Safe Assets in Emerging Market Economies

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This version: May 24, 2024
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Abstract

I examine whether local-currency sovereign bonds in emerging markets (EMEs) serve as safe assets by estimating convenience yields attributed to their safety and liquidity. Analyzing a sample of 9 middle-income EMEs, I estimate a significant convenience yield from the perspective of a global and a domestic investor. Notably, unlike U.S. Treasuries, global investors' convenience yield diminishes during periods of heightened global uncertainty. Investigating exogenous shocks (the Taper Tantrum and Covid-19), I find that the drop in convenience yield isn't due to increased credit risk or risk aversion but rather a shift in investor preference towards global safe assets, resembling a loss of safe asset status. I develop a model of a small open economy featuring both foreign and local sovereign bonds earning convenience yields as collateral. The model illustrates the effect of a shock to the demand for safety and its impact on EME volatility.

JEL Codes: E43, F30, G12.
Keywords: convenience yields, sovereign bonds, emerging markets.

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1 Introduction

The conventional view on emerging markets contends that capital flows are driven by yield-oriented investors that respond to interest rate differentials with the U.S. However, investors may not only consider the yield of a bond but also might derive non-pecuniary benefits from their liquidity and safety. The value assigned to these benefits, known as the "convenience yield," determines the attractiveness of assets often referred to as "safe assets." While there is substantial evidence of convenience yields on sovereign bonds in advanced economies, it remains unclear whether emerging market economies (EMEs) share this characteristic. Over the past two decades, EME governments have deepened their local currency bond markets and improved their credit ratings significantly, and local currency debt now represents the lion's share of outstanding sovereign bonds in EMEs (BIS, 2020). This prompts the question: do local-currency sovereign bonds in EMEs hold the same safe asset status within their local economies? This paper is the first attempt to estimate convenience yields of local-currency sovereign bonds across nine middle-income EMEs, contrasting them with advanced economies and examining their implications for macroeconomic dynamics.

Krishnamurthy and Vissing-Jorgensen (2012) quantified the convenience yield for U.S. Treasuries relative to comparable dollar assets. This safe asset status influences equilibrium interest rates, expands government fiscal capacity, and acts as a transmission channel for large-scale central bank asset purchases[1] This paper underscores that, in emerging markets, government bonds can function as local safe assets, albeit competing with other global sources of safety. Recent work by Kekre and Lenel (2021) suggests that shifts in safety/liquidity demand contributes significantly to output volatility, both in the U.S. and globally. It's crucial to note that being deemed a safe asset doesn't necessitate (near) zero default or liquidity risk, a condition not met in emerging economies. Rather, it requires lower risk compared to alternatives, and investors with a special demand for this lower risk.

The convenience yields I will estimate may stem from safety or liquidity services, two distinct yet intertwined concepts. Liquidity pertains to the ease of selling assets for cash, while safety refers to an asset's valuation at face value without extensive analysis (Gorton, 2017). Safe assets typically exhibit high liquidity, and liquid assets tend to be safe, complicating empirical disentanglement, especially in EMEs due to data constraints compared to the U.S.

In the first part of the paper, I estimate the convenience yield of EME local-currency sovereign bonds. I construct a simple asset pricing model accommodating convenience assets with varying credit risks, assets denominated in different currencies, and two investor types. The first type resembles a domestic investor, who (1) compares the local-currency sovereign bond to a domestic private local-currency asset with similar maturity but lacking equivalent safety and liquidity

[1] See Del Negro et al. (2017a), Lenel et al. (2019), Jiang et al. (2022), Krishnamurthy and Vissing-Jorgensen (2011).

services, such as a term deposit; and (2) measures her returns in the domestic currency. As shown in Krishnamurthy and Vissing-Jorgensen (2012), the spread between these assets gauges the safety/liquidity premium on the local-currency sovereign bond. Reliable daily data on domestic private local-currency assets is available for shorter maturities, which I match against corresponding local-currency sovereign bonds.

The second estimation adopts the perspective of a global investor. This estimate is relevant as foreign investors have increased their participation in EME local-currency sovereign bonds in recent years[2]. I assume an international investor (1) decides on a portfolio of assets in domestic and foreign currency and (2) measures her returns in dollars. I assume this investor can access a synthetic dollar bond (a local-currency EME sovereign bond with its cash flows swapped into dollars via a forward contract) 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, Im, and Schreger (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, (4) frictions in swap and forward currency markets, and (5) the differential convenience yield. After accounting for the first four, I obtain the latter as a residual. Data is available for nine EMEs, and I consider assets with 5-year maturity.

The analysis reveals a significant convenience yield for EME local-currency sovereign bonds, robust across the two measures. The dollar measure indicates an average of nearly 30 basis points, while the domestic measure yields a higher average of 59 basis points. Furthermore, I characterize the dynamics of 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; and decreasing 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, which is driven by global risk appetite. Notably, both measures of the convenience yield have different responses. 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 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 global-investor convenience yield increased amid scarcer liquidity during the Taper Tantrum, it significantly dropped

[2]See Onen, Shin, and von Peter (2023) and Du and Schreger (2022).

against the flight to safety in March 2020. Surprisingly, this drop was not mechanically driven by the rise in credit risk or higher risk aversion but by a switch in investors' preferences away from EME bonds, akin to a loss of safe asset status.

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.

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: an increase in U.S. households' demand for collateral to smooth consumption, coupled with an increase in the collateral quality of the U.S. sovereign bond. The convenience yield of the EME sovereign bond resembles the global investors' convenience yield of the empirical section of the paper. 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. The collateral value of the local sovereign bond makes local yields 20% less volatile, but local interest rates are 10% more volatile than a country where the convenience yield increases against a safety shock. In addition, safety shocks explain more than 4% 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).

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; Nagel, 2016) and against sovereign bonds of other advanced countries (Du, Im, and Schreger, 2018; Jiang et al., 2021). This paper is the first attempt to apply this empirical work to pricing local-currency sovereign bonds in emerging markets. Indeed, going beyond advanced economies can help us to better understand the determinants and the role of safe assets.

Convenience yields have been shown to be important in explaining exchange rate levels and puzzles (Engel, 2016; Jiang, Krishnamurthy, & Lustig, 2021; Engel & Wu, 2023); can lower equilibrium interest rates (Del Negro et al., 2017a); can increase the government's fiscal capacity (Jiang et al., 2022); and are a channel for the effectiveness of large scale asset purchases (Krishnamurthy and Vissing-Jorgensen, 2011; Del Negro et al, 2017b). Moreover, they are a relevant driver of global capital flows in Jiang, Krishnamurthy & Lustig (2019) and Kekre & Lenel (2021).

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. In addition, I provide a model to understand the differences with advanced economies and analyze the implications for macroeconomic variables.

This paper also relates to the literature on 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 given and analyze its pricing by domestic and global investors.

This paper also adds to recent studies of the drivers of capital inflows to EMEs. While the conventional view assumes yield-oriented investors that respond to interest rate differentials with the U.S., recent papers have found a role for spillovers in risk perceptions (Kalemli-Ozcan, 2019; Kalemli-Ozcan & Varela, 2023). This paper complements this view, and the convenience yields I estimate can be thought of as one component of the risk perceptions studied in Kalemli-Ozcan (2019). In particular, a drop in the dollar convenience yield increases the risk premia attached to EMEs' sovereign bonds.

The model is a setting where sovereign bonds earn a convenience yield from their use as collateral when borrowing is constrained. A full quantitative version of this framework can be found in Devereux, Engel, & Wu (2023) and Mendoza & Quadrini (2023). Here, I develop a version for a small open economy and choose to keep the model purposefully simple by relying on flexible prices and abstracting from modeling financial intermediaries. The model is an extension to previous well-known real small open economy models that had not introduced a role for safe assets (for example, Uribe & Yue, 2006; Mendoza, 2010; Farhi & Werning, 2012).

