Safe Assets in Emerging Market Economies

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Abstract

Do local-currency sovereign bonds in emerging markets work as safe assets? I estimate convenience yields arising from safety/liquidity premia both from the perspective of a global and a domestic investor. In a sample of 9 middle-income EMEs, I find a large convenience yield robust to both measures. I characterize the dynamics of this premium along the local and global financial cycle. The main difference relative to the convenience yields of U.S. Treasuries is not only their smaller magnitude but also that the global investor's convenience yield is procyclical to the global financial cycle (drops during episodes of high global risk aversion). I analyze two exogenous shocks to EMEs (the Taper Tantrum and Covid-19) and find that the availability of alternative global safe assets like the U.S. Treasury drives this procyclicality. Results are consistent with a model of a small open economy facing endogenous borrowing constraints and where a foreign and a local sovereign bond serve as collateral (although with different qualities) and thus carry a convenience yield. I use the model to show that shocks to demand for safety have markedly different effects from the standard interest rate or risk premium shocks, accounting for a relevant portion of their impact on business cycle volatility.

Keywords: convenience yields, sovereign bonds, emerging markets.

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1 Introduction

Investors derive non-pecuniary benefits from the liquidity and safety of certain assets, commonly known as "safe assets". For example, an asset that works as collateral in financial transactions or a low-risk asset for which a defined-benefit pension fund has a "preferred habitat" demand to back long-term obligations. In both cases, investors will be willing to accept a lower yield than alternative assets offering the same cash flows. Importantly, to be a safe asset, it is unnecessary to have (near) zero default or liquidity risk (which, of course, does not hold for emerging economies). All that is required is to have lower risk than alternatives and investors with a special demand for this lower risk. The extent to which they value these non-pecuniary benefits is often called the "convenience yield". Do local-currency sovereign bonds in emerging market economies (EMEs) share this safe asset status in their local economy? This paper is the first attempt to estimate convenience yields of local-currency sovereign bonds in 9 middle-income EMEs, draw the differences with advanced economies, and explore their implications for business cycle volatility.

Krishnamurthy and Vissing-Jorgensen (2012) quantify this convenience yield for U.S. Treasuries relative to comparable dollar assets. This safe asset status affects equilibrium interest rates, expands the fiscal capacity of the government, and is a transmission channel for the central bank's large-scale asset purchases[1]. This paper emphasizes that, in emerging markets, government bonds can be a local safe asset, but they might compete with other global sources of safety. Recently, Kekre and Lenel (2021) showed that shocks to safety/liquidity demand accounted for 25% of output volatility in the U.S. and 6% of output volatility in the rest of the world. From the perspective of emerging markets, there is no empirical work on the role of their local debt as a safe asset and their interaction with global safe assets.

The convenience yields I will estimate in this paper could come from safety or liquidity services. Safety and liquidity, however, are different concepts. Liquidity refers to the ease with which investors can sell assets for cash. According to Gorton (2017), safety refers to an asset valued at face value without expensive and prolonged analysis. Thus, safe assets will generally be liquid, and liquid assets will be safe. The difficulty in empirically disentangling them is compounded in EMEs due to the lack of data compared to the U.S. Hereafter, I will not aim to distinguish between these two sources.

In the first part of this paper, I estimate the convenience yield of EME local-currency sovereign bonds. For robustness, I provide two estimates. The first one resembles a domestic investor. I assume a domestic investor (1) decides a portfolio of assets in domestic currency and (2) measures her returns in the domestic currency. This investor compares the local-currency sovereign bond to a domestic private local-currency asset with the same maturity that does not provide as much

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

safety and liquidity services, such as a term deposit on a local commercial bank. As shown in Krishnamurthy and Vissing-Jorgensen (2012), the spread between the two assets measures the safety/liquidity premium on the local-currency sovereign bond. Reliable daily data for domestic private local-currency assets is available for fewer EMEs and for shorter maturities (1-year term deposits, certificate of deposits, or unsecured interbank term loans, which I compare with 1-year local-currency sovereign bonds).

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

I find a sizable convenience yield for EME local-currency sovereign bonds, which is robust to the measure used. The dollar measure shows an average of more than 30 basis points, accounting for almost 10% of their total yield. The domestic measure gives a larger average of 59 basis points. I then characterize the dynamics of the EME local-currency convenience yields along two dimensions. First, along the local financial cycle: the cyclical variations in the supply and demand for local-currency liquidity in the domestic economy, whose primary determinant is the local central bank. Results show that local investors value the convenience services of local sovereign bonds along the business cycle, which aligns with evidence for advanced economies. Second, along the global financial cycle, whose primary determinant is global risk appetite as measured by the VIX and drives capital inflows. The main finding is that, unlike U.S. Treasuries, the EME local-currency convenience yield drops during high global risk aversion episodes. To gain insight into the mechanism, I analyze two exogenous adverse shocks to EMEs (the Taper Tantrum and the Covid pandemic). These episodes suggest that the safety status of EME sovereign bonds drops because of the availability of alternative global safe assets to investors.

In the second part of the paper, I extend a small open economy (SOE) model to include demand for safe assets by households (beyond standard precautionary savings demand). In particular, I take the SOE limit of the two-country model (US and EME), which allows for more clarity on the interaction between the global and the local safe asset. The EME can borrow abroad in a non-sovereign foreign bond up to the market value of its holdings of U.S. sovereign bonds and domestic sovereign bonds. However, the former is a better collateral than the latter. Therefore, both bonds will carry a convenience yield. The economy is subject to safety shocks: an exogenous increase in the foreign bond's convenience yield. This shock resembles a global flight to safety episode, and I calibrate it following Kekre and Lenel (2021). The model matches the empirical responses of the local convenience yields to the different shocks, characterizes the effects of safety shocks on small open economies, and quantifies the role of safety demand on SOE's business cycles. Against a safety shock, the EME household increases its holdings of foreign bonds, and there is a drop in consumption. At the same time, the local sovereign bond has a negative realized excess return due to the home goods' depreciation. As a result, the local sovereign bond endogenously loses its safety status against both the non-sovereign and the sovereign foreign bond, and the convenience yield drops.

