy limit. On the one hand, the US openness parameter,  $1 - \omega^*$ , is assumed to be arbitrarily small:  $\omega^* \rightarrow 1$ . Conversely, I assume the US is arbitrarily large relative to the EME,  $n \rightarrow 1$ . The rationale for these assumptions is that the EME is very small relative to the United States and, therefore, has negligible weight in US consumption and investment baskets. This implies that the US behaves effectively like a closed economy. I choose to model a small open economy in this way because it allows for a more transparent analysis of both the global and the local safe asset and their effects on convenience yields (see De Paoli (2009) and Akinci and Queralto (2022) for other applications of this framework).

## 5 Macroeconomic Implications

I calibrate the parameters with standard values for the small open economy literature (see Table 5). The parameters specific to this paper that need a more careful discussion are the ones related to the safety shocks and the collateral constraint.

I calibrate the EME productivity shock according to Mendoza (2010) and set  $\sigma = 0.0196$ . This corresponds to the volatility of the Mexican economy found in that paper, which I take as a representative example of an EME.

The parameters  $\rho^s$  and  $\sigma^s$  govern the persistence and volatility of the safety shock. I take the persistence of the safety shock to be  $\rho^s = 0.4$ , as in Kekre and Lenel (2021). However, I change



their estimation of its volatility. They estimate the moments of the US Treasury premium, which is the differential convenience yield of the US Treasury against sovereign bonds of G10 countries. It is not precisely the same empirical counterpart to the safety shock in the model. I set  $\sigma^s = 0.29$  because that is the volatility of the convenience yield of the US Treasury against highly-rated US corporate bonds.

The parameters  $\kappa^*$  and  $\kappa$  determine the two collateral qualities' drift in the exogenous process. I calibrate them to match the cross-section average and standard deviation of the dollar investor's convenience yield for the nine countries in my sample. The average convenience yield is 31 basis points, and the standard deviation is 0.442. This calibration gives values of  $\kappa^* = 1.4$  and  $\kappa = 1.05$ .

## 5.1 Impulse responses to a safety shock

Safety shocks are an important contributor to global macroeconomic volatility. Kekre and Lenel (2021) show that safety shocks account for around 25% of output volatility in the U.S. and around 6% of the volatility in the rest of the world.

I show the response to a safety shock, which could resemble a global flight to safety (like the one experienced in March 2020), where investors take refuge in U.S. Treasuries as a safe haven. This type of dynamics is exogenous from the standpoint of a small open economy, and the demand of EME households should have a negligible impact on such a shock. In Kekre and Lenel (2021), the convenience yield of US safe assets comes from including these bonds in the utility function, and the safety shock is an exogenous shock to a wedge in the Euler equation on U.S. safe bonds.

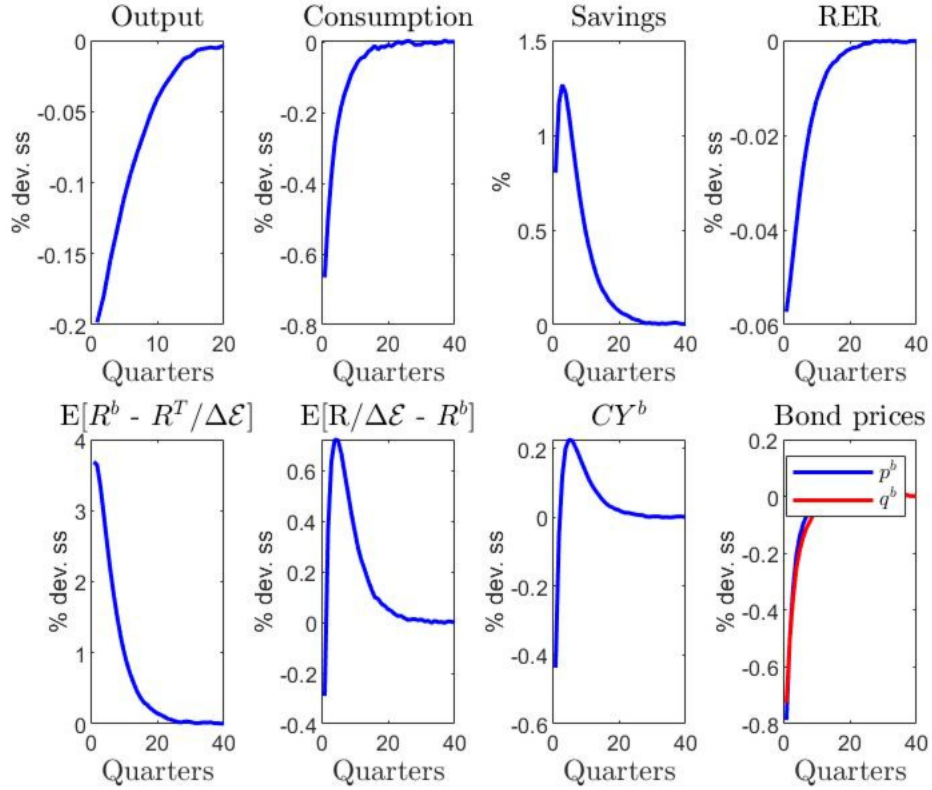
Figure 3 shows the impulse responses for a subset of the endogenous variables. The top row shows the output, consumption, savings, and real exchange rate responses. The household increases its savings in the non-sovereign foreign bond, so consumption drops. As foreign goods are more valuable, the real exchange rate appreciates. Output also drops in response to the reduction in the relative price of home goods and its effect on labor supply.

The bottom row shows the response of asset prices. The expected excess return of the local sovereign bond relative to the U.S. sovereign bond increases on impact. The reason is that the higher convenience yield of the U.S. sovereign bond lowers its expected return.

In addition, the expected excess return of the non-sovereign foreign bond relative to the local sovereign bond decreases on impact. This decrease can be due to the foreign goods' expected depreciation (that follows their impact appreciation) or a reduction in the convenience yield. The third graph on the bottom row shows the impulse response of the convenience yield alone, and it shows that the reaction of the convenience yield drives the drop in the expected excess return.

This is the more interesting result, as this is the model counterpart of the dollar-investor's convenience yield of the empirical section. Accordingly, the model successfully matches the drop of the convenience yields against a safety shock, captured by the negative effect of the VIX index

Figure 3: Impulse Responses to a Safety Shock



on the dollar-investors' convenience yield. The convenience yield of the local sovereign bond falls on impact because the U.S. household's demand for collateral is more than satiated with the extra value of the U.S. sovereign bond.

Although the shock to collateral quality is exogenous, the endogenous responses of asset prices to a safety shock make the local sovereign bond to lose value in a bad state of the world. To see this, notice that although all three bonds pay one unit of consumption, the EME sovereign bond loses value due to the drop in the convenience yield. Therefore, the EME sovereign bond is paying "badly" in a bad state of the world since consumption also falls.