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

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

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, θ_t^i. The assets that enter into θ_t^i will be specified later for each investor type. The agent's income is 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, 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 GDP_t^i and θ_t^i. Thus define $v(\frac{\theta_t^i}{\mathrm{GDP}_t^i})\mathrm{GDP}_t^i \equiv \nu(\theta_t^i, \mathrm{GDP}_t^i)$. Assume that the convenience function is increasing in $\theta_t^i/\mathrm{GDP}_t^i$, but the marginal convenience benefit is decreasing in $\theta_t^i/\mathrm{GDP}_t^i$, and $\lim_{\theta_t^i/\mathrm{GDP}_t^i\to\infty} v'(\theta_t^i/\mathrm{GDP}_t^i) = 0$.

The Euler equation for holdings of a convenience asset, θ_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 Λ_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:

$$\theta_t^d = \theta_t^M + \kappa_t^{T,d}\theta_t^T + \kappa_t^{P,d}\theta_t^P \tag{2}$$

where θ_t^M, θ_t^T, and θ_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 $\kappa^{P,d}$ 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 $\kappa^{P,d}$ 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:*

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

where $\lambda_t^{T,d}$ measures the marginal safety/liquidity services the domestic investor (d) derives from the sovereign bond (the convenience yield), $\lambda_t^{T,d} \approx \kappa_t^{T,d}v'(\theta_t^d/GDP_t^d)$, and $\lambda_t^{P,d} \approx \kappa_t^{P,d}v'(\theta_t^d/GDP_t^d)$; 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:

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

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).

In the 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 or unsecured interbank term loans, which I compare with 1-year local-currency sovereign bonds. Term 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 not collateralized, and thus spreads that use these assets will measure a mix of a safety and a liquidity 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:

$$\theta_t^f = \theta_t^{\$M} + \kappa_t^{T,f}\theta_t^T + \kappa_t^{US,f}\theta_t^{US} \tag{5}$$

where $\theta_t^{\$M}$ correspond to money and near-money assets such as U.S. Treasuries; θ_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; θ_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 θ_t^{US} and θ_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:*

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

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, $\rho_t = logF_{t+1} - logS_t$, 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:

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

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; $l_t^T - q_t$ 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.

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

$$
\begin{aligned}
\underbrace{y_t^{US} - (y_t^T - \rho_t)}_{\text{Spread}} = & \underbrace{\lambda_t^{T,f} - \lambda_t^{US,f}}_{\text{Diff. Convenience yield}} \\
& + \underbrace{(l_t^{US} - l_t^T)}_{\text{Differential default risk}} - \underbrace{k_t}_{\text{Regulatory risk}} + \underbrace{(q_t^T + p_t + (\xi_t^{T,f} - \xi_t^{US,f}) + \psi_t^{T,f})}_{\text{Covariances}}
\end{aligned}
\tag{8}
$$

If the CIP condition holds for risk-free rates, then $y_{rf,t} - \rho_t = y_{rf,t}^{US}$. In this case, the dollar convenience yield on local-currency sovereign bonds of EMEs, which is a *differential* convenience yield, corresponds to:

$$
\begin{aligned}
CY_t^f \equiv & \lambda_t^{T,f} - \lambda_t^{US,f} \\
= & (\kappa_t^{T,f} - \kappa_t^{US,f}) v'(\theta_t^f / \text{GDP}_t^f) \\
= & \left[y_{rf,t} - \left(y_t^T - l_t^T + q_t^T - k_t + p_t + \xi_t^{T,f} + \psi_t^{T,f} \right) \right] - \left[y_{rf,t}^{US} - \left(y_t^{US} - l_t^{US} + \xi_t^{US,f} \right) \right]
\end{aligned}
\tag{9}
$$

The second line in Equation (9) gives the model's interpretation of the dollar convenience yield, and the third line gives its empirical counterpart.

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.

The empirical counterpart in Equation (9) shows that $\lambda_t^{T,f}$, in the first square bracket, corresponds to the spread between the local-currency risk-free rate and the sovereign bond (adjusted by all risks to resemble a riskless return). Similarly, $\lambda_t^{US,f}$, in the second square bracket, corresponds to the spread between the dollar risk-free rate and the dollar bond (after adjusting for its default risk to make it comparable).

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 $\lambda_t^{T,f} - \lambda_t^{US,f}$.

Regulatory risk. The main challenge is finding a proxy for the regulatory risk variables and the covariances in the right-hand side of Equation (8). 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 Φ_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 Φ_t^{FC} will be approximately equal to the term on regulatory risk plus covariances in (8). 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 $l_t^{FC} \approx l_t^T$. I refer to the discussion by Du and Schreger (2016), where they conclude that recent history in emerging markets does not give a clear higher probability of defaults or higher haircuts in either currency. Of the countries in my sample, only Turkey selectively defaulted on local-currency debt in 1999, and Indonesia selectively defaulted on foreign-currency debt in 2002.

Second, the differential convenience yield between foreign currency bonds and swapped local currency bonds, $\lambda_t^{FC,f} - \lambda_t^{T,f} \equiv tau_t$. 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.

Other financial frictions. This correction also addresses the empirical findings of Jiang, Krishnamurthy, and Lustig (2021), who estimate, for the sample of G10 countries, that most of the convenience of swapped local-currency bonds comes from being swapped into dollars, not from the actual bond. This follows from the liquidity of the dollar currency, which they claim makes any asset denominated in dollars inherit the convenience of the currency. I take the view that, in the case of swapped local currency bonds, their "dollarness" must depend on the liquidity of the forward markets. If a foreigner is investing in a swapped local currency bond, the liquidity of the dollar currency is well captured by how easy is to swap the local currency into dollars, which will depend on the liquidity of the EME forward market.

Engel and Wu (2023) and Du, Im, & Schreger (2018) also consider an additional source of swap market frictions: it could be that the observed forward premium, ρ_t, is different than the hypothetical premium that ensures CIP for risk-free rates. In this case, we would have $\tau_t^{CIP} \equiv y_{rf,t} - \rho_t - y_{rf,t}^{US} > 0$, and the empirical counterpart in Equation 9 would no longer capture the full dollar convenience yield. Du, Tepper, and Verdelhan (2018) explain that CIP deviations in risk-free rates can arise when the dollar rate is lower than the swapped foreign rate, and banks face balance sheet costs that prevent them from arbitraging the difference. When global financial intermediaries are constrained and demand for dollar liquidity is strong, this shows up as a positive CIP deviation and can lead to the mispricing of forward contracts. This friction shows up twice in my derivation (in Equation (8) and again in Equation (10)), and they cancel out, and therefore it does not affect my estimation.

The result in Proposition 4 can be substituted in Equation (8), 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 Φ_t^{FC} on the right-hand side of Equation (11). τ_t corresponds to the liquidity risk in forward markets. 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 aversion, recessions, 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. Regarding the domestic convenience yield, I omit data for Peru and the Philippines because their benchmark interbank rate was discontinued after 2020. I also omit the data for Brazil since the spread is taken against a 1-year interest rate swap, and it is very likely that foreigners are the marginal investors for these instruments. However, the empirical results in the next Section are nonetheless robust to including all of these three series.

Chile and Mexico have the largest average dollar convenience yield among the nine countries. Column 7 shows that the correlation between the two measures is positive and significant. 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

Table 1: Summary Statistics

	Dollar-investor's CY			Domestic CY			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Country	Sample starts	Mean	Std	Sample starts	Mean	Std	Corr
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. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