The effect of the safety shock is markedly different from the effect on small open economies of interest rate shocks (Uribe & Yue, 2006; Mendoza, 2010) or risk premium shocks (Farhi & Werning, 2012). A drop in the world interest rate in those papers increases borrowing, consumption, and investment and decreases net exports. In contrast, although world rates drop, a safety shock produces a dollar appreciation, a drop in consumption (via more savings in the global safe asset), and an improvement in the trade balance.

The quantitative exercise shows that safety shocks increase the volatility of the local sovereign bond rate due to the convenience yield's procyclicality. It also explains around 2% of output volatility and 9% of consumption volatility in the small open economy. These effects are relevant compared to the quantitative exercise in Uribe and Yue (2006), who explore the role of shocks to world interest rates and country spreads in small open economies. My results suggest that demand for safety and convenience yields account for 10% of the effect of world interest rate shocks and almost 20% of the impact of country spreads shocks on local economic activity. In addition, in a version of the model where the local sovereign bond does not work as collateral at all, output and consumption volatility are higher. In contrast, the local bond rate is 13% less volatile, which comes from the relevance of the safety shocks and the convenience yield's procyclical response.

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 et al., 2015; Del Negro et al., 2017a) and against sovereign bonds of other advanced countries (Du et al., 2018; Jiang et al., 2021). Du and Schreger (2016) apply a similar methodology to analyze EMEs' sovereign bonds, but they aim to explain local versus foreign-currency credit spreads. Engel (2016), Jiang, Krishnamurthy, and Lustig (2021), and Engel and Wu (2023) find that increases in non-pecuniary benefits related to safety or liquidity drive an appreciation of the currency, and can help to explain some exchange rate puzzles.

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

Theoretically, my approach is novel as it is the first to build on the small open economy model and analyze the interaction of two competing safe assets (local and foreign bonds). Unlike my approach, the safe asset literature has focused on the international role of dollar debt as a global safe asset (Brunnermeier & Sannikov, 2019; Jiang et al., 2019; and Kekre and Lenel, 2021). These papers do not take the stand of a small open economy, do not consider the interaction between safe assets of different countries and usually rely on exogenous convenience yields.

This paper contributes to understanding the interaction of small open economies with the global financial cycle. Kalemli-Ozcan (2019) highlighted the response of risk premia in emerging markets against U.S. monetary policy. Brunnermeier et al. (2020) analyze monetary and macroprudential policy implications of international capital flows for EMEs, but theirs is a partially-fledged international model specific to developing countries.

Finally, by documenting the existence of domestic safe assets and their interaction with the U.S. Treasury, this paper can contribute to the discussion on the scarcity of safe assets (Caballero et al., 2016, 2017). Recently, Mendoza and 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 and shows a preliminary time series analysis. 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 Data and Derivation

In this section I explain the derivation of the local-currency convenience yield under two measures. The first is the "domestic convenience yield", and considers an investor that compares returns of only domestic assets and measures returns in the domestic currency. The second will be called the "dollar investor's convenience yield", and considers an investor that measures returns in dollars and compares the local-currency sovereign bond with a non-Treasury safe dollar bond.

2.1.1 Domestic convenience yield

Here I follow closely the derivation in Krishnamurthy and Vissing-Jorgensen (2012). In the next subsection, where I derive the dollar-investor's convenience yield, I extend the framework to include assets in different currencies.

Start by modifying a standard representative agent model to include a term whereby agents derive utility directly from holding a "convenience" asset (Sidrauski, 1967; Krishnamurthy and Vissing-Jorgensen, 2012). A representative investor i maximizes

$$E\sum_{t=1}^{\infty}\beta^t u(c_t+\nu_i(\theta_{j,t},\mathrm{GDP}_t;\zeta_t)) \tag{1}$$

where $i\in\{d,f\}$ for domestic investor or foreign investor, respectively. c_t is consumption from an endowment stream and the second term are "convenience" benefits of holding bonds from country j, $\theta_{j,t}$. For the domestic convenience yield, $i=j$ and the investor measures returns in the same currency denominating the assets.

The function $\nu_i(\cdot)$ is a reduced-form way of capturing non-pecuniary benefits from the safety and liquidity of bonds from country j, $\theta_{j,t}$. For example, the benefits of holding a liquid asset that eases transactions (as collateral), or the benefits from holding an asset that promises stable nominal returns. In this paper, I will not empirically distinguish between safety and liquidity benefits. These assets could be sovereign bonds, $\theta^T_{j,t}$, or private assets that share to some extent these characteristics, $\theta^P_{j,t}$ (like insured bank deposits, central bank reserves, or corporate bonds of highly rated companies). Then, $\theta_{j,t}=\theta^T_{j,t}+k_t\theta^P_{j,t}$, where k_t measures the (possibly time-varying) relative convenience services provided by private assets and sovereign bonds. The term ζ_t is a preference shock that affects how much utility is derived from convenience assets. The income of the agent is GDP_t, which is measured in real terms.

Assume that the convenience function is homogeneous of degree one in GDP_t and $\theta_{j,t}$. Thus define $v_i(\frac{\theta_{j,t}}{\mathrm{GDP}_t};\zeta_t)\mathrm{GDP}_t\equiv\nu_i(\theta_{j,t},\mathrm{GDP}_t;\zeta_t)$. Assume that the convenience function is increasing in $\theta_{j,t}/\mathrm{GDP}_t$ for all j, but the marginal convenience benefit is decreasing in $\theta_{j,t}/\mathrm{GDP}_t$, and $\lim_{\theta_{j,t}/\mathrm{GDP}_t\to\infty}v_i'(\theta_{j,t}/\mathrm{GDP}_t;\zeta_t)=0$.