## 5.2 Business cycle volatility

Convenience yields and the safety shock have implications for the business cycle in the local economy. The responses of the convenience yields due to safety shocks will be accommodated by changes in the real exchange rate and the yields of the two sovereign bonds. The yield on the foreign sovereign bond,  $R_t^T$ , trades below the international interest rate that governs consumption-savings decisions,  $R_t$ , and this spread corresponds to the convenience yield of foreign sovereign bonds. Similarly, the yield on the local sovereign bond,  $R_t^b$ , trades below the international rate  $R_t$ ,

Table 6: Output and local interest rate volatility

	Model	No safety shocks
$\sigma_Y$	3.65	3.6
$\sigma_C$	1.8	1.63
$\sigma_{R^b}$	1.65	1.59

Notes: based on the simulation of 50,000 periods, dropping the first 10,000 as burn-in.

and this spread corresponds to the convenience yield of the local sovereign bond.

Against a safety shock, the international rate increases, and the local convenience yield drops. This means that the yield on the local sovereign bond needs to rise more than proportionally compared to the international rate. Therefore, the model implies that convenience yields increase the volatility of EMEs' sovereign interest rates. The reason is the procyclicality of the local-currency convenience yield: if the convenience yield increases against a safety shock, the yield of the local sovereign bond would increase less than proportionally compared to the international rate.

Table 6 summarizes the quantitative exercise. Column 1 shows the model's volatility of output, consumption, and local interest rate. Column 2 shows the moments in a model with no safety shocks. Overall, my model implies that safety shocks account for 2% and around 9% of output and consumption volatility, respectively.

These effects are economically relevant when compared to the results of Uribe and Yue (2006), who quantify the role of shocks to world rates and country spreads on small open economies' economic activity. The two models share many features, but differ in that I introduce demand for safety.

Compared to their framework, my exercise can be understood as exploring the role of one source of movements in world interest rates, i.e., those coming from safety demand and flight to safety episodes. Uribe and Yue (2006) find that U.S. interest rate shocks explain about 20% of movements in aggregate economic activity in emerging economies. Table 6 suggests that demand for safety explains about 10% of that effect on output.

Similarly, Uribe and Yue (2006) explore the role of shocks to country spreads. The country spreads in their paper correspond to the financing cost of dollar-denominated debt in emerging markets. Again, convenience yields arising from safety/liquidity benefits can be understood as one component of country spreads, in addition to default risk and others. They find that country-spread shocks explain about 12% of the business cycle in emerging economies. Table 6 suggests

that convenience yields explain about 17% of that effect on output.

## 6 Conclusion

This paper shows that local-currency convenience yields due to safety/liquidity services are relevant in pricing sovereign bonds in EMEs. An important difference with sovereign bonds of advanced economies is that local currency convenience yields for global investors drop during periods of high global uncertainty. Evidence from the Taper Tantrum and the Covid episodes suggest that the explanation does not rest on higher credit risk or risk premia, as it would be expected, but on losing the safe asset status due to a switch in preferences towards U.S. Treasuries. This provides further evidence that demand for safety is a relevant driver of capital flows for advanced economies and emerging economies. A simple extension of the standard open economy-real business cycle model to include demand for safety and two alternative safe assets shows that the drop in convenience yields against safety shocks increases the volatility of local interest rates.

The dynamics of convenience yields and their response to global shocks have important implications for EMEs that call for more research on this topic. For example, a higher interest rate volatility can have an impact on fiscal capacity for EMEs' governments, as it leads to a rise in borrowing costs. Additionally, convenience yields are one reason for bond demand to be downward sloping, allowing large-scale asset purchases (LSAPs) by EMEs' central banks to have an impact on yields. Indeed, many EME central banks conducted such purchases during the Covid crisis. Therefore, if the convenience yield from global investors drops during a crisis, that will limit the effectiveness of LSAPs.

Finally, given the relevance of the demand for safety, more research is needed to know what specific feature makes a sovereign bond a safe asset (primary surpluses, low inflation risk, or others). This, in turn, will allow for a more microfounded specification of the safety shock. In addition, future research can aim to understand better how policies common to EMEs interact with convenience yields, such as reserve accumulation, different forms of capital controls, or foreign exchange intervention.

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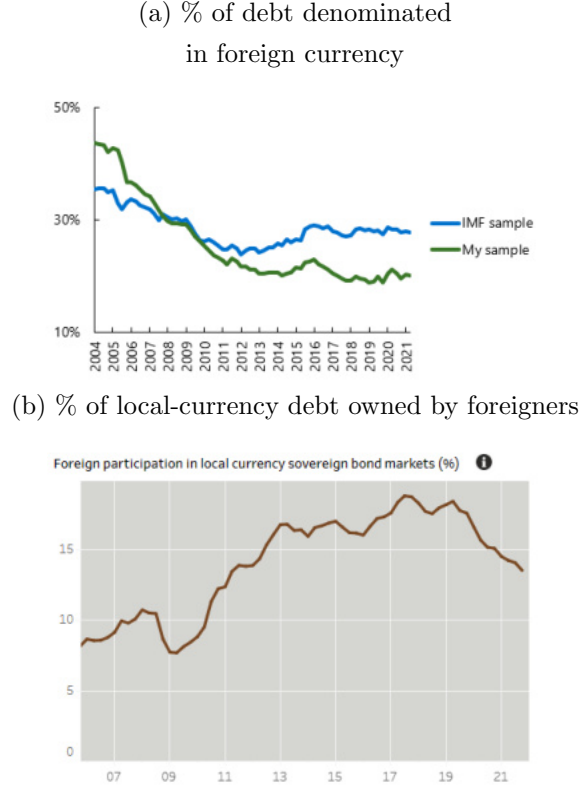
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## Appendix A Trends in EME's Local-Currency Sovereign Bonds

Figure 4 shows an upward trend in the local currency denomination of sovereign debt and an increase in foreign ownership of these bonds. This evidence is consistent with that shown in Du and Schreger (2022) on the currency denomination of sovereign external debt in EMEs.

Figure 4: EME Sovereign Debt, 2004-2021



IMF sample includes Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay, China, India, Indonesia, Malaysia, Philippines, Turkey, Bulgaria, Poland, Hungary, Romania, Egypt, Russia, South Africa, Thailand, and Ukraine.

## Appendix B Proofs of Propositions in Section 2

**Proof of Proposition 1.** This proof is similar to the one in Krishnamurthy and Vissing-Jorgensen (2012). Denote the domestic price level at date  $t$  as  $Q_t$ . If the investor buys a zero-coupon nominal domestic sovereign bond for a price  $P_t^T$ , her real holdings  $\theta_t^T$  rise by  $P_t^T/Q_t$ . The first order condition for this bond holdings is, then,

$$-\frac{P_t^T}{Q_t}u'(C_t) + \beta E_t \left[ \frac{P_{t+1}^T}{Q_{t+1}}u'(C_{t+1}) \right] + \frac{P_t^T}{Q_t}v'(\theta_t^d/\text{GDP}_t^d)u'(C_t) = 0 \quad (36)$$



Define the pricing kernel for nominal payoffs as

$$M_{t+1} = \beta \frac{u'(C_{t+1})}{u'(C_t)} \frac{Q_t}{Q_{t+1}} \quad (37)$$

so that, in the absence of default risk, we would have:

$$P_t^T = E_t[M_{t+1} P_{t+1}^T \Lambda_t^{T,d}] \quad (38)$$

where  $\Lambda_t^{T,d} \equiv 1/(1 - v'(\theta_t^d/\text{GDP}_t^d))$  captures the marginal benefits investor  $d$  derives from these local-currency sovereign bonds of the EME. A positive marginal value of convenience,  $v'(\cdot)$ , raises  $\Lambda_t^{T,d}$ , and therefore raises the price of the bond,  $P_t^T$ .