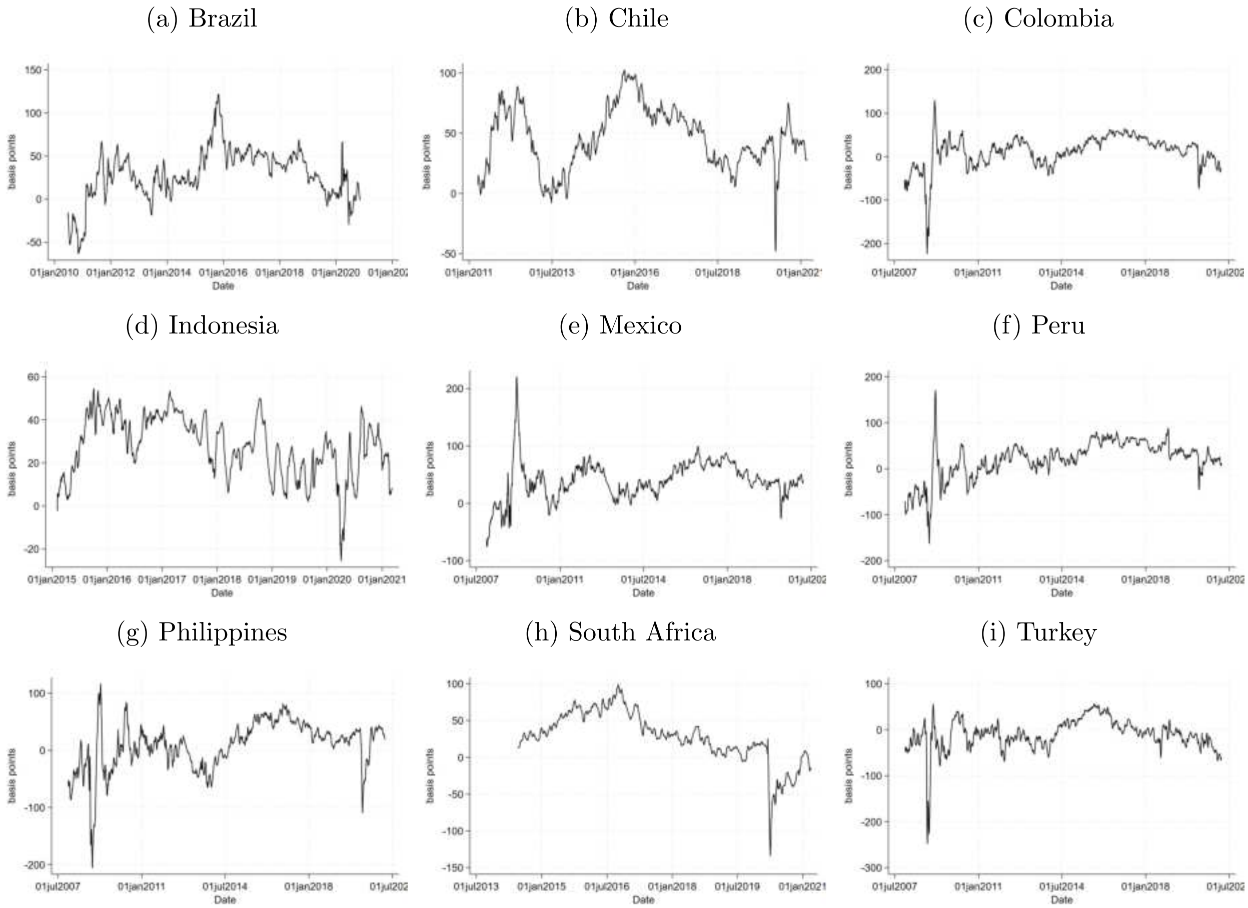
EMEs (according to BIS data), which has dropped sharply in recent years.

Figure 1 shows the evolution of the dollar-investor's convenience yield computed for the 5-year maturity. A common pattern emerges: first, an increase around 2011-2012 (that coincides with the Euro debt crisis, where some EMEs had lower default risk than some European countries), and another increase starting around 2014-2015, when the Fed started raising rates and dollar liquidity became scarcer. Second, sharp drops during crises, especially the Covid shock in 2020. 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).

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.

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:

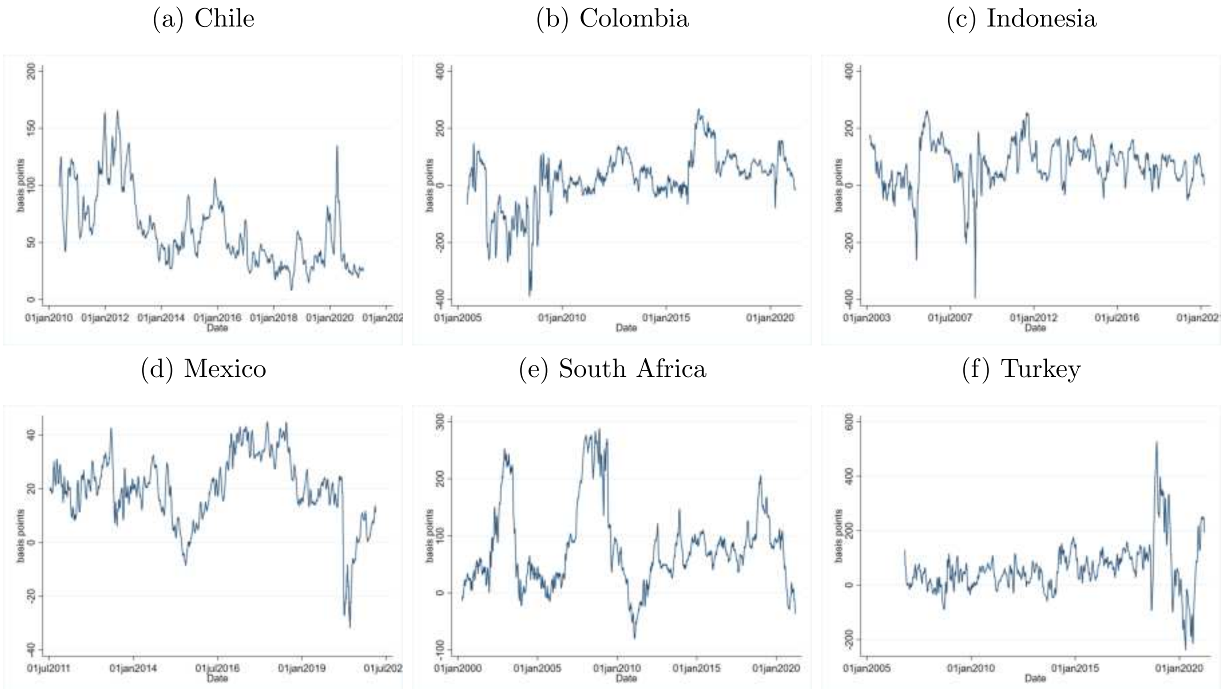
$$cy_{i,t} = \beta_1(\text{Gov. debt supply/GDP})_{t-1} + \beta_2 i^{MP}_{t-1} + \beta_3 i^{US}_t + \beta_4 X_t + c_i + \tau_t + \epsilon_{i,t} \tag{12}$$

where i is currency/country, t is time, and $cy_{i,t}$ is either the dollar investors' or the domestic convenience yield. The variable $(\text{Gov. debt supply/GDP})_t$ 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 θ^T_t/GDP^d_t in the model's Equations (2) and (4), and for the dollar convenience yield, a proxy for $\theta^{\$M}_t/GDP^f_t$

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

(a) Chile (b) Colombia (c) Indonesia

(d) Mexico (e) South Africa (f) Turkey



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

in (5) and (9). If there is a demand for safety and liquidity from investors, the coefficient β_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 θ_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.

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 ξ_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 τ_t are country and time-fixed effects, respectively, that allow control for time and country-

Table 2: Determinants of Convenience Yields

	Dep. var.: dollar CY			Dep. var.: domestic CY		
	(1)	(2)	(3)	(4)	(5)	(6)
Local MP rate$_{t-1}$	0.350	0.083	0.343	11.00***	8.140**	10.95***
	(0.547)	(0.739)	(0.544)	(1.478)	(3.147)	(1.462)
U.S. MP rate$_{t-1}$	11.58***	9.131**	10.90***	-0.163	-3.196	-6.891
	(3.817)	(3.857)	(4.012)	(9.470)	(10.69)	(11.92)
$\log(\frac{\text{Local gov debt}}{GDP_{local}})_{t-1}$	8.27	2.89	8.219	-31.58***	-32.47***	-31.87***
	(8.510)	(8.288)	(8.51)	(10.62)	(9.551)	(10.57)
$\log(\frac{\text{U.S. gov debt}}{GDP_{US}})_{t-1}$	-135.9***	-132.0***	-137.2***	111.0	107.98	93.25
	(45.04)	(43.63)	(46.86)	(86.14)	(99.17)	(88.28)
slope$_{local,t-1}$		-0.107			-11.29	
		(1.550)			(7.441)	
slope$_{US,t-1}$			-1.378			-10.49
			(4.019)			(9.162)
Constant	-345.1***	-338.9***	-345.3***	8.30	22.41	3.519
	(82.13)	(80.29)	(83.1)	(126.8)	(139.4)	(125.7)
Observations	1,137	1,103	1,137	967	918	967
R-squared	0.660	0.676	0.663	0.331	0.346	0.332

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. *** p<0.01, ** p<0.05, * p<0.1

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 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. Columns 3 and 6 use the slope of the dollar yield curve. 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. This results are robust to including the output gap as an alternative control for the state of the local business cycle.