The Euler equation for holdings of sovereign bonds, $\theta^T_{j,t}$, gives the following expression for its price, P^j_t (in the case of no default risk):

$$P^j_t=E_t[M_{t+1}P^j_{t+1}]\Lambda^{j,i}_t$$

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. $\Lambda^{j,i}_t\equiv 1/(1-v_i'(\theta_{j,t}/\mathrm{GDP}_t;\zeta_t))$ captures the marginal benefits investor i derives from these bonds. A positive marginal value of convenience by investor i, $v'_i(\cdot)$, raises $\Lambda_t^{j,i}$, and therefore raises the price of the bond, P_t^j.

Now, consider a domestic investor, $i = d$, that has the alternative of investing in a domestic sovereign bond (with some level of default risk), and a private asset (with a higher default risk) but with lower convenience services.

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

$$y_t^p - y_t^j \approx (\lambda_t^{j,d} - \lambda_t^{p,d}) + (l_t^p - l_t^j) \tag{2}$$

where $\lambda_t^{j,d}$ measures the marginal safety/liquidity services the domestic investor (d) derives from the sovereign bond of country j (the convenience yield), $\lambda_t^{j,d} \approx v'_d(\theta_{j,t}/GDP_t;\zeta_t)$, and $\lambda_t^{p,d} \approx k_t v'_d(\theta_{j,t}/GDP_t;\zeta_t)$; l_t^p and l_t^j are the expected losses upon default for each asset.

Proof: see the Appendix.

Therefore, data on spreads between the two tyes of assets measures the differential convenience yield and the differential default risk. I can account for the default risk of these assets, which will isolate the differential convenience yield. The derivation in Krishnamurthy and Vissing-Jorgensen (2012) assumes that the domestic private asset provides zero convenience benefits, and therefore they equate the spread in (1) with the whole convenience yield of the sovereign bond. Here I am allowing the domestic private asset to provide some (but lower) convenience benefits. I consider it a more accurate description of the data, as it is very likely that secured private deposits or term deposits share some safety and liquidity benefits. However, henceforth whenever I mention the "domestic convenience yield" I will be referring to this differential convenience yield.

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

The Appendix describes the series and 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 has the alternative of investing in a non-Treasury safe dollar bond (such as a highly rated U.S. corporate bond or a U.S. agency bond), whose yield is given in the following Proposition (all proofs are in the Appendix).

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

$$y_t^{US} \approx y_{rf,t}^{US} - \lambda_t^{US,f} + l_t^{US} - \xi_t^{US} \tag{3}$$

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 loss upon default and ξ_t^{US} is the covariance between default risk and the convenience yield.

Equation (3) 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. In addition, the yield of the bond is higher the larger the expected loss upon default, l_t^{US}, as investors require a compensation for this risk. The covariance ξ_t^{US} measures how the convenience yield reacts to default risk. If the convenience yield drops in states where default risk is higher, the covariance is negative and the investor will require a higher yield on the bond, y_t^{US}.

Alternatively, the investor can purchase a local-currency sovereign bond from country j ($j \neq$ US) with all the cash flows swapped into dollars. This is called a synthetic dollar bond, and it involves the purchase of the local-currency bond and a forward contract to set the future exchange rate at which the cash flows will be swapped.

Proposition 3. *The yield on the synthetic dollar bond can be calculated as the yield of the local-currency bond of country j ($j \neq US$) , y_t^j, minus the forward premium between the local currency and the dollar, $\rho_{j,t} = logF_{t+1} - logS_t$, 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, $y_t^j - \rho_{j,t}$, can be decomposed as:

$$y_t^j - \rho_{j,t} \approx y_{rf,t}^{US} - \lambda_t^{j,f} + (l_t^j - q_t^j) + (k_t^j - p_t^j) - \xi_t^j - \psi_t^j \tag{4}$$

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

Again, the larger the safety and liquidity services of the local-currency sovereign bond, the larger $\lambda_t^{j,f}$ and the lower the equilibrium yield on the synthetic bond. The term k_t^j 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. Equation (4) shows that the risk of regulations increases the yield on the synthetic bond. Both the default risk and k_t^j are net of their covariance with currency risk. Intuitively, when dollar investors invest in local-currency EME sovereign bonds, default or capital controls cause an additional, indirect extra loss on them. They not only receive fewer 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 yield on the synthetic bond underestimates the risk of loss upon these events. The terms ξ_t^j and ψ_t^j show that when these covariances are negative (meaning the convenience yield drops when default risk or capital control risk increases), this increases the required yield on the synthetic bond.

Propositions 1 and 2 give the yields of two bonds denominated in dollars. Therefore, the spread between the two does not contain currency risk. Given these two decompositions, the premium the dollar investor is willing to pay for the safety and liquidity of EME local-currency bonds against non-Treasury safe dollar bonds is given by $\lambda_t^{j,f} - \lambda_t^{US,f}$. The two expressions in (3) and (4) can be combined to give an expression for this premium:

$$
\begin{aligned}
\underbrace{\lambda_t^{j,f} - \lambda_t^{US,f}}_{\text{EME convenience yield}} &= \underbrace{y_t^{US} - (y_t^j - \rho_{j,t})}_{\text{CIP deviation}} \\
&\quad - \underbrace{(l_t^{US} - l_t^j)}_{\text{Differential default risk}} + \underbrace{k_t^j}_{\text{Regulatory risk}} \underbrace{- q_t^j - p_t^j - \xi_t^j - \psi_t^j}_{\text{Covariances}}
\end{aligned} \tag{5}
$$

Equation (5) is intuitive. If the yield on the non-Treasury safe dollar bond, y_t^{US}, is higher than the yield on the synthetic bond, $y_t^j - \rho_{j,t}$, this has to be explained either because the former has higher default risk, $(l_t^{US} - l_t^j)$, or because of differences in capital controls risks and other currency covariances. Once we account for those, any remaining positive spread between y_t^{US} and $y_t^j - \rho_{j,t}$ has to be explained by the larger safety/liquidity services of the synthetic bond, $\lambda_t^{j,f} - \lambda_t^{US,f}$. In other words, the EME local-currency convenience yield (on the left-hand side) is the residual once the spread between the non-Treasury dollar bond and the synthetic bond has been cleaned up of differences in default risk, regulatory risks, and other covariances.