Suppose that the EME sovereign can default next period with probability  $\pi_t^T$ , and  $L_{t+1}^T$  measures the amount of losses suffered in default (a random variable). If the bond does not default, it is worth  $P_{t+1}^T$ . Then, its price satisfies,

$$P_t^T = \pi_t^T E_t[M_{t+1} \Lambda_t^{T,d} (1 - L_{t+1}^T) | \text{Default}] + (1 - \pi_t^T) E_t[M_{t+1} P_{t+1}^T \Lambda_t^{T,d} | \text{No Default}] \quad (39)$$

For simplicity, assume continuously compounded yields and consider the case of one-period bonds (so  $P_{t+1}^T = 1$ ). Define  $\tilde{L}_{t+1}^T$  as a random variable that is equal to zero if there is no default and equal to  $L_{t+1}^T$  if there is a default. Then, the expression for the price of the bond is

$$\begin{aligned} e^{-y_t^T} = P_t^T &= E_t[M_{t+1} \Lambda_t^{T,d}] - E_t[M_{t+1}] E_t[\tilde{L}_{t+1}^T] - \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^T] - \text{cov}_t[\Lambda_t^{T,d}, \tilde{L}_{t+1}^T] \\ &\approx e^{\lambda_t^{T,d} - \pi_t^T (E_t[L_{t+1}^T] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}]) - \text{cov}_t[\lambda_t^{T,d}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}]} E_t[M_{t+1}] \end{aligned} \quad (40)$$

where  $\lambda_t^{T,d} \approx v'(\theta_t^d/\text{GDP}_t^d)$  and  $\text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}]$  is a risk premium if default events coincide with bad states. Take logs on both sides to get :

$$y_t^T \approx y_t^{rf} - \lambda_t^{T,d} + l_t^T - \xi_t^{T,d} \quad (41)$$

where  $y_t^{rf} = -\log M_{t+1}$  (no arbitrage condition);  $l_t^T = \pi_t^T (E_t[L_{t+1}^T] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}])$  denotes the compensation for default (expected losses plus premium);  $\lambda_t^{T,d}$  is the convenience yield (how much the total yield is reduced because of the marginal services provided by the bond); and  $\xi_t^{T,d} = \text{cov}_t[\lambda_t^{T,d}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}]$  denotes the covariance between default risk and the convenience yield.

The decomposition of the yield of the private asset follows the same logic,

$$y_t^P \approx y_t^{rf} - \lambda_t^{P,d} + l_t^P - \xi_t^{P,d} \quad (42)$$

Take the spread between the two yields of the same maturity to get:

$$y_t^P - y_t^T \approx (\lambda_t^{T,d} - \lambda_t^{P,d}) + (l_t^p - l_t^j) + (\xi_t^{T,d} - \xi_t^{P,d}) \quad (43)$$

□

**Proof of Proposition 2.** Denote the US price level at date  $t$  as  $Q_t^\$$ . If the investor buys a zero-coupon nominal non-Treasury safe U.S. bond for a dollar price  $P_t^{US}$ , her real holdings  $\theta_t^{US}$  rise by  $P_t^{US}/Q_t^\$$ . The first order condition for this bond holdings is then

$$-\frac{P_t^{US}}{Q_t^\$} u'(C_t) + \beta E_t \left[ \frac{P_{t+1}^{US}}{Q_{t+1}^\$} u'(C_{t+1}) \right] + \frac{P_t^{US}}{Q_t^\$} v'(\theta_t^f / \text{GDP}_t^f) u'(C_t) = 0 \quad (44)$$

Define the pricing kernel for nominal payoffs as

$$M_{t+1} = \beta \frac{u'(C_{t+1})}{u'(C_t)} \frac{Q_t^\$}{Q_{t+1}^\$} \quad (45)$$

so that, in the absence of default risk, we would have:

$$\begin{aligned} P_t^{US} &= E_t[M_{t+1} P_{t+1}^{US}] + P_t^{US} v'(\theta_t^f / \text{GDP}_t^f) \Rightarrow \\ P_t^{US} &= E_t[M_{t+1} P_{t+1}^{US} \Lambda_t^{US,f}] \end{aligned} \quad (46)$$

where  $\Lambda_t^{US,f} \equiv 1/(1 - v'(\theta_t^f / \text{GDP}_t^f))$  captures the marginal benefits investor  $f$  derives from these non-Treasury safe bonds. A positive marginal value of convenience,  $v'(\cdot)$ , raises  $\Lambda_t^{US,f}$ , and therefore raises the price of the bond,  $P_t^{US}$ .

To add default risk, suppose that the issuer may default next period with probability  $\pi_t$  and, in default, pays  $1 - L_{t+1}^{US}$ , where  $L_{t+1}^{US}$  measures the amount of losses suffered in default (and is a random variable). If the bond does not default, it is worth  $P_{t+1}^{US}$ . Then, its price satisfies,

$$P_t^{US} = \pi_t E_t[M_{t+1} \Lambda_t^{US,f} (1 - L_{t+1}^{US}) | \text{Default}] + (1 - \pi_t) E_t[M_{t+1} P_{t+1}^{US} \Lambda_t^{US,f} | \text{No Default}] \quad (47)$$

For simplicity, assume continuously compounded yields and consider the case of one-period bonds (so  $P_{t+1}^{US} = 1$ ). Define  $\tilde{L}_{t+1}^{US}$  as a random variable that is equal to zero if there is no default and equal to  $L_{t+1}^{US}$  if there is a default. Then, the expression for the price of the bond is

$$\begin{aligned} e^{-y_t^{US}} &= P_t^{US} = E_t[M_{t+1} \Lambda_t^{US,f}] - E_t[M_{t+1}] E_t[\tilde{L}_{t+1}^{US}] - \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^{US}] - \text{cov}_t[\Lambda_t^{US,f}, \tilde{L}_{t+1}^{US}] \\ &\approx e^{\lambda_t^{US,f} - \pi_t (E_t[L_{t+1}^{US}] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^{US}] / E_t[M_{t+1}]) - \text{cov}_t[\lambda_t^{US,f}, \tilde{L}_{t+1}^{US}] / E_t[M_{t+1}]} E_t[M_{t+1}] \end{aligned} \quad (48)$$

where  $\lambda_t^{US,f} \approx v'(\theta_t^f / \text{GDP}_t^f)$  and  $\text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^{US}] / E_t[M_{t+1}]$  is a risk premium if default events coincide with bad states. Take logs on both sides to get :

$$y_t^{US} \approx y_{rf,t}^{US} - \lambda_t^{US,f} + l_t^{US} - \xi_t^{US,f} \quad (49)$$

where  $y_{rf,t}^{US} = -\log M_{t+1}$  (no arbitrage condition);  $l_t^{US} = \pi_t(E_t[L_{t+1}^{US}] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^{US}]/E_t[M_{t+1}])$  denotes the compensation for default (expected losses plus premium);  $\lambda_t^{US,f}$  is the convenience yield (how much the total yield is reduced because of the marginal services provided by the bond); and  $\xi_t^{US,f} = \text{cov}_t[\lambda_t^{US,f}, \tilde{L}_{t+1}^{US}]/E_t[M_{t+1}]$  denotes the covariance between default risk and the convenience yield.  $\square$