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 Columns 1 and 5, the coefficient on the VIX is negative for the dollar-investor convenience yield and positive for the domestic convenience yield. This suggests that, in times of high global uncertainty, domestic investors increase their demand for the safety/liquidity of their local bonds while foreign investors' demand decreases. This is a striking result as it is the opposite of the response of dollar-convenience yields in advanced economies: in the U.S., a rise in the VIX increases the dollar-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).

The VIX index combines a measure of the price of risk (risk aversion) and a measure of genuine uncertainty (the quantity of risk). The latter is my main object of interest in these regressions. Higher risk aversion mechanically makes government debt riskier and lowers investors' willingness to pay for its safety, which is a well-known result in sovereign debt analysis. On the other hand, in terms of the model of Section 2.1, the effect of higher uncertainty measures a switch in investors' preferences for certain safe assets over others, captured by the time-varying parameter $\kappa_t^{T,f}$ and $\kappa_t^{T,d}$.

To disentangle this, in Columns 2 and 6, I control for the yield curve's slope to measure the credit/liquidity risk aversion. In Column 6, including the slope variable causes the VIX to lose its

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$_{t-1}$	0.683	0.545	0.403	2.070***	10.77***	8.187**	8.869***	7.051***
	(0.560)	(0.774)	(0.760)	(0.773)	(1.534)	(3.334)	(3.206)	(2.044)
U.S. MP rate$_{t-1}$	2.201	-2.363	-2.209	4.354	-0.249	-7.801	-10.02	0.580
	(2.852)	(3.050)	(2.901)	(4.370)	(9.087)	(13.55)	(13.10)	(11.62)
$\log(\frac{\text{Local gov debt}}{GDP_{local}})_{t-1}$	9.10	2.560	1.673	-2.463	-31.91***	-32.75***	-33.00***	-41.10***
	(8.502)	(8.146)	(8.125)	(9.084)	(10.65)	(9.537)	(9.702)	(11.03)
$\log(\frac{\text{U.S. gov debt}}{GDP_{US}})_{t-1}$	-145.1***	-144.3***	-133.0***	-125.89***	59.71	33.80	29.60	73.29
	(40.95)	(43.29)	(40.35)	(46.38)	(77.36)	(91.77)	(90.79)	(84.36)
vix$_{t-1}$	-1.129***	-0.979***	-0.977***	-1.252***	0.787*	0.604	0.649	0.763
	(0.332)	(0.309)	(0.304)	(0.450)	(0.473)	(0.575)	(0.566)	(0.517)
slope$_{local,t-1}$		0.596	0.272			-10.60	-10.27	
		(1.570)	(1.548)			(7.878)	(7.655)	
slope$_{US,t-1}$		-7.924*	-8.030*			-6.199	-5.402	
		(4.560)	(4.392)			(12.22)	(11.91)	
$(\frac{GovdebtInflow}{GDP})_{t-1}$			-1.364				4.130	
			(1.276)				(4.359)	
$(\frac{BankdebtInflow}{GDP})_{t-1}$			-2.927***				6.960**	
			(1.003)				(3.456)	
$(\frac{CorpdebtInflow}{GDP})_{t-1}$			2.542***				3.193	
			(0.941)				(3.165)	
Terms of trade				-108.2				-237.2
				(103.9)				(346.5)
Diff. Inflation				-1.564*				7.583***
				(0.809)				(1.922)
Democratic risk				-10.48***				-17.64*
				(3.792)				(9.208)
Constant	-293.2***	-295.1***	-276.9***	193.8	-52.81	-66.42	-76.07	1084.4
	(70.52)	(74.1)	(69.30)	(482.9)	(152.3)	(171.3)	(167.1)	(1603.5)
Observations	1,137	1,103	1,103	1,012	967	918	918	883
R-squared	0.688	0.695	0.703	0.716	0.332	0.347	0.361	0.439

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). *** $p<0.01$, ** $p<0.05$, * $p<0.1$

effect on the domestic convenience yield. This suggests that in times of high global uncertainty, increased risk aversion among local investors increases the demand for safety/liquidity and the domestic convenience yield.

In the case of the dollar-convenience yield, introducing the slope variable reduces the magnitude of the estimated coefficient on the VIX, but the effect of the VIX is robust. Therefore, the rise in the risk premia does not fully explain the drop in the convenience yield. This suggests that the drop in the dollar convenience yield comes from losing its "safe asset" status in investors' preferences (a drop in $\kappa_t^{T,f}$) during periods of higher uncertainty.

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 remains significant 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 (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

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***	2.972		
	(1.348)	(2.778)		
MP $\text{rate}_{t-1} \times$ TT		2.030***		
		(0.524)		
$\log(\frac{\text{US debt to GDP}}{\text{Local Debt to GDP}})_{t-1} \times$ TT		0.682*		
		(0.366)		
$\text{vix}_{t-1} \times$ TT		-0.783**		
		(0.379)		
$\text{slope}_{local,t-1} \times$ TT		0.413		
		(1.551)		
Covid-19_{t-1}			-18.92***	-21.84***
			(5.908)	(5.517)
MP $\text{rate}_{t-1} \times$ Covid-19				-1.830
				(1.513)
$\log(\frac{\text{US debt to GDP}}{\text{Debt to GDP}})_{t-1} \times$ Covid-19				-2.358***
				(0.601)
$\text{vix}_{t-1} \times$ Covid-19				0.570*
				(0.288)
$\text{slope}_{local,t-1} \times$ Covid-19				3.108
				(1.930)
Constant	46.92**	49.41***	47.11**	51.79**
	(18.32)	(18.55)	(18.60)	(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

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 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 and (2) quantify the role of safety demand on SOE's business cycles.

Time is discrete and runs to infinity: $t = 0, 1, 2, ...$ I refer to the two countries in the model as the EME (home) and the US (foreign). There are two frictions: households can borrow up to a fraction of their holdings of U.S. Treasuries and EME local-currency sovereign bonds, and the exogenous collateral quality of sovereign bonds is time-varying. The funding liquidity friction means that when the constraint binds, households derive a "convenience yield" for holding sovereign bonds. The time-varying collateral quality resembles a reduced-form market liquidity friction.

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 $n \to 0$ (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 coupled 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 U.S. 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

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

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

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

with elasticity parameter θ, and share parameter ω 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:

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

where $P_{D,t}$ and $P_{F,t}$ are the local currency prices at which the EME households purchase EME and U.S. 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 U.S. 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

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

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 U.S. 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 U.S. period-t price index, and S_t denotes the period-t nominal exchange rate measured as the price of EME currency in U.S. dollars (hereafter, I use * notation for US variables). According to this definition, a depreciation (appreciation) in the real value of the U.S. 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,

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

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 U.S.,

$$\mathcal{E}_t = \frac{S_t P_t}{P_t^*} \tag{18}$$

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

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

U.S. households can trade the dollar bond and hold both sovereign bonds as collateral. Their budget constraint is analogous to that of 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:

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

According to this expression, a depreciation of the real exchange rate, $\mathcal{E}_t$, lowers the relative price of U.S. 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 U.S. (EME) preference puts higher weight on U.S. (EME) goods than EME (U.S.) preference does.

Financial friction and demand for safe assets. The world credit market is imperfect. Households need to guarantee their debt by offering domestic and foreign assets as collateral. The collateral constraint takes the form of the margin requirement:

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

for the case of the U.S. households and an analogous constraint for EME households. Thus, households can borrow internationally up to a fraction κ_t^* of the market value of U.S. sovereign bonds and a fraction κ_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[3].

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.