This derivation is analogous to the methodology of Du and Schreger (2016) and Du et al. (2018), but extended to fit emerging economies. Du et al. (2018) rely on CIP deviations to estimate how much investors are willing to pay for the safety and liquidity of U.S. Treasuries compared to the sovereign bonds of G10 countries. When considering EMEs, this exercise proves to be incomplete. Not only because default and liquidity risk are much larger, but also because local-currency sovereign bonds in EMEs carry a larger number of risks, like regulatory risks and large currency depreciation during default or capital controls events.

The main challenge is to estimate the variables of regulatory risk and the covariances in Equation (5). I rely on the spread between the synthetic bond and the bond denominated in foreign-currency issued offshore.

Proposition 4. *Let Φ_t^{FC} denote the spread between the yield of the synthetic bond, $y_t^j - \rho_{j,t}$, and the yield of the sovereign bond of country j ($j \neq US$) issued in dollars, $\hat{y}_t^j$. Then,*

$$\begin{aligned} \Phi_t^{FC} &\equiv y_t^j - \rho_{j,t} - \hat{y}_t^j \\ &\approx (\hat{\lambda}_t^{j,f} - \lambda_t^{j,f}) + (l_t^j - \hat{l}_t^j - q_t^j) + (k_t^j - p_t^j) - \xi_t^j - \psi_t^j \end{aligned} \tag{6}$$

where $\hat{\lambda}_t^{j,f}$ and $\hat{l}_t^j$ are the convenience yield and the default risk of the sovereign bond issued in dollars, respectively.

As long as $\hat{l}_t^j \approx l_t^j$ and $\hat{\lambda}_t^{j,f} \approx \lambda_t^{j,f}$, the expression Φ_t^{FC} will be approximate equal to the term on capital control risk plus covariances in (5). Intuitively, EME sovereign bonds denominated in foreign-currency do not carry the currency covariances. Furthermore, they do not carry the convenience yield of *local*-currency bonds. And finally, EME sovereign bonds denominated in foreign currency are almost entirely issued in foreign jurisdictions and under foreign law, and thus are not subject to the imposition of capital controls and other regulations.

The condition $\hat{l}_t^j \approx l_t^j$ requires that the default risk of the EME sovereign is approximately equal for local versus foreign currency-denominated debt (I discuss this in Appendix C). On the other hand, the condition $\hat{\lambda}_t^j \approx \lambda_t^j$ holds as long as the dollar investor derives approximately the same convenience services from EME sovereign bonds denominated in either currency. I will maintain this assumption henceforth. Previous evidence has found that swapped local-currency bonds are slightly more liquid than foreign currency-denominated debt. Du and Schreger (2016) studied a sample of EMEs and found a mean bid-ask spread of 11.1 basis points for the swapped bond versus 14.5 basis points for the foreign currency bond.

The term Φ_t^{FC} can be substituted in equation (5) to obtain the following:

$$\lambda_t^{j,f} - \lambda_t^{US,f} = y_t^{US} - (y_t^j - \rho_{j,t}) + (l_t^j - l_t^{US}) + \Phi_t^{FC} + \xi_t^{US} \tag{7}$$

On the left-hand side, I have the desired convenience yield of EME sovereign bonds against non-Treasury safe dollar bonds. Appendix C describes all data sources for each variable in the right hand side of Equation (2.3).

The nine countries included in the rest of the paper are Brazil, Chile, Colombia, Indonesia, Mexico, Peru, the Philippines, South Africa and Turkey. This selection is based solely on data availability.

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	62.83	28.76	n.a.	n.a.	n.a.	-
Chile	April 2011	43.72	25.11	May 2010	60.63	33.42	0.3253***
Colombia	December 2007	24.09	25.99	June 2005	53.72	64.76	0.4749***
Indonesia	February 2015	29.06	15.1	February 2003	85.03	56.74	0.2582***
Mexico	December 2007	40.63	23.72	July 2011	19.26	14.1	0.5076***
Peru	December 2007	39.40	27.89	n.a.	n.a.	n.a.	-
Philippines	December 2007	34.55	27.71	n.a.	n.a.	n.a.	-
South Africa	December 2013	23.62	36.63	April 2000	66.6	47.24	0.1581***
Turkey	December 2007	-3.42	25.32	October 2006	73.45	101.17	0.0167
United States				February 2006	40.95	12.39	

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

The Appendix discusses common features and financial frictions of EME financial markets that could potentially affect the estimation of the convenience yield according to Equation (2.3): the issuance of eurobonds (local-currency sovereign bonds issued under international law and thus not subject to regulatory risk), the relative illiquidity of forward currency contracts in most EMEs, 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-investor's convenience yield ($\lambda_t^{j,f} - \lambda_t^{US,f}$ in Equation (2.3)), and Columns 4-6 do the same for the domestic convenience yield ($\lambda_t^{j,d} - \lambda_t^{p,d}$ in Equation (2.3)). The last Column shows the correlation between the two measures.

Overall, both measures show positive and sizable averages. The domestic convenience yield measure shows a larger mean compared to the dollar-investor's convenience yield. Column 7 provides an important piece of evidence by showing that the correlation between the two measures is positive and significant.