**Proof of Proposition 3.** Again, denote the price level at date  $t$  as  $Q_t^\$$ . Let the price of the EME sovereign bond be  $P_t^T$ . If the investor purchases one unit, her real holdings  $\theta_t^T$  rise by  $P_t^T/Q_t^\$ \times 1/S_t$ , where  $S_t$  is the nominal exchange rate. The first order condition for holdings of the synthetic bond is

$$-\frac{P_t^T}{Q_t^\$} \frac{1}{S_t} u'(C_t) + \beta E_t \left[ \frac{P_{t+1}^T}{Q_{t+1}^\$} \frac{1}{F_{t+1}} u'(C_{t+1}) \right] + \frac{P_t^T}{Q_t^\$} \frac{1}{S_t} v'(\theta_t^f/\text{GDP}_t^f) u'(C_t) = 0 \quad (50)$$

As before, for simplicity, assume one-period bonds, so  $P_{t+1}^T = 1$  and the forward rate is a one-period ahead rate,  $F_{t+1} = F_t^1$ . In the absence of other risks, we would have:

$$\begin{aligned} P_t^T \frac{F_t^1}{S_t} &= E_t[M_{t+1}] + P_t^T \frac{F_t^1}{S_t} v'(\theta_t^f/\text{GDP}_t^f) \Rightarrow \\ P_t^T \frac{F_t^1}{S_t} &= E_t[M_{t+1} \Lambda_t^{T,f}] \end{aligned} \quad (51)$$

where  $\Lambda_t^{T,f} \equiv 1/(1 - v'(\theta_t^f/\text{GDP}_t^f))$  captures the marginal benefits investor  $f$  derives from the bond issued by the EME sovereign.

Recall that the EME sovereign can default next period with probability  $\pi_t^T$ , and  $L_{t+1}^T$  measures the amount of losses suffered in default (a random variable). The synthetic bond faces an additional loss upon default. If the sovereign defaults, the currency hedging becomes imperfect, and the investor  $f$  loses  $L_{t+1}^T$  and still needs to unwind the swap position with unmatched local EME currency cash flows. Regarding positively correlated default and currency risk, the local currency depreciates more upon default than the non-default state. The investor  $f$  holding the synthetic bond has a net long position in dollars in the event of default, corresponding to additional currency gains. As a consequence, in the default state, the bond pays  $[1 - L_{t+1}^T + L_{t+1}^T(1 - F_{t+1}/S_{t+1})]$ .

Du and Schreger (2016) show that the pricing impact of the foreign exchange hedging error,  $L_{t+1}^T(1 - F_{t+1}/S_{t+1})$ , is precisely equal to  $\frac{\text{cov}_t(1 - L_{t+1}^T, 1/S_{t+1})}{E_t(1 - L_{t+1}^T)E_t(1/S_{t+1})}$ . I will denote this term  $q_t^T$  and refer to it as the covariance between default and currency risks.

Analogously, assume that the EME sovereign can enact regulations on local-currency assets with probability  $\tilde{\pi}_t^T$  (for example, capital controls or currency convertibility restrictions), and this event imposes a loss of  $K_{t+1}$  on the investor (a random variable). This loss will also produce a

hedging error in the swap position of the investor, as in the case of default losses. Equivalently, define the bond payoff in the event of capital controls as  $[1 - K_{t+1} + K_{t+1}(1 - F_{t+1}/S_{t+1})]$ . The hedging error term will be exactly equal to  $\frac{\text{cov}_t(1-K_{t+1}/S_{t+1})}{E_t(1-K_{t+1})E_t(1/S_{t+1})}$ , term which I will denote as  $p_t$  and refer to it as the covariance between capital control risk and currency risk.

In the end, the losses in the event of default and regulations impositions are  $L_{t+1}^T - q_t^T$  and  $K_{t+1} - p_t$ , respectively. Define  $\tilde{L}_{t+1}^T$  as a random variable that is equal to zero if there is no default and equal to  $L_{t+1}^T - q_t^T$  if there is a default. Equivalently, define  $\tilde{K}_{t+1}$  as a random variable that is equal to zero if capital controls are not imposed and equal to  $K_{t+1} - p_t$  if they are set. Then, the expression for the price of the synthetic bond is

$$\begin{aligned}
e^{-y_t^T + \rho_t} &= P_t^T \frac{F_{t+1}}{S_t} = E_t[M_{t+1}\Lambda_t^{T,f}] - E_t[M_{t+1}]E_t[\tilde{L}_{t+1}^T] - E_t[M_{t+1}]E_t[\tilde{K}_{t+1}] \\
&\quad - \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^T] - \text{cov}_t[M_{t+1}, \tilde{K}_{t+1}] - \text{cov}_t[\Lambda_t^{T,f}, \tilde{L}_{t+1}^T] - \text{cov}_t[\Lambda_t^{T,f}, \tilde{K}_{t+1}] \\
&\approx e^{\lambda_t^{T,f} - \pi_t^T(E_t[L_{t+1}^T] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}]) + q_t^T - \tilde{\pi}_t^T(E_t[K_{t+1}] + \text{cov}_t[M_{t+1}, \tilde{K}_{t+1}]/E_t[M_{t+1}])} \\
&\quad \times e^{p_t - \text{cov}_t[\Lambda_t^{T,f}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}] - \text{cov}_t[\Lambda_t^{T,f}, \tilde{K}_{t+1}]/E_t[M_{t+1}]} \times E_t[M_{t+1}]
\end{aligned} \tag{52}$$

Taking logs on both sides gives:

$$y_t^T - \rho_t \approx y_{rf,t}^{US} - \lambda_t^{T,f} + (l_t^T - q_t^T) + (k_t - p_t) - \xi_t^{T,f} - \psi_t^{T,f} \tag{53}$$

where  $y_{rf,t}^{US} = -\log M_{t+1}$ ;  $\lambda_t^{T,f} \approx v'(\theta_t^f/\text{GDP}_t^f)$  is the convenience yield on the local-currency bond;  $l_t^T = \pi_t^T(E_t[L_{t+1}^T] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}])$  and  $k_t = \tilde{\pi}_t^T(E_t[K_{t+1}] + \text{cov}_t[M_{t+1}, \tilde{K}_{t+1}]/E_t[M_{t+1}])$  are the extra yield demanded for default and regulatory losses; and  $\xi_t^{T,f} = \text{cov}_t[\Lambda_t^{T,f}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}]$  and  $\psi_t^{T,f} = \text{cov}_t[\Lambda_t^{T,f}, \tilde{K}_{t+1}]/E_t[M_{t+1}]$  are the covariances of the convenience yield with default risk and regulatory risk, respectively.  $\square$