The collateral quality of the U.S. sovereign bonds, captured by κ_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:

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

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

[3]See Bianchi and Mendoza (2020) for a comprehensive review of the models using these type of financial constraints

where λ_t^* and μ_t^* are the Lagrange multipliers for the budget and collateral constraints of the U.S. household, respectively. As usual, λ_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 (μ_t^*), the quality as collateral (κ_t^*), and the level of consumption (λ_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:

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

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

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

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. Recent papers like Maggiori (2017) and Hassan and Zhang (2021) consider a currency a safe haven if it appreciates during global downturns. They look 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 μ_t) and positively on the demand for consumption smoothing, which increases the collateral value.

Equations (24) and (25) indicate that the presence of differential collateral qualities leads to a deviation from UIP, which will be proportional to the convenience yields of the sovereign bonds. As in Jiang, Krishnamurthy, and Lustig (2021), Engel and Wu (2023), and Devereux, Engel, and Wu (2023), the dollar appreciates in response to interest rate differentials and expected convenience yields on U.S. sovereign bonds.

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

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

s.t.

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

where λ_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

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

Similarly, a representative EME firm solves

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

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 U.S. Treasuries (in the case of the U.S.) and the supply of the EME local-currency sovereign bond. For simplicity, I normalize the supply of the EME sovereign bond to zero and assume that government debt in the U.S. has a 1-period maturity.

The U.S. 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 $b_{ss}^{*g} = b_t^{*g}/Y_t^*$ 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 constraint:

$$\tau_t^* + q_t^T b_{t+1}^{g*} = b_t^{g*} \tag{30}$$

This budget constraint implies that the supply of safe assets will be procyclical, consistent with evidence from the U.S. (see Caramp and Singh, 2021).

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: $F(A, L) \equiv exp(\epsilon_t^A)AL^{1-\alpha}$, with $1 > \alpha \geq 0$. I also assume that log productivity in the EME economy follows a stationary $AR(1)$.

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, κ_t^*. In particular, this parameter follows an AR(1) process whose statistical moments are calibrated in the next section,

$$\log \kappa_t^* = (1 - \rho^s) \log \kappa^* + \rho^s \log \kappa_{t-1}^* + \sigma^s \epsilon_t^{\kappa^*} \tag{31}$$

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.

4.5 Discussion

In the model, convenience yields in bonds arise from their use as collateral. The borrowing constraint is a funding liquidity friction while varying collateral quality is an exogenous market liquidity friction[4]. The interaction of both gives rise to a time-varying convenience yield. 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. 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.

The model does not provide a micro-foundation for the loss of safe asset status. Indeed, that would require including financial intermediaries and their choice of collateral. I also abstract from nominal rigidities. My goal is to set up a simpler model, although it could easily include local and global financial intermediaries to analyze the interaction of specific financial frictions with convenience yields. For recent models including these features, see Devereux, Engel, & Wu (2023) and Mendoza & Quadrini (2023).

There are alternative models that give rise to convenience yields via exogenous market liquidity frictions (Kiyotaki and Moore, 2005, 2019; Del Negro et al., 2017b). 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. Kekre and Lenel (2021) rely on a reduced-form, bond-in-the-utility-function specification, where the convenience yield comes from an unmodeled exogenous demand for safety. A safety shock is an exogenous increase in this wedge on the Euler equation.

[4]See Dou et al. (2023) for a recent survey of macro-financial models and the connection between these two types of frictions.

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}.

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,

$$\{p^*_{D,t}, p^*_{F,t}, q^T_t, q^b_t, p^b_t, p_{D,t}, p_{F,t}, q_t, \mathcal{E}_t\}$$

such that the allocations solve households' and firms' optimization problems and markets clear.

Market clearing in the two goods markets requires that

$$Y^*_t = A^*_t L^{*1-\alpha}_t = C^*_{D,t} + \frac{n}{1-n} C_{F,t} \tag{32}$$

and

$$Y_t = A_t L^{1-\alpha}_t = C_{D,t} + \frac{1-n}{n} C^*_{F,t} \tag{33}$$

The non-sovereign bonds are in zero net supply, so $0 = nb_t + (1-n)b^*_t$. Thus, b_{t-1} identifies the EME net foreign asset position at the start of period 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. 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) 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: $\omega^* \to 1$. Conversely, I assume the US is arbitrarily large relative to the EME, $n \to 1$. The rationale for these assumptions is that the EME is very small relative to the United States and, therefore, has negligible weight in the US consumption baskets. This implies that the US behaves effectively like a closed economy.

5 Macroeconomic Implications

5.1 Calibration

The EME's productivity shock, ϵ^A, is modeled as a Markov process approximating its statistical moments as an AR(1) process. I take the autocorrelation parameter and the standard deviation from Mendoza (2010). For the safety shock, I need the average collateral quality of the U.S. sovereign bond, κ^*, the autocorrelation coefficient of κ^*_t, and its standard deviation. With these, I can approximate a Markov process with a transition probability matrix. The three moments I target are the average intertemporal dollar rate, its standard deviation, and the average U.S. convenience yield. The drop in U.S. productivity accompanying this shock is calibrated to match the EME's dollar convenience yield standard deviation. The parameter κ, which is not subject to shocks, is calibrated to match the average of the EME's dollar convenience yield. Table 5 summarizes the calibration exercise.

The shocks are modeled as a joint discrete Markov process that approximates the statistical moments of their actual time-series processes. The Markov process is defined by a set $\mathbf{E}$ of all combinations of realizations of the shocks, each combination given by a triple $e = (\epsilon^{A^*}, \epsilon^{A}, \epsilon^{\kappa^*})$, and by a matrix π of transition probabilities of moving from e_t to e_{t+1}. Given how I define the safety shock, (ϵ^{A^*} and ϵ^{κ} are perfectly correlated. Each shock has two realizations, so $\mathbf{E}$ contains eight triples.

5.2 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. In this model, the safety shock corresponds to an increase in the demand for collateral by U.S. households, joined by an increase in the collateral quality of U.S. sovereign bonds. In Kekre and Lenel (2021), the convenience yield of U.S. 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 of the small open economy. The top row shows the output, consumption, savings, and real exchange rate responses. In the U.S. (not shown), the temporary drop in productivity drops the consumption of U.S. and EME goods and increases the demand for borrowing to smooth consumption. In the EME, the drop in consumption (second panel) is driven by a drop in consumption of U.S. goods. However, on the margin, they pick up the demand for EME goods left by U.S. households. The dollar real

Table 5: Calibration

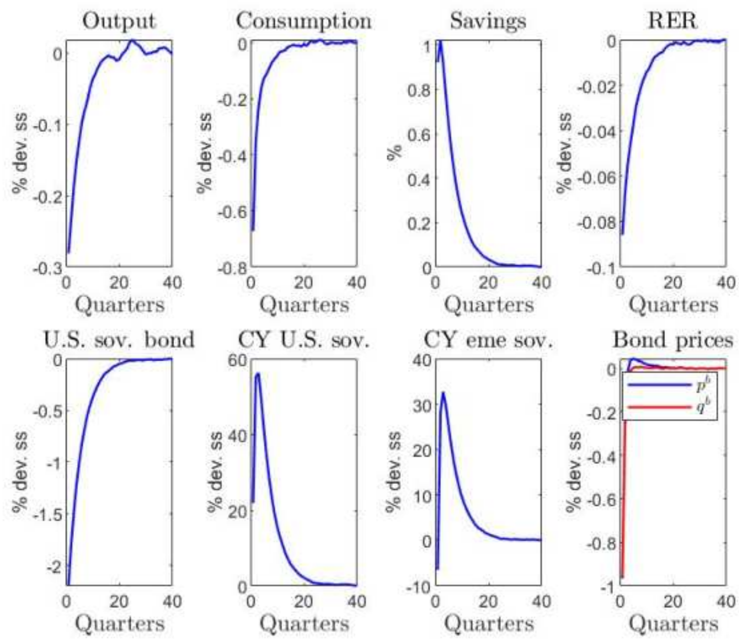
A. Externally calibrated			
Parameter	Description	Value	
β	Discount factor	0.98	
γ	Risk aversion	2	
η	Labor elasticity	1.846	
$1-\omega$	Home bias	0.7	
θ	Consumption elasticity	5	
$1-\alpha$	Labor share	0.64	
ρ	Productivity persistence	0.82	
σ	Productivity volatility	0.0196	
B. Calibrated			
Parameter	Description	Target	Value
κ^*	Foreign collateral	mean U.S. Treasury conv. yield	1.14
κ	Local collateral	mean EME dollar-conv. yield	1.07
ρ^s	Safety persistence	average dollar interest rate	0.4
σ^{z*}	U.S. prod. shock	std EME dollar-conv. yield	0.01
σ^s	Safety volatility	std dollar interest rate	0.06
C. Targeted Moments			
Moment	Data	Model	
mean U.S. Treasury conv. yield	60 bp	64 bp	
mean EME dollar-conv. yield	26 bp	28 bp	
std EME dollar-conv. yield	0.3557	0.4063	
average dollar interest rate	1.6%	1.53%	
std dollar interest rate	0.49%	0.63%	