Moments for two countries deserve more attention. First, in Column 2, Brazil's dollar-investor's convenience yield is an order of magnitude above the rest. The robustness exercise in the Appendix shows that part of it is explained by the illiquidity of forward contracts in Brazilian markets that was used to calculate the yield of the synthetic bond. It also shows that this larger convenience yield represents a smaller share of the total yield of the 5-year sovereign bond (Brazil has one of the highest nominal total yields among these countries).

Second, in Turkey the correlation between the two measures is not significantly different from zero. However, notice that Column 3 shows that local-currency sovereign bonds in Turkey enjoy almost no convenience yield from the dollar-investor perspective. This is consistent with evidence that shows that Turkey has the lowest foreign investors' participation in local-currency sovereign bonds among these nine EMEs (according to BIS data), and the participation has been dropping sharply in recent years

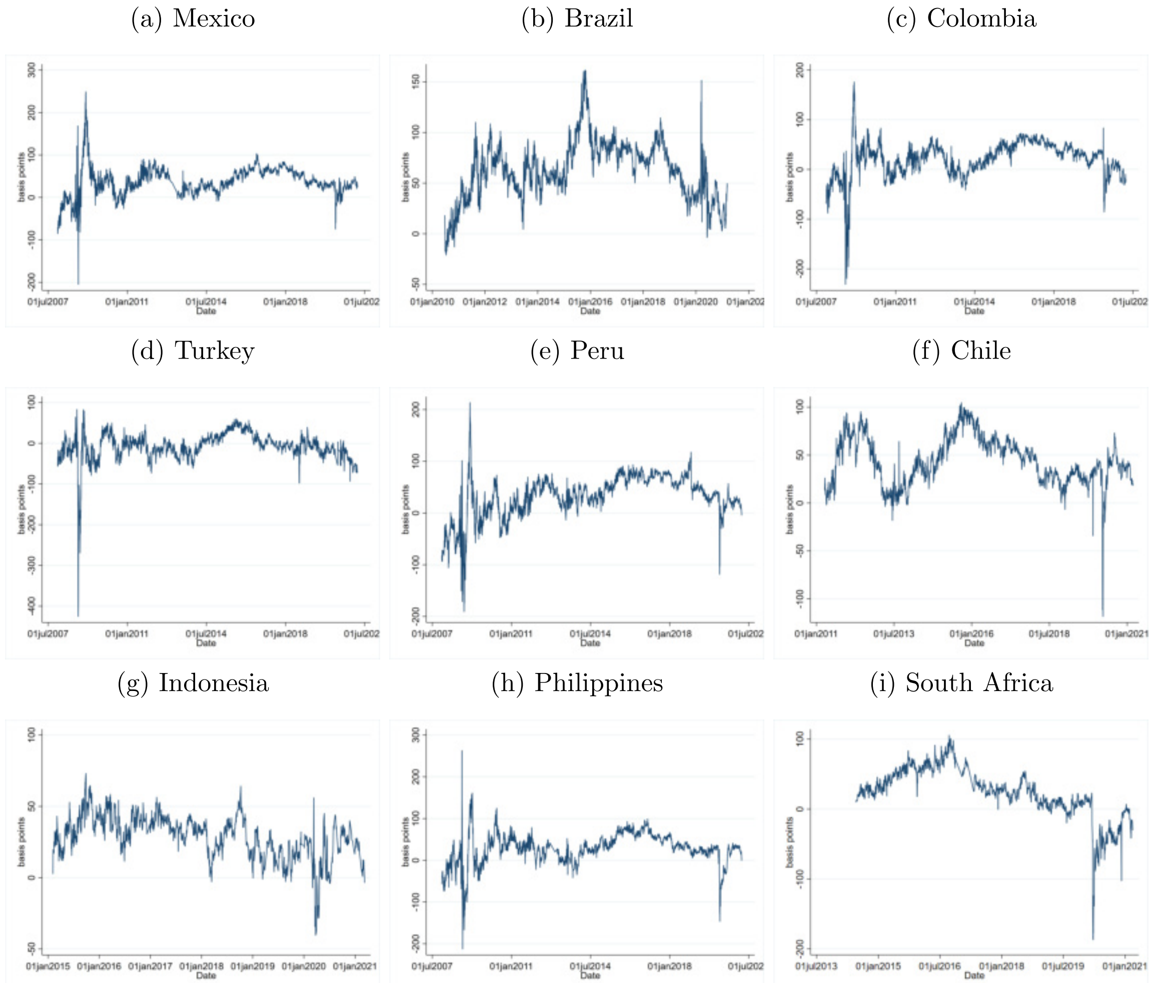
Figure 1 shows the evolution of the dollar-investor's convenience yield computed for the 5-year maturity. First, notice that local-currency convenience yield drops sharply during crises (both the 2008 financial crisis and the Covid pandemic in 2020). In those episodes, the convenience yields turned significantly negative. Negative values must be interpreted as EME sovereign bonds providing less safety and liquidity than non-Treasury U.S. safe debt. Second, there was a widespread increase in local-currency convenience yields around 2014-2016, followed by a persistent decline from then on. Third, not all countries seem to have been affected by the Covid crisis in a similar way. Large drops in local-currency convenience yields happened in Mexico, Peru, Chile, Indonesia, the Philippines, and South Africa, while Brazil did not experience a large drop.

The series in Figure 1 shows large increases after large drops during the 2008 crisis, especially for Mexico, Colombia, Peru, and the Philippines. This noise might be explained by EME bonds becoming illiquid during periods of financial stress. In particular, during 2008, there was a significant increase in CDS spreads that might have been driven by mispricing of these contracts. This concern will be more formally addressed in the empirical section.

The Appendix shows how economically relevant are these magnitudes by showing this the local-currency convenience yield as a proportion of the total yield of the local-currency bond. In addition, 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 computed in Du et al. (2018) for G10 countries).