**Proof of Proposition 4.** Following the same reasoning as in the two previous proofs, the price of an EME sovereign bond issued offshore in dollars,  $\hat{P}_t^T$ , is given by:

$$\hat{P}_t^T = E_t[M_{t+1}\hat{P}_{t+1}^T]\hat{\Lambda}_t^{T,f} \tag{54}$$

Assume the local government can default on this bond with probability  $\hat{\pi}_t^T$ , imposing a loss of  $\hat{L}_{t+1}^T$  on the investor. In this case,  $\tilde{L}_{t+1}^T$  is a random variable taking the value  $\hat{L}_{t+1}^T$  in the case of default and zero otherwise. However, since the bond is issued in dollars and offshore, the government cannot impose capital controls or currency convertibility restrictions. Therefore, assuming again one-period bonds and continuous compounding, the price is given by

$$\begin{aligned}
e^{-\hat{y}_t^T} &= \hat{P}_t^T = E_t[M_{t+1}\hat{\Lambda}_t^{T,f}] - E_t[M_{t+1}]E_t[\tilde{L}_{t+1}^T] - \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^T] - \text{cov}_t[\hat{\Lambda}_t^{T,f}, \tilde{L}_{t+1}^T] \\
&\approx e^{\hat{\lambda}_t^{T,f} - \hat{\pi}_t^T(E_t[\hat{L}_{t+1}^T] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}]) - \text{cov}_t[\hat{\Lambda}_t^{T,f}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}]} E_t[M_{t+1}]
\end{aligned} \tag{55}$$

Taking logs on both sides gives:

$$\hat{y}_t^T \approx y_{rf,t}^{US} - \hat{\lambda}_t^{T,f} + \tilde{l}_t^T \quad (56)$$

where variables have the same interpretation as in the previous two proofs. Now, define  $\Phi_t^{FC}$  as the spread between the yield of the synthetic bond (Equation (53)) and the yield on the foreign currency-denominated bond (Equation (56)). Then,

$$\begin{aligned} \Phi_t^{FC} &\equiv y_t^T - \rho_t - \hat{y}_t^T \\ &\approx (y_{rf,t}^{US} - \lambda_t^{T,f} + (l_t^T - q_t^T) + (k_t - p_t) - \xi_t^{T,f} - \psi_t^{T,f}) - (y_{rf,t}^{US} - \hat{\lambda}_t^{T,f} + \tilde{l}_t^T) \\ &= (\hat{\lambda}_t^{T,f} - \lambda_t^{T,f}) + (l_t^T - \tilde{l}_t^T - q_t^T) + (k_t - p_t) - \xi_t^{T,f} - \psi_t^{T,f} \end{aligned} \quad (57)$$

□

## Appendix C Data Sources

Recall from the main text the expression for the dollar-investor convenience yield:

$$\lambda_t^{T,f} - \lambda_t^{US,f} = y_t^{US} - (y_t^T - \rho_t) + (l_t^T - l_t^{US}) + \Phi_t^{FC} - \tau_t + (\xi_t^{US,f} - \xi_t^{FC,f}) \quad (58)$$

The sources for each component are the following:

**Bond yields and forward premia.** I used data from the Resolution Funding Corporation (Refcorp) bonds for various maturities for yields of non-Treasury-safe dollar bonds. As suggested by Longstaff (2004), Refcorp bonds are effectively guaranteed by the U.S. government and are subject to the same taxation, but are not as liquid as Treasuries. As in Longstaff (2004), I measured the yields by taking the differences between the constant maturity on the Bloomberg Fair Value curves for Refcorp zero-coupon bonds. Maturities available are 6-month, 1-, 2-, 3-, 4-, 5-, 7-, 10-, and 20-year. For robustness, I also used the yields for Aaa corporate bonds, which Krishnamurthy and Vissing-Jorgensen (2012) argued have very low default rates but are not as liquid as Treasuries. Data on these corporate bond spreads are available in FRED but only provide a 20-year maturity benchmark. All these sources also include data on yields for U.S. treasuries, which I use in Appendix D.

The other two yields for non-Treasury safe dollar bonds correspond to the ICE Bank of America AAA and BBB US Corporate Index. These track the performance of US dollar-denominated corporate debt issued in the US domestic market, with AAA and BBB credit ratings, respectively. They include all maturities greater than one year. The series were retrieved from FRED, Federal Reserve Bank of St. Louis.

The value of the forward premium for each country was taken from the database of Du et al. (2018). The authors provided estimations of CIP deviations of sovereign bonds for ten developed

and 18 developing countries to U.S. Treasuries. The data are at a daily frequency between approximately 2000 and March 9, 2021, although the start date varied among countries. Data are available for maturities at 3-months, 1-, 2-, 3-, 5- and 10-years.

I focused on their observations of developing countries. Their bond yields data came from Bloomberg and Thomson Reuters. Since forward contracts are, in general, not very liquid, they computed  $\rho_{i,t}$  from a hedging strategy involving interest rate swaps and cross-currency swaps, according to the formula  $\rho_{i,n,t} = irs_{i,n,t} + bs_{i,n,t} - irs_{US,n,t}$ .  $irs_{i,n,t}$  is the  $n$ -year interest rate swap for exchanging fixed currency  $i$  cash flows into the floating interbank rate benchmark in country  $i$ .  $bs_{i,n,t}$  is the  $n$ -year cross-currency basis swap rate for exchanging the floating benchmark interbank rate in country  $i$  for the U.S. Libor rate, and  $irs_{US,n,t}$  is the  $n$ -year U.S. Libor swap rate for exchanging fixed dollar cash flows into the U.S. Libor rate. The combination of these three swaps eliminates all floating cash flows. At the inception and maturity of the swap, only fixed cash flows remain between local currency and U.S. dollars, which exactly replicates an  $n$ -term forward contract.

**Default risk differentials** ( $l_t^{US} - l_t^T$ ). I proxied  $l_{i,t}$  with data on CDS spreads. I obtained the CDS spread series for EMEs' sovereign bonds of different maturities from Bloomberg at a daily frequency. However, some caveats apply. First, I used the CDS spreads for foreign-currency debt, as their data are more widely available and show greater liquidity than local-currency CDS. Therefore, I assumed that the risk of default on foreign-currency debt also applies to local-currency bonds. As discussed in Du and Schreger (2016), this assumption is not much different from reality as default events in EMEs since the late 1990s show that the incidence of default on domestic-currency debt is comparable with the incidence of external foreign-currency defaults.