Notes: in Panel C, Data values come from: the average U.S. Treasury conv. yield is taken from Jiang et al. (2022). The mean dollar rate is calculated as 1% mean Treasury rate plus 60 bp convenience yield. The std is taken from Mendoza (2010). The mean and std of the EME dollar-convenience yield are taken from Section 2 of this paper and correspond to the values for South Africa.

exchange rate appreciates to facilitate this re-balancing (fourth panel). These effects translate into an increase in savings in the non-sovereign foreign bond (third panel). 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 first panel shows the drop in the supply of U.S. sovereign bonds, which captures the procyclicality of the supply of safe assets found, for example, in Caramp and Singh (2021). The second panel shows the increase in the convenience yield of the U.S. sovereign bond, or the spread between the dollar bond used to smooth consumption and the U.S. sovereign bond.

Figure 3: Impulse Responses to a Safety Shock



The third panel shows the response of the EME sovereign bond's convenience yield, which decreases on impact. This matches the negative effect of the VIX index 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. The increase in the next periods in the convenience yield captures the positive expected excess return of the local sovereign bond with respect to the non-sovereign dollar 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.

5.3 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

A. Output and Consumption		
	Model	No safety shocks
std Y	3.68	3.67
std C	1.59	1.52
B. Interest Rates		
	Model	$\kappa = 0$
std R^b (local sov. bond)	0.65	0.78
std R (dollar bond)	0.62	0.62
std R^T (U.S. sov. bond)	0.59	0.59

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. The model implies that safety shocks account for more than 4% of consumption volatility. These effects are economically relevant when compared to the previous literature. Uribe and Yue (2006) quantify 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. The two models share many features but differ in that I introduce demand for safety. 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 safety shocks explain about a third of that effect on consumption.

Panel B in Table 6 explores the effects on interest rate volatility. Compared to a scenario where the EME sovereign bond has no value as collateral ($\kappa = 0$), the existence of a convenience yield lowers the volatility of interest rates by almost 20%. However, the negative response of the convenience yield increases volatility, offsetting part of this effect. I can quantify this second effect by comparing the volatility of the U.S. sovereign bond, which responds positively to global safety shocks. Table 6 shows that the negative response against the safety shock increases volatility by more than 10%.

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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Appendix A 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 θ_t^T rise by P_t^T/Q_t. The first order condition for this bond holdings is, then,

$$-\frac{P_t^T}{Q_t}u'(C_t) + \beta E_t\left[\frac{P_{t+1}^T}{Q_{t+1}}u'(C_{t+1})\right] + \frac{P_t^T}{Q_t}v'(\theta_t^d/\mathrm{GDP}_t^d)u'(C_t) = 0 \tag{34}$$

Define the pricing kernel for nominal payoffs as

$$M_{t+1} = \beta\frac{u'(C_{t+1})}{u'(C_t)}\frac{Q_t}{Q_{t+1}} \tag{35}$$

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

$$P_t^T = E_t[M_{t+1}P_{t+1}^T\Lambda_t^{T,d}] \tag{36}$$

where $\Lambda_t^{T,d} \equiv 1/(1-v'(\theta_t^d/\mathrm{GDP}_t^d))$ 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 π_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,

$$P_t^T = \pi_t^T E_t[M_{t+1}\Lambda_t^{T,d}(1-L_{t+1}^T)|\text{Default}] + (1-\pi_t^T)E_t[M_{t+1}P_{t+1}^T\Lambda_t^{T,d}|\text{No Default}] \tag{37}$$

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

$$\begin{aligned} e^{-y_t^T} = P_t^T &= E_t[M_{t+1}\Lambda_t^{T,d}] - E_t[M_{t+1}]E_t[\tilde{L}_{t+1}^T] - \mathrm{cov}_t[M_{t+1},\tilde{L}_{t+1}^T] - \mathrm{cov}_t[\Lambda_t^{T,d},\tilde{L}_{t+1}^T] \\ &\approx e^{\lambda_t^{T,d}-\pi_t^T(E_t[L_{t+1}^T]+\mathrm{cov}_t[M_{t+1},\tilde{L}_{t+1}^T]/E_t[M_{t+1}])-\mathrm{cov}_t[\lambda_t^{T,d},\tilde{L}_{t+1}^T]/E_t[M_{t+1}]}E_t[M_{t+1}] \end{aligned} \tag{38}$$

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

$$y_t^T \approx y_t^{rf} - \lambda_t^{T,d} + l_t^T - \xi_t^{T,d} \tag{39}$$

where $y_t^{rf} = -\log M_{t+1}$ (no arbitrage condition); $l_t^T = \pi_t^T(E_t[L_{t+1}^T]+\mathrm{cov}_t[M_{t+1},\tilde{L}_{t+1}^T]/E_t[M_{t+1}])$ 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,

$$y_t^P \approx y_t^{rf} - \lambda_t^{P,d} + l_t^P - \xi_t^{P,d} \tag{40}$$

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

$$y_t^P - y_t^T \approx (\lambda_t^{T,d} - \lambda_t^{P,d}) + (l_t^p - l_t^j) + (\xi_t^{T,d} - \xi_t^{P,d}) \tag{41}$$

□

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 θ_t^{US} rise by $P_t^{US}/Q_t^\$$. The first order condition for this bond holdings is then

$$-\frac{P_t^{US}}{Q_t^\$}u'(C_t) + \beta E_t\left[\frac{P_{t+1}^{US}}{Q_{t+1}^\$}u'(C_{t+1})\right] + \frac{P_t^{US}}{Q_t^\$}v'(\theta_t^f/\text{GDP}_t^f)u'(C_t) = 0 \tag{42}$$

Define the pricing kernel for nominal payoffs as

$$M_{t+1} = \beta\frac{u'(C_{t+1})}{u'(C_t)}\frac{Q_t^\$}{Q_{t+1}^\$} \tag{43}$$

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

$$\begin{aligned} P_t^{US} &= E_t[M_{t+1}P_{t+1}^{US}] + P_t^{US}v'(\theta_t^f/\text{GDP}_t^f) \Rightarrow \\ P_t^{US} &= E_t[M_{t+1}P_{t+1}^{US}\Lambda_t^{US,f}] \end{aligned} \tag{44}$$

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 π_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,

$$P_t^{US} = \pi_t E_t[M_{t+1}\Lambda_t^{US,f}(1 - L_{t+1}^{US})|\text{Default}] + (1 - \pi_t)E_t[M_{t+1}P_{t+1}^{US}\Lambda_t^{US,f}|\text{No Default}] \tag{45}$$

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

$$
\begin{aligned}
e^{-y_t^{US}} = P_t^{US} &= E_t[M_{t+1}\Lambda_t^{US,f}] - E_t[M_{t+1}]E_t[\tilde{L}_{t+1}^{US}] - \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^{US}] - \text{cov}_t[\Lambda_t^{US,f}, \tilde{L}_{t+1}^{US}] \\
&\approx e^{\lambda_t^{US,f} - \pi_t(E_t[L_{t+1}^{US}] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^{US}]/E_t[M_{t+1}]) - \text{cov}_t[\lambda_t^{US,f}, \tilde{L}_{t+1}^{US}]/E_t[M_{t+1}]} E_t[M_{t+1}]
\end{aligned} \tag{46}
$$

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 :

$$
y_t^{US} \approx y_{rf,t}^{US} - \lambda_t^{US,f} + l_t^{US} - \xi_t^{US,f} \tag{47}
$$