Figure 2.3 shows the evolution of the domestic convenience yield for the 1-year sovereign bond. The same patterns can be observed. Since this measure does not use data on CDS and forward premia, the series show less noise during crises. Still, large drops can be observed during the financial crisis of 2008 (in Colombia, Indonesia, and Turkey) and during the Covid shock. As for the latter, two notable exceptions are Chile and Indonesia.

Figure 1: Dollar-Investor's Convenience Yield on 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

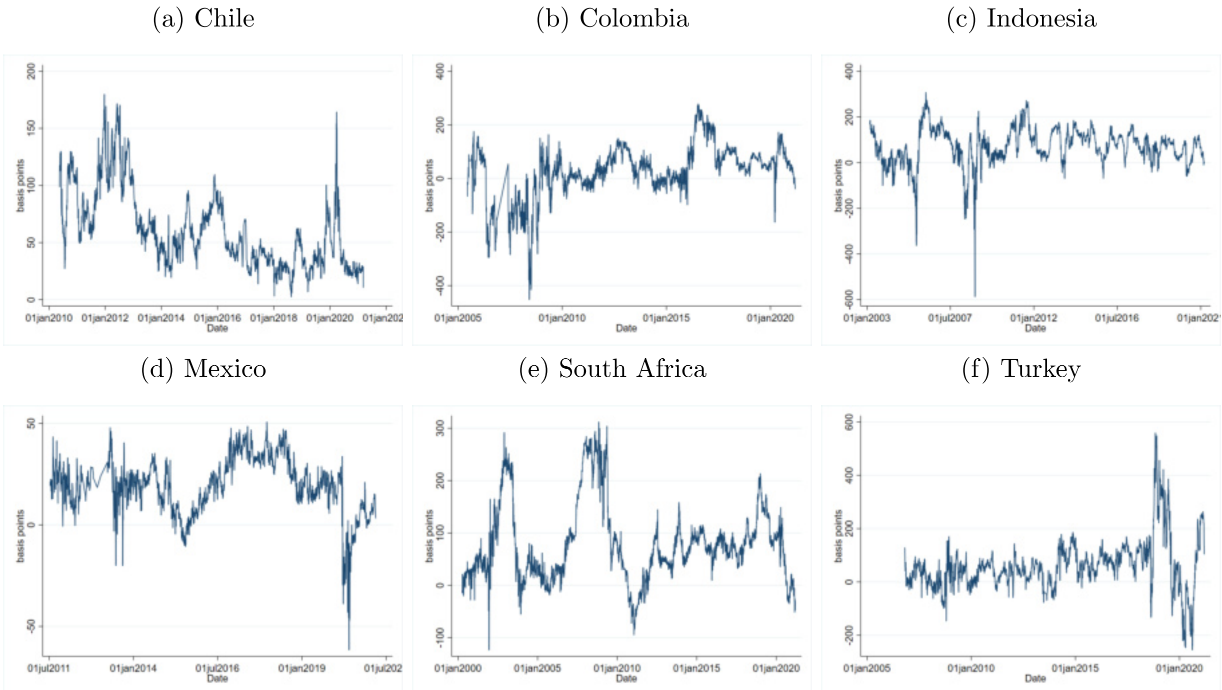
2.3 The Role of Safety/Liquidity Services

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

$$cy_{i,t} = \beta_1 i^{MP}_{t-1} + \beta_2(\text{Gov. debt supply/GDP})_{t-1} + \beta_3 i^{US}_t + \beta_4 X_t + c_i + \tau_t + \epsilon_{i,t} \tag{8}$$

where i is currency/country, t is time, and $cy_{i,t}$ is either the dollar-investor's or the domestic convenience yield. The variable i^{MP} is the level of the local monetary policy rate, which proxies for the supply of alternative safe assets other than government bonds. In terms of the model in Equation (1), this is a proxy for $k_t\theta^P_{j,t}$. Interest rate hikes drain the supply of central bank reserves and of private deposits. Therefore, if the estimated convenience yields capture safety/liquidity services, they should respond positively to a drop in the supply of alternative safe assets and

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



to interest rate hikes (see Nagel, 2016). The inclusion of i_t^{US} serves the same purpose, but for alternative safe assets denominated in dollars.

$(\text{Gov. debt supply/GDP})_t$ is the outstanding supply of government debt. Here I added both the local-currency sovereign debt as well as U.S. government debt supply. Both quantities are net of central bank holdings. If there is a demand for safety and liquidity from investors, the convenience yields should respond negatively to this supply. In terms of (1), this is a proxy for $\theta^T_{j,t}$. The coefficient β_2 represents the slope of the demand curve for safe assets. X_t refers to other control variables.

The independent variables are lagged one month to avoid endogeneity and reverse causality as much as possible (I address endogeneity in a different way in Section 3.3 below). The variables c_i and τ_t are country and time fixed effects, respectively, that allow to control for time and country-specific factors. I double-clustered the standard errors across year and country.

Table 2 shows the results. Columns 1 and 4 show that both measures respond positively to the level of the monetary policy rate. As explained above, this is the sign one expects if EME local-currency convenience yields arise from liquidity and safety benefits: a higher monetary policy rate is related to lower supply of private safe assets, increasing the convenience yield on other remaining safe assets, such as government debt.

The local monetary policy rate has a larger effect on the domestic convenience yield, while the U.S. monetary policy rate has a larger effect on the convenience yield measured in dollar terms.