**Spread between swapped local-currency bond and foreign-currency bond** ( $\Phi_t^{FC}$ ). I used the data from Du and Schreger (2016). For  $y_t^{FC}$ , I used the Bloomberg Fair Value curves (BFV) for the prices of foreign-currency sovereign bonds for each EME. These are at par yield curves, so they must be adjusted to represent zero-coupon yields. BFV prices are not available for some of the countries. In those cases, I estimated prices by collecting data for each bond and computing the overall zero-coupon yield curve using the methodology of Nelson and Siegel (1987).

**Liquidity risk of forwards contracts** ( $\tau_t$ ).  $\tau_t$  is measured as half the bid-ask spread of each cross-currency swap. Daily data is available on Bloomberg. For Brazil, Colombia, Indonesia, Peru, Philippines, and Turkey, the cross-currency swap is the non-deliverable swap between the fixed local rate and the floating U.S. Libor. For Chile, Mexico, and South Africa, it corresponds to the bid-ask spread of the interest rate swap used to construct the cross-currency swap in Du and Schreger (2016).

**Domestic convenience yield** The yield on the 1-year local-currency sovereign bond comes from the dataset in Du et al. (2018). The private local-currency domestic assets used for each country are listed in Table 7. All yields are for the 1-year maturity except for Mexico, where only

the 9-month maturity was available.

Table 7: Private local-currency domestic assets

Country	Asset	Bloomberg ticker
Chile	Nominal average interbank rate 360 days	CLTN360N
Colombia	Time deposits of banks yield curve	COMM1YR
Indonesia	Unsecured interbank loan	JIN12M
Mexico	Certificate of Deposits 9 month	MPDRI
South Africa	Interbank agreed rate 12 month	JIBA12M
Turkey	Interbank unsecured loan	TRLXB1Y

## Appendix D Robustness for estimation of Section 2.1.1

I describe some financial frictions and prominent features in the markets for EMEs' local-currency government bonds. I address how these issues may affect my estimate of the local-currency convenience yield and propose some robustness checks when applicable.

### D.1 The role of regulatory risk

As explained in the main text, local-currency bonds in EMEs carry the risk of the local government imposing capital controls, taxes on outflows, or currency convertibility restrictions. The term  $\Phi_t^{FC,i}$  in Equation (11) intends to account for the risk by taking the spread between sovereign bonds issued under international vs. domestic law. The former does not give as much regulatory freedom to the EME government; therefore, this spread should account for most of these regulatory risks.

In this subsection, I want to provide an idea of how relevant this adjustment is by using the example of Brazil. Figure 5 plots the time series of  $\Phi_t^{FC,i}$  for the period 2010-2021.

Recall from Equation (10) that this spread will be larger: (1) the larger the domestic regulatory risk ( $k_t^j$ ), and (2) the lower the covariance between default and regulatory risk and currency risk ( $q_t^j$  and  $p_t^j$ ). The spread is positive and large at the beginning of the sample. Importantly, this period coincides with the Brazilian government's imposition of capital outflow taxes. In October 2009, the government introduced a tax on financial transactions (the IOF) of 2% on foreign investment in fixed-income instruments. In 2010, the tax was raised to 4 and then to 6%, and stayed at that level until it was abandoned in June 2013. Consistent with this timing, the spread  $\Phi_t^{FC,i}$  moved around 200-500 basis points. A negative value of this spread (relevant after 2016) means that the positive

Figure 5: Local vs. Foreign jurisdiction spread for Brazil



Notes: The Figure shows the spread between the swapped local-currency sovereign bond and the foreign-currency-denominated bond.

covariance of currency risk with other risks is more significant than the risk of capital controls and other regulations.

## D.2 Eurobonds

Eurobonds are securities denominated in a different currency than the local one of the country where the bond is being issued (despite their name, they are not necessarily bonds issued in Europe or in euros). EME sovereigns frequently issue Eurobonds, which usually correspond to sovereign bonds issued in international markets in the EME's local currency.

Importantly, these bonds are governed under international law, settled in U.S. dollars, and therefore free of capital control, convertibility restrictions, and other regulatory risks imposed by the EME government. Equation (11) in Section 2.1 measures the convenience yield for local-currency bonds issued under *domestic* law, and that is the reason it corrects for the risk of capital controls and other regulatory risks imposed by the local government. However, this correction is unsuitable for Eurobonds, and Equation (11) overstates the magnitude of the local-currency convenience yield if a country issues most of its local-currency debt via Eurobonds.

Although I don't have a precise breakdown of Eurobonds on the total local currency sovereign debt outstanding, I use the International Debt Securities (IDS) database from the Bank of Inter-



national Settlements to get an estimate of the prevalence of Eurobonds in local-currency sovereign debt in EMEs. The IDS reports the outstanding government bonds issued in international markets in local currency. Although it doesn't distinguish between foreign and domestic law, it still serves as a proxy for the amount of local currency bonds governed by foreign law.

Table 8 shows the percentage of outstanding local currency government bonds issued in international markets according to IDS over the total amount of outstanding local currency bonds issued in all markets. Data is available for only 5 of the nine countries in my sample.

Table 8: Share of total LC-bonds outstanding issued in international markets

Country	Mean	Max
Brazil	0.5%	0.9% (Dec. 2007)
Chile	2.4%	4.8% (Dec. 2021)
Colombia	3.6%	6.1% (Dec. 2007)
Peru	35.4%	47.5% (Dec. 2019)
Philippines	3.3%	4.3% (Dec. 2021)

Notes: annual frequency for 2004-2021.  
Share calculated with outstanding values at the end of each year. Column 3 shows the year in which the maximum share was achieved.

Overall, only Peru has a significant amount of outstanding local-currency bonds issued in international markets as a proportion of total local-currency debt. Brazil has less than 1% of the total, while Chile, Colombia, and the Philippines move around only 3% of the whole. Even if all these local-currency bonds are governed by foreign law, that still would represent a minimal percentage with the only exception of Peru. However, Peru has no capital controls on foreign investments during the period considered.

### D.3 Market segmentation

Another potential issue with Equation (11) in Section 2.1 would be that the market for EME sovereign bonds is segmented. Here, I consider two possible segmentation dimensions: foreign vs. local investors and local-currency bonds issued under international vs. domestic law.

Regarding the first dimension, if local investors are the only holders of local-currency sovereign bonds while foreign investors only hold sovereign bonds denominated in foreign currency, the spread in Equation (11) would be misleading. The reason is that the two bonds would have two different marginal investors.

Recently published data by the BIS shows that this is not the case for sovereign bonds in EMEs in general and for the countries in my sample in particular (Onen et al., 2023). This database provides a breakdown of government bonds (with maturity over one year), currency denomination, and foreign/local investor ownership. In Table 9, I report two statistics for the nine countries in my sample. Column 1 shows the average share of all local-currency government bonds that foreign investors own. Column 2 shows the percentage of local-currency bonds in foreign investors' portfolios. Both averages are calculated from 2005 to 2021 at the quarterly frequency.