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. □

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 θ_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

$$
-\frac{P_t^T}{Q_t^{\$}}\frac{1}{S_t}u'(C_t) + \beta E_t\left[\frac{P_{t+1}^T}{Q_{t+1}^{\$}}\frac{1}{F_{t+1}}u'(C_{t+1})\right] + \frac{P_t^T}{Q_t^{\$}}\frac{1}{S_t}v'(\theta_t^f/\text{GDP}_t^f)u'(C_t) = 0 \tag{48}
$$

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:

$$
\begin{aligned}
P_t^T\frac{F_t^1}{S_t} &= E_t[M_{t+1}] + P_t^T\frac{F_t^1}{S_t}v'(\theta_t^f/\text{GDP}_t^f) \Rightarrow \\
P_t^T\frac{F_t^1}{S_t} &= E_t[M_{t+1}\Lambda_t^{T,f}]
\end{aligned} \tag{49}
$$

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 π_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, $L^T_{t+1}(1 - F_{t+1}/S_{t+1})$, is precisely equal to $\frac{\text{cov}_t(1-L^T_t, 1/S_{t+1})}{E_t(1-L^T_{t+1})E_t(1/S_{t+1})}$. 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 $L^T_{t+1} - q^T_t$ and $K_{t+1} - p_t$, respectively. Define $\tilde{L}^T_{t+1}$ as a random variable that is equal to zero if there is no default and equal to $L^T_{t+1} - q^T_t$ 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

$$\begin{aligned}
e^{-y^T_t + \rho_t} = P^T_t \frac{F_{t+1}}{S_t} &= E_t[M_{t+1}\Lambda^{T,f}_t] - E_t[M_{t+1}]E_t[\tilde{L}^T_{t+1}] - E_t[M_{t+1}]E_t[\tilde{K}_{t+1}] \\
&- \text{cov}_t[M_{t+1}, \tilde{L}^T_{t+1}] - \text{cov}_t[M_{t+1}, \tilde{K}_{t+1}] - \text{cov}_t[\Lambda^{T,f}_t, \tilde{L}^T_{t+1}] - \text{cov}_t[\Lambda^{T,f}_t, \tilde{K}_{t+1}] \\
&\approx e^{\lambda^{T,f}_t - \pi^T_t(E_t[L^T_{t+1}] + \text{cov}_t[M_{t+1}, \tilde{L}^T_{t+1}]/E_t[M_{t+1}]) + q^T_t - \tilde{\pi}^T_t(E_t[K_{t+1}] + \text{cov}_t[M_{t+1}, \tilde{K}_{t+1}]/E_t[M_{t+1}])} \\
&\times e^{p_t - \text{cov}_t[\Lambda^{T,f}_t, \tilde{L}^T_{t+1}]/E_t[M_{t+1}] - \text{cov}_t[\Lambda^{T,f}_t, \tilde{K}_{t+1}]/E_t[M_{t+1}]} \times E_t[M_{t+1}]
\end{aligned} \tag{50}$$

Taking logs on both sides gives:

$$y^T_t - \rho_t \approx y^{US}_{rf,t} - \lambda^{T,f}_t + (l^T_t - q^T_t) + (k_t - p_t) - \xi^{T,f}_t - \psi^{T,f}_t \tag{51}$$

where $y^{US}_{rf,t} = -\log M_{t+1}$; $\lambda^{T,f}_t \approx v'(\theta^f_t/\text{GDP}^f_t)$ is the convenience yield on the local-currency bond; $l^T_t = \pi^T_t(E_t[L^T_{t+1}] + \text{cov}_t[M_{t+1}, \tilde{L}^T_{t+1}]/E_t[M_{t+1}])$ 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 $\xi^{T,f}_t = \text{cov}_t[\Lambda^{T,f}_t, \tilde{L}^T_{t+1}]/E_t[M_{t+1}]$ and $\psi^{T,f}_t = \text{cov}_t[\Lambda^{T,f}_t, \tilde{K}_{t+1}]/E_t[M_{t+1}]$ are the covariances of the convenience yield with default risk and regulatory risk, respectively. □

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:

$$\hat{P}^T_t = E_t[M_{t+1}\hat{P}^T_{t+1}]\hat{\Lambda}^{T,f}_t \tag{52}$$

Assume the local government can default on this bond with probability $\hat{\pi}^T_t$, imposing a loss of $\hat{L}^T_{t+1}$ on the investor. In this case, $\tilde{L}^T_{t+1}$ is a random variable taking the value $\hat{L}^T_{t+1}$ 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

$$\begin{aligned} e^{-\hat{y}_t^T} = \hat{P}_t^T &= E_t[M_{t+1}\hat{\Lambda}_t^{T,f}] - E_t[M_{t+1}]E_t[\tilde{L}_{t+1}^T] - \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^T] - \text{cov}_t[\hat{\Lambda}_t^{T,f}, \tilde{L}_{t+1}^T] \\ &\approx e^{\hat{\lambda}_t^{T,f} - \hat{\pi}_t^T(E_t[\hat{L}_{t+1}^T] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}]) - \text{cov}_t[\hat{\lambda}_t^{T,f}, \tilde{L}_{t+1}^T]/E_t[M_{t+1}]} E_t[M_{t+1}] \end{aligned} \tag{53}$$

Taking logs on both sides gives:

$$\hat{y}_t^T \approx y_{rf,t}^{US} - \hat{\lambda}_t^{T,f} + \hat{l}_t^T \tag{54}$$

where variables have the same interpretation as in the previous two proofs. Now, define Φ_t^{FC} as the spread between the yield of the synthetic bond (Equation (51)) and the yield on the foreign currency-denominated bond (Equation (54)). Then,

$$\begin{aligned} \Phi_t^{FC} \equiv& y_t^T - \rho_t - \hat{y}_t^T \\ &\approx (y_{rf,t}^{US} - \lambda_t^{T,f} + (l_t^T - q_t^T) + (k_t - p_t) - \xi_t^{T,f} - \psi_t^{T,f}) - (y_{rf,t}^{US} - \hat{\lambda}_t^{T,f} + \hat{l}_t^T) \\ &= (\hat{\lambda}_t^{T,f} - \lambda_t^{T,f}) + (l_t^T - \hat{l}_t^T - q_t^T) + (k_t - p_t) - \xi_t^{T,f} - \psi_t^{T,f} \end{aligned} \tag{55}$$

□

Appendix B Data Sources

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

$$\lambda_t^{T,f} - \lambda_t^{US,f} = y_t^{US} - (y_t^T - \rho_t) + (l_t^T - l_t^{US}) + \Phi_t^{FC} - \tau_t + (\xi_t^{US,f} - \xi_t^{FC,f}) \tag{56}$$

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 (Φ_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 (τ_t). τ_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	JIIN12M
Mexico	Certificate of Deposits 9 month	MPDRI
South Africa	Interbank agreed rate 12 month	JIBA12M
Turkey	Interbank unsecured loan	TRLXB1Y

Appendix C 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.

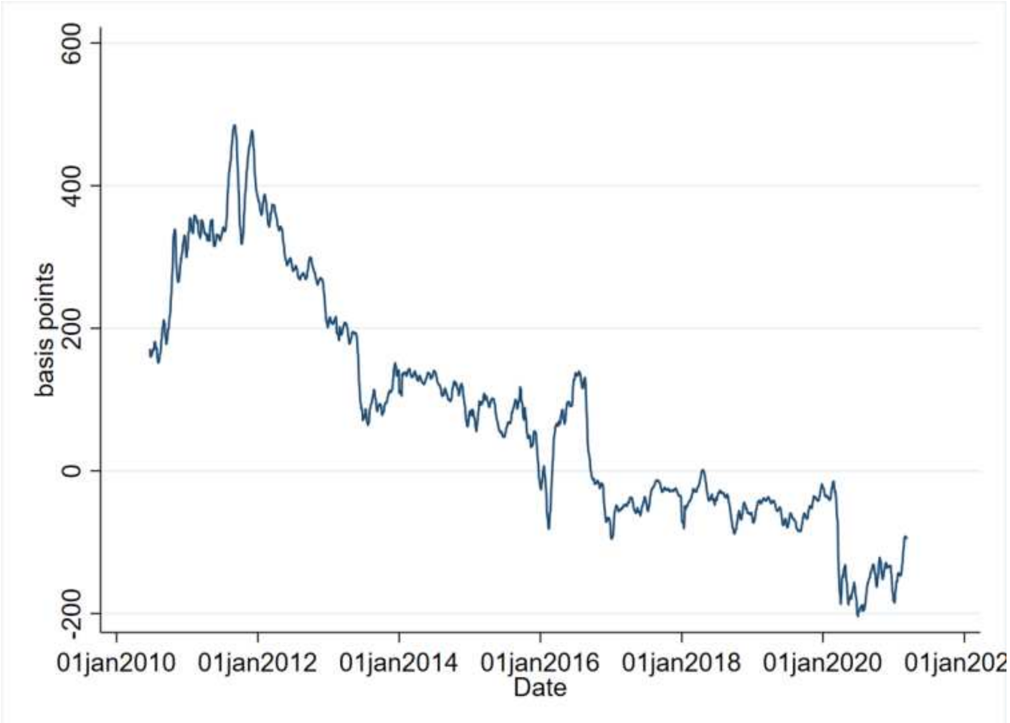
C.1 The role of regulatory risk

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 4 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

Figure 4: 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.