Table 2: Determinants of Convenience Yields

	Dep. var.: dollar CY			Dep. var.: domestic CY		
	(1)	(2)	(3)	(4)	(5)	(6)
Local MP rate$_{t-1}$	0.867*	1.504**	0.974	10.51***	16.68***	16.62***
	(0.509)	(0.688)	(0.744)	(1.486)	(4.787)	(4.765)
U.S. fedfunds rate$_{t-1}$	11.66***	8.673***	7.288*	1.649	-5.392	-5.072
	(3.269)	(3.019)	(4.276)	(9.517)	(12.88)	(12.72)
$\log(\frac{\text{Local gov debt}}{GDP_{local}})_{t-1}$	14.33*	13.76*	-1.603	-31.73***	-38.93***	-38.96***
	(8.018)	(7.902)	(10.519)	(10.50)	(11.24)	(11.26)
$\log(\frac{\text{U.S. gov debt}}{GDP_{US}})_{t-1}$	-131.0***	-145.1***	-159.2***	119.4	103.3	103.5
	(39.74)	(40.39)	(57.59)	(87.53)	(106.44)	(106.4)
Credit risk		-0.058	-0.039		-0.053	-0.053
		(0.034)	(0.045)		(0.999)	(0.100)
Output gap			18.09**			-5.735
			(8.860)			(11.98)
Constant	-297.0***	-305.8***	-319.7***	20.2	-53.00	-52.69
	(71.78)	(70.40)	(104.1)	(127.9)	(153.8)	(153.7)
Observations	1,137	1,132	829	955	730	730
R-squared	0.670	0.674	0.702	0.324	0.328	0.328

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. Both U.S. debt and EME local-currency debt-to-GDP variables are net of the central bank's holdings. The output gap is measured as the 12-month log difference in industrial production (OECD series, data available for Brazil, Chile, Colombia, Mexico, Indonesia, South Africa, and Turkey). *** $p<0.01$, ** $p<0.05$, * $p<0.1$

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 large negative effect on the domestic convenience yield, and the supply of U.S. government debt has a negative effect on the dollar-investor's convenience yield. This suggests that both measures of convenience yields correctly capture the currencies that are relevant 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 key result. As explained above, if the measures of local-currency convenience yield are actually capturing demand for safety and liquidity, then the estimated coefficient represents the slope of the demand for safe assets and, therefore, should be negative.

Columns 2 and 5 add a measure of credit risk (the monthly CDS spread). As in Krishnamurthy and Vissing-Jorgensen (2012), this is a robustness check to ensure the two convenience yield measures are not capturing standard default risk. In terms of Equations () and (), this covariate controls for the effect of differential credit risk, $(l_t^j - l_t^{US})$.

Results in Table 2 are robust to including a time trend (that controls for trends in the dependent variable) and to including 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 Empirical Analysis

Having estimated the size of the EMEs convenience yields and showed evidence that they actually come from investors' safety and liquidity demand, this section analyzes their dynamics.

3.1 EME Local-Currency Convenience Yield and the Local Financial Cycle

Results shown in Table 2 above can be given an interpretation that describes the dynamics of the EME local-currency convenience yield along the local financial cycle. By the latter I refer to the short-term variations in supply of- and demand for- local currency liquidity along the local business cycle.

The main determinant of the local financial cycle is the stance of monetary policy defined by the local central bank. During recessions, investors increase their demand for money as a safe haven and a source of liquidity. If investors perceive the local currency as providing these services, then the local central bank responds by lowering rates and increasing the supply of local-currency reserves, and banks by increasing the supply of local-currency deposits. This increased supply of local-currency liquidity reduces the marginal convenience yield of all liquid assets in the economy, including the convenience yield of local-currency government bonds.

De Leo et al. (2022) have recently shown that monetary policy is countercyclical in EMEs, meaning that the central banks cut rates during recessions. According to the intuition above, this shows that money in the form of central bank reserves and private deposits are valued by investors in EMEs along the local business cycle. The positive coefficient of the local monetary policy rate in

Table 2 suggests that local-currency government debt plays the same role along the local business cycle.

To further test the dynamics of the local-currency convenience yield along the local business cycle, in Columns 3 and 6 of Table 2 I add a proxy for the output gap. The coefficient on the output gap will measure the cyclicality of the local-currency convenience yield conditional on the short-term policy rate, the supply of safe assets, and demand shifters such as the U.S. interest rate. I measure the output gap using the year-on-year change in the log of industrial production index. This index is available monthly only for seven of the countries considered (not available for Peru and the Philippines).

In Column 3 (for the dollar-investor convenience yield), the inclusion of the output gap makes both the local monetary policy rate and the supply of debt to become statistically non-significant. This can be interpreted as the output gap not having an independent impact, but rather having an influence on the convenience yield *through* the response of monetary and fiscal policy. This reinforces the finding that monetary policy is countercylical: when the output gap is negative the central bank lowers the local interest rate. This further supports the role of the local-currency convenience yield described above.

As for fiscal policy, it implies that the effect of the debt-to-GDP ratio is mostly driven by the dynamics of the denominator. A lower output gap increases the debt-to-GDP ratio (the supply variable) and this reduces the convenience yield.

Overall, the evidence shows that convenience yields respond in the "right" direction along the local financial cycle: the safety status of local-currency government debt increases when the supply of safe assets (either in the form of central bank liabilities or government borrowing) decreases.

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 aversion as the main driver. 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.

Miranda-Agrippino and Rey (2021) document that the VIX is strongly correlated with a global factor that explains about a quarter of the variance in risky asset prices and about 35% of the variance of gross capital flows. This evidence supports the wide acceptance of the VIX as a measure of global risk aversion and as the main driver of the global financial cycle. They also review the findings linking the U.S. monetary policy decisions with perceptions of global risk aversion. Rey

(2013) found that reductions in the federal funds rate were associated with reductions in the VIX after about 4 quarters. The mechanism would go as follows: the lower federal funds rate would decrease the cost of dollar funding, encouraging leverage in global banks, which increased credit flows and led to a lowering of the perception of risk.

These findings may alter the interpretation of some of the results in the previous section. There, I found that increases in the federal funds rate increased the convenience yield of EMEs' local-currency sovereign bonds. To be sure that this captures the effect of the supply of dollar liquidity, I need to control for the impact of the federal funds rate on global risk aversion.