Table 9: Share of total LC-bonds owned by foreigners

Country	$\frac{\text{LC owned by foreigners}}{\text{Total LC bonds}}$	$\frac{\text{LC owned by foreigners}}{\text{Total foreigners portfolio}}$
Brazil	8%	65%
Chile	9%	29%
Colombia	16%	36%
Indonesia	27%	49%
Mexico	24%	51%
Peru	40%	36%
South Africa	27%	71%
Turkey	16%	42%

Notes: quarterly frequency for 2005-2021. Data comes from the BIS (Onen et al., 2023) and only considers bonds with one year or more maturity.

Table 9 shows no signs of market segmentation in local-currency bonds. Foreigners own a sizable share of these bonds, representing a significant share of their portfolio of EMEs. This is especially clear in the case of Brazil and Chile, where, although foreigners own less than ten percent of local currency bonds, they still are a relevant component of foreigners' investment in these countries. The time series (not captured in this table) shows an upward trend until the mid-2010s, with a drop afterward for most countries. Moreover, this share is also sizable when taken over the overall portfolio of foreign investors.

A second dimension of market segmentation can arise between local-currency bonds issued under international and domestic law. In this case, it might be that all the share of local-currency government bonds owned by foreigners correspond to bonds governed by international law (Eurobonds), while local investors own only the bonds issued under domestic law. Again, evidence does not show this to be the case. Onen et al. (2023) show that most of the increase in foreign ownership of local-currency sovereign bonds in the past two decades has come from foreigners increasingly participating in the *domestic* market.

## Appendix E Analysis of the U.S. Treasury Premium

I discuss the evidence for the differential convenience yield of U.S. Treasuries against EME sovereign bonds and compare it with the results for G10 countries shown in Du et al. (2018). I calculate the components of Equation (11) in the main text, but this time using the U.S. Treasury as the dollar bond. In this case, the term  $\lambda_t^{US,i} - \lambda_t^{j,i}$  corresponds to the U.S. Treasury premium (how much investors pay for the safety/liquidity of U.S. Treasuries against EME local-currency bonds).  $y_t^{US} - y_t^j - \rho_{jt}$  corresponds to the CIP deviation between the two sovereign bonds. Figure 6 compares the evolution of CIP deviations and two components: differential default risk and the U.S. Treasury premium.

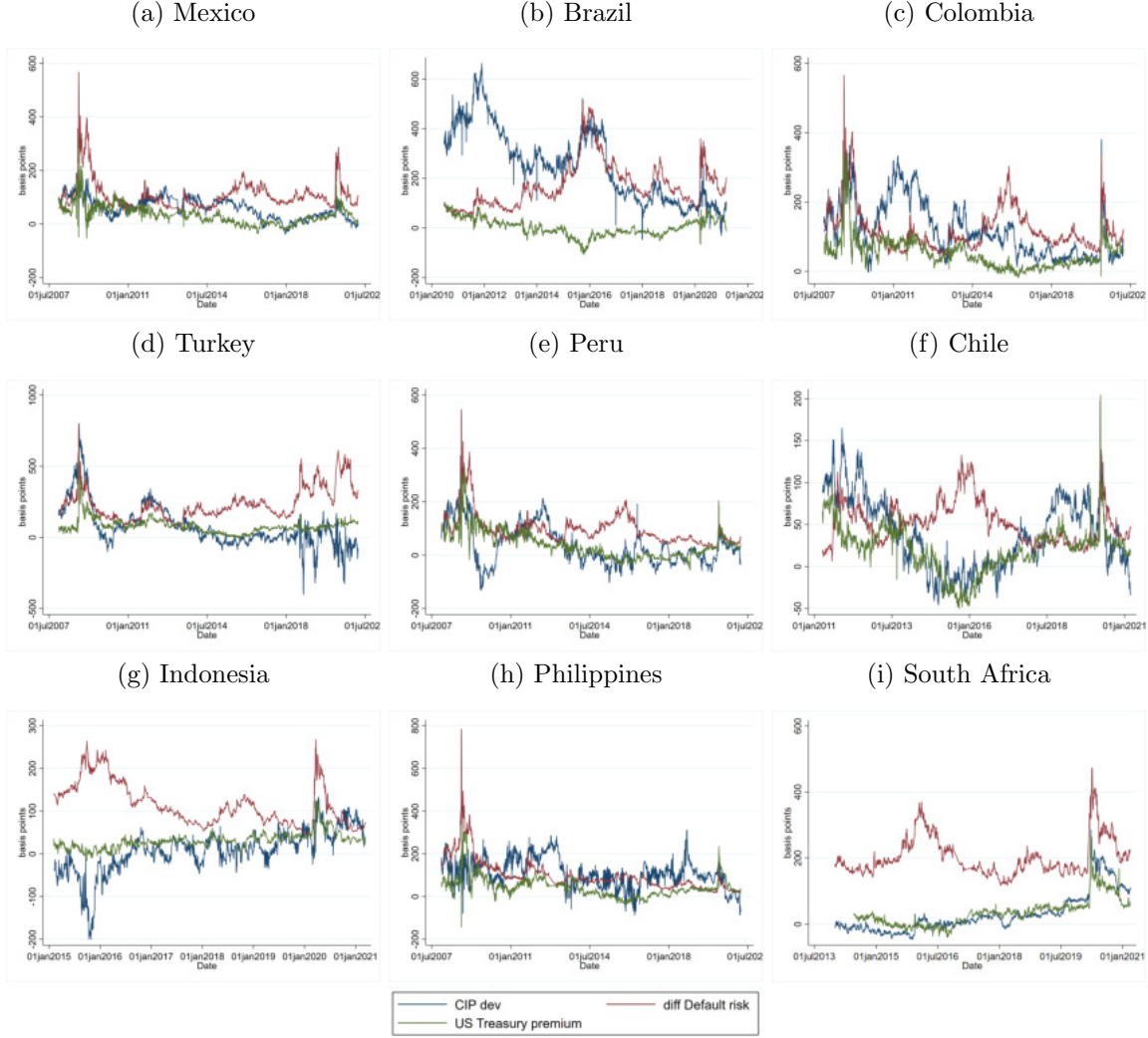
CIP deviations spiked during crises (i.e., in 2008 and 2020), which was driven by an increase in differential default risk and the U.S. Treasury premium. The increase in the U.S. Treasury premium aligns with intuition: During financial distress, investors prefer the liquidity and safety of U.S. Treasuries. After 2008, the U.S. Treasury premium steadily declined until 2015-2016. This means that during this period, investors were willing to pay a lower premium for the safety and liquidity of U.S. government debt versus comparable debt of EMEs. This premium then increased again until the end of the sample.

These patterns starkly contrast with the G10 counterparts Du et al. (2018) estimated. In that paper, the authors showed that the U.S. Treasury premium for long maturities became consistently negative after 2010, meaning that investors were no longer willing to pay an extra price for the safety and liquidity of U.S. Treasuries compared to the sovereign bonds of the G10 countries. Based on this result, some authors have cast doubt on the safety status of long-term U.S. Treasuries. Figure 6 shows that this is not the case for EMEs. U.S. Treasuries are still considered a safe asset compared to their EME counterparts.