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

C.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 International 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.

C.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 D 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 5 compares the evolution of CIP deviations and two components: differential default risk and the U.S. Treasury premium.

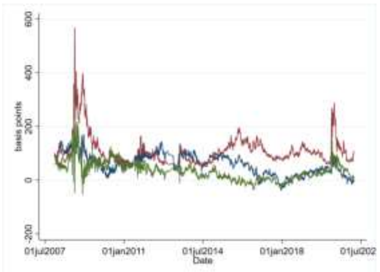
CIP deviations spiked during crises (i.e., in 2008 and 2020), which was driven by an increase in differential default risk and the U.S. Treasury premium. The increase in the U.S. Treasury premium aligns with intuition: During financial distress, investors prefer the liquidity and safety of U.S. Treasuries. 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 5 shows that this is not the case for EMEs. U.S. Treasuries are still considered a safe asset compared to their EME counterparts.

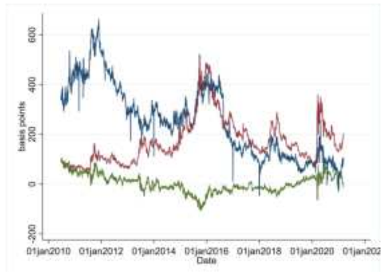
Surprisingly, CIP deviations outside of financial crises closely followed the U.S. Treasury premium dynamics -and not the dynamics of default risk- for Mexico, Colombia, Peru, Chile, Indonesia, and South Africa. In these countries, even though differential credit risk significantly increased in 2015-16, 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

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

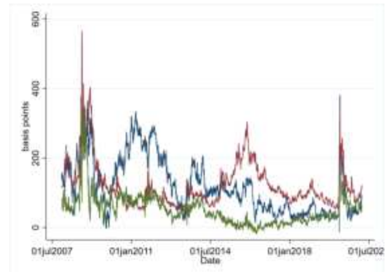
(a) Mexico



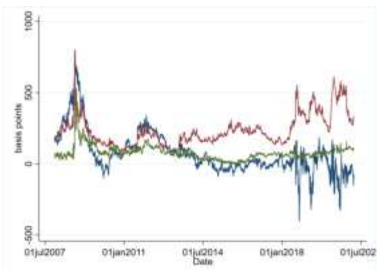
(b) Brazil



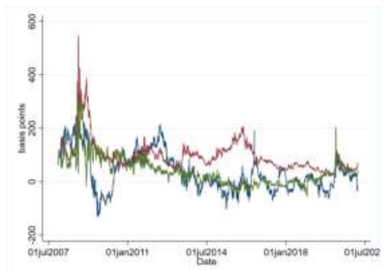
(c) Colombia



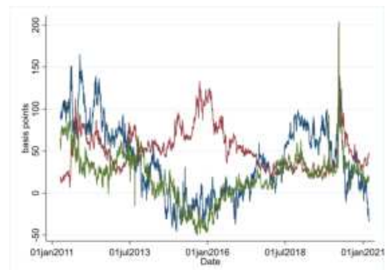
(d) Turkey



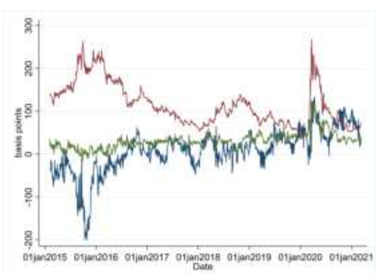
(e) Peru



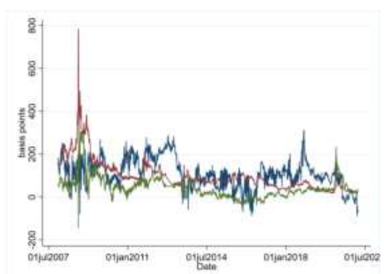
(f) Chile



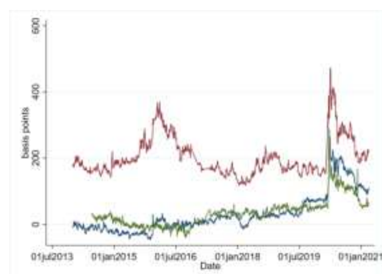
(g) Indonesia

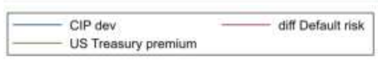


(h) Philippines



(i) South Africa





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 5 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 (8). Two episodes in the data stand out: Brazil during 2010-2014 and Colombia 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 E Robustness for Section 3

E.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.

E.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***	11.48***	11.65***	11.70***	6.214***
	(1.410)	(1.377)	(1.404)	(1.413)	(1.924)
$\log(\frac{\text{US debt to GDP}}{\text{Debt to GDP}})_{t-1}$	-8.027	-4.336	-8.776	-9.849	-30.78**
	(16.09)	(14.86)	(16.37)	(16.47)	(12.11)
US fed funds$_{t-1}$	-14.66**	-11.31	-13.86*	-14.09*	-11.77
	(7.115)	(7.349)	(7.149)	(7.177)	(7.894)
vix$_{t-1}$	4.575***	4.352***	4.429***	4.339***	4.271***
	(0.420)	(0.456)	(0.421)	(0.442)	(0.520)
$(\frac{DebtInfl}{GDP})_{t-1}$		-26.84***			-21.75***
		(6.746)			(7.064)
$(\frac{EqtInfl}{GDP})_{t-1}$		-30.39*			-13.49
		(15.58)			(14.77)
$(\frac{GovdebtInfl}{GDP})_{t-1}$			-6.065*	-6.690**	
			(3.167)	(3.198)	
$(\frac{BankdebtInfl}{GDP})_{t-1}$			-8.105**	-7.921**	
			(3.154)	(3.151)	
$(\frac{CorpdebtInfl}{GDP})_{t-1}$			-3.961*	-3.982*	
			(2.142)	(2.121)	
Terms of Trade				-241.4	-196.4
				(189.7)	(165.3)
Diff. Inflation					8.440***
					(2.229)
Democratic risk					-1.152
					(7.117)
Constant	-1.286	-28.20	-7.972	1,110	1,058
	(88.08)	(86.53)	(91.53)	(875.5)	(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**	1.210**	1.140**	1.078*
	(0.515)	(0.511)	(0.525)	(0.548)
$\log(\frac{\text{US debt to GDP}}{\text{Debt to GDP}})_{t-1}$	-16.71**	-17.42**	-16.95**	-11.27
	(8.318)	(8.076)	(8.155)	(11.85)
US fed funds$_{t-1}$	-6.322*	-6.923*	-5.395	-7.775*
	(3.582)	(3.660)	(3.593)	(4.079)
vix$_{t-1}$	-0.0180	-0.0425	-0.0436	0.0223
	(0.264)	(0.250)	(0.263)	(0.318)
$(\frac{DebtInfl}{GDP})_{t-1}$		2.768		
		(2.471)		
$(\frac{EqtInfl}{GDP})_{t-1}$		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**	102.9**	98.58**	83.33
	(42.77)	(41.31)	(41.93)	(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<0.01, ** p<0.05, * p<0.1