Surprisingly, CIP deviations outside of financial crises closely followed the U.S. Treasury premium dynamics -and not the dynamics of default risk- for Mexico, Colombia, Peru, Chile, Indonesia, and South Africa. In these countries, even though differential credit risk significantly increased in 2015-16, CIP deviations decreased, following the dynamics of the U.S. Treasury premium. This is surprising as research on EMEs has predominantly focused on the determinants of default risk, not convenience yields. One final note of caution is needed for Turkey in 2018-2019. The series for CIP deviations became very noisy and turned negative. These were years of severe capital outflows and recession in Turkey, and the negative values of the CIP deviation likely arose because of market segmentation, in which only local investors predominantly hold local-currency sovereign bonds.

The role of capital control risk (absent in Du et al., 2018) can be seen in Figure 6 by the vertical distance between the CIP deviation (blue line) and the two components shown (red and green lines). This was accounted for by the sum of the capital control risk term plus the covariances term Equation (9). Two episodes in the data stand out: Brazil during 2010-2014 and Colombia

Figure 6: CIP Deviation and Components, 5-Year Local-Currency Sovereign Bonds



soon after 2010. In the case of Brazil, the government imposed a tax on financial transactions in October 2009 to curb portfolio investment flows and cross-border derivative trading. Still, the tax was lifted in June 2013.

## Appendix F Robustness for Section 3

### F.1 Credit risk as the dependent variable

Suppose my decomposition of CIP deviations in Section 2 successfully disentangled differential default risk from differential convenience yields. In that case, default risk should respond differently to the determinants of convenience yields analyzed in Section 3.

Table 10 replicates the regressions in Section 3 but with the CDS for each country and time

as the dependent variable. The larger number of observations is because I had data for CDS spreads for a few more countries than I had convenience yield estimates. Unlike the EME local-currency convenience yield, credit risk was unaffected by relative safe asset supply, suggesting that the convenience yield accurately captures the demand for safety and liquidity. The local monetary policy rate level increased credit risk since it likely increased the cost of servicing the debt. The VIX index also positively impacted credit risk, which is consistent with intuition. Interestingly, debt inflows to government debt significantly reduced credit risk, which is expected as foreigners' buying local debt increases the chance of repayment. The same happened with inflows into bank debt, which is consistent with sovereign debt being mostly held by banks in EMEs. Overall, this evidence suggests that the decomposition of CIP deviations in Section 2 accurately distinguished between credit risk and convenience yields.

## F.2 Shorter sample

As a second robustness test, I re-ran the regressions in Section 3 with a shorter sample that did not include the 2008 financial crisis and the 2020 pandemic crisis. In particular, I replicated the regression with the sample starting in September 2009 and ending in December 2019. The goal was to confirm that results in Section 3 were not driven by these two crises and the possible mispricing of EME assets during those two events.

Table 11 shows that results remain in this shorter sample. EME local-currency convenience yields increased when the local interest rate increased, and a larger relative supply of safe assets significantly reduced the convenience yield. The main difference is that the VIX index was insignificant. The absence of any global risk aversion episode in this period likely explains this result. The only exception could have been the Euro crisis in 2011-2012, but this event did not evolve into a global crisis like the 2008 or 2020 crises. Column 4 tests for the robustness of the procyclicality of the local-currency convenience yield.

Table 10: Determinants of Credit Risk (5-Year Sovereign Bond)

Dep. var: $cds_{i,t}$	(1)	(2)	(3)	(4)	(5)
MP rate $_{t-1}$	11.94*** (1.410)	11.48*** (1.377)	11.65*** (1.404)	11.70*** (1.413)	6.214*** (1.924)
$\log(\frac{\text{US debt to GDP}}{\text{Debt to GDP}})_{t-1}$	-8.027 (16.09)	-4.336 (14.86)	-8.776 (16.37)	-9.849 (16.47)	-30.78** (12.11)
US fed funds $_{t-1}$	-14.66** (7.115)	-11.31 (7.349)	-13.86* (7.149)	-14.09* (7.177)	-11.77 (7.894)
vix $_{t-1}$	4.575*** (0.420)	4.352*** (0.456)	4.429*** (0.421)	4.339*** (0.442)	4.271*** (0.520)
$(\frac{DebtInfl}{GDP})_{t-1}$		-26.84*** (6.746)			-21.75*** (7.064)
$(\frac{EqInfl}{GDP})_{t-1}$		-30.39* (15.58)			-13.49 (14.77)
$(\frac{GovdebtInfl}{GDP})_{t-1}$			-6.065* (3.167)	-6.690** (3.198)	
$(\frac{BankdebtInfl}{GDP})_{t-1}$			-8.105** (3.154)	-7.921** (3.151)	
$(\frac{CorpdebtInfl}{GDP})_{t-1}$			-3.961* (2.142)	-3.982* (2.121)	
Terms of Trade				-241.4 (189.7)	-196.4 (165.3)
Diff. Inflation					8.440*** (2.229)
Democratic risk					-1.152 (7.117)
Constant	-1.286 (88.08)	-28.20 (86.53)	-7.972 (91.53)	1,110 (875.5)	1,058 (746.5)
Observations	1,338	1,338	1,338	1,338	1,213
R-squared	0.689	0.702	0.698	0.700	0.734

Notes: see Table 3. All columns include country and year-fixed effects. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 11: Determinants of Convenience Yields (Shorter Sample)

Dep. var: $cy_{i,t}$	(1)	(2)	(3)	(4)
MP rate $_{t-1}$	1.179** (0.515)	1.210** (0.511)	1.140** (0.525)	1.078* (0.548)
$\log(\frac{\text{US debt to GDP}}{\text{Debt to GDP}})_{t-1}$	-16.71** (8.318)	-17.42** (8.076)	-16.95** (8.155)	-11.27 (11.85)
US fed funds $_{t-1}$	-6.322* (3.582)	-6.923* (3.660)	-5.395 (3.593)	-7.775* (4.079)
vix $_{t-1}$	-0.0180 (0.264)	-0.0425 (0.250)	-0.0436 (0.263)	0.0223 (0.318)
$(\frac{DebtInfl}{GDP})_{t-1}$		2.768 (2.471)		
$(\frac{EqInfl}{GDP})_{t-1}$		6.451 (9.754)		
$(\frac{GovdebtInfl}{GDP})_{t-1}$			-0.706 (1.446)	
$(\frac{BankdebtInfl}{GDP})_{t-1}$			-2.173 (1.479)	
$(\frac{CorpdebtInfl}{GDP})_{t-1}$			1.596** (0.718)	
Output gap				6.659** (3.219)
Constant	98.06** (42.77)	102.9** (41.31)	98.58** (41.93)	83.33 (58.90)
Observations	979	979	979	729
R-squared	0.726	0.728	0.730	0.749

Notes: see Table 3. All columns include country and year-fixed effects.

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1