Table 3 shows the results, where I added the VIX index as a proxy for global risk aversion. The coefficient on the VIX is negative and statistically significant for the dollar-investor convenience yield. This is a striking result as it is the opposite of the response of convenience yields in advanced economies. This suggests that the safety status of local-currency sovereign bonds decreases during periods of high risk aversion. In the U.S., a rise in the VIX increases the convenience yield on its debt, driving dollar rates down and creating liquidity shortages.

Notice that the federal funds rate loses its significance. However, since both the federal funds rate and the VIX are identified at the time series dimension (they do not vary at the cross-section dimension), this exercise still cannot completely distinguish between them. The empirical exercise in Section 3.3 will address this issue an be able to disentangle their effect. This will also clarify the effect of the VIX on the domestic currency convenience yield.

Next, 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 mentioned earlier, the VIX is strongly correlated with a global factor that explains about 35% of the variance of gross capital flows. As the global financial cycle literature suggests, a lower federal funds rate lowers dollar funding costs, lowering risk perception and encouraging credit and capital inflows. If the coefficient of the VIX index keeps its significance after controlling for capital inflows this would confirm that global uncertainty has a negative effect on its own.

In Columns 2 and 5 I added capital inflows disaggregated by the sector to which they are directed (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).

Notice that capital inflows into bank debt significantly reduce the dollar-investor convenience yield. That this effect shows up in inflows to bank debt might be explained by the fact that most of the sovereign debt in EMEs is held by local banks. However, it is very difficult to further interpret these coefficients on their own, becuase the data does not report the currency denomination of these inflows.

In Column 3 and 6, I control for the terms of trade for each country, measured as the commodity price index of exports over the equivalent for imports. This is an important robustness check as

Table 3: Convenience Yields and the Global Financial Cycle

	Dep. var.: dollar CY			Dep. var.: domestic CY		
	(1)	(2)	(3)	(4)	(5)	(6)
Local MP rate$_{t-1}$	1.167**	1.106**	2.244***	10.29***	10.58***	6.322***
	(0.527)	(0.534)	(0.742)	(1.529)	(1.561)	(1.936)
$\log(\frac{\text{Local gov debt}}{GDP_{local}})_{t-1}$	15.07*	14.19*	6.333	-32.03***	-30.73***	-40.85***
	(8.015)	(7.869)	(9.274)	(10.55)	(10.32)	(10.95)
$\log(\frac{\text{U.S. gov debt}}{GDP_{US}})_{t-1}$	-139.2***	-133.5***	-121.6***	109.4	98.48	55.47
	(36.71)	(35.88)	(41.86)	(85.62)	(86.50)	(86.67)
U.S. fedfunds rate$_{t-1}$	3.229	3.376	4.294	6.187	3.864	1.571
	(2.822)	(2.792)	(4.261)	(10.56)	(10.71)	(11.65)
vix$_{t-1}$	-1.015***	-1.026***	-1.125***	0.686	0.743	0.639
	(0.299)	(0.296)	(0.407)	(0.469)	(0.477)	(0.525)
$(\frac{GovdebtInflow}{GDP})_{t-1}$		-1.152			1.949	
		(1.749)			(4.512)	
$(\frac{BankdebtInflow}{GDP})_{t-1}$		-2.702**			5.788	
		(1.246)			(4.123)	
$(\frac{CorpdebtInflow}{GDP})_{t-1}$		1.703*			3.583	
		(0.936)			(2.318)	
Terms of trade			-156.5			-304.5
			(102.3)			(344.3)
Diff. Inflation			-1.098			7.958***
			(0.784)			(1.855)
Democratic risk			-10.42**			-13.88
			(4.610)			(11.18)
Constant	-250.4***	-242.8***	469.0	-10.29	-27.53	1355.2
	(62.97)	(62.6)	(478.6)	(127.8)	(127.0)	(1567.2)
Observations	1,137	1,137	1,012	955	955	871
R-squared	0.692	0.696	0.714	0.326	0.334	0.427

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 ends in March 2021 for all. Capital inflows-to-GDP variables are standardized by mean and standard deviation of each country. "Diff. inflation" is 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 mean and standard deviation of each country (higher values reflect higher risk). *** p<0.01, ** p<0.05, * p<0.1

Miranda-Agrippino and Rey (2021) found that a global factor highly correlated with commodity indices and international trade was the second main factor for capital flows and additionally explained 31% of the variance of fluctuations in private liquidity worldwide. The estimation shows that my results regarding the local-currency convenience yield were not driven by this global factor. More importantly, it provides further evidence that local-currency convenience yields are driven by risk perceptions rather than factors related to trade.

One last robustness exercise consists of introducing local secular factors that do not vary at the business cycle frequency. It is natural to expect that EMEs with better institutions, governance, and higher levels of investor confidence would enjoy a higher local-currency convenience yield. It might be the case that the global determinants I have considered so far are just masking these local secular factors. To check this possibility, in Columns 3 and 6 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. I standardized this index so higher values mean higher political risk. The results show that higher political risk decreased the dollar-investor convenience yield, but, importantly, it did not account for the effect of the global determinants.

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

3.3 Event Studies

In this subsection, I address two possible econometric issues in the previous section. First, the local monetary policy rate is likely to be endogenous, as an unobserved liquidity demand shock can affect both the local central bank's rate decisions and the local-currency convenience yield. Second, both the U.S. federal funds rate and the VIX index only vary at the time series dimension, making it difficult to correctly disentangling their effects.

To address these issues, I conducted event studies within narrow windows around monetary policy movements and risk-on events. In particular, I tested the panel specification:

$$\Delta cy_{i,t} = c_i + \tau_t + \gamma \times MPM_t^i + \beta \times MPM_t^{US} + \delta \times RP_t + \epsilon_{i,t} \tag{9}$$

In Equation (9), MPM_t^{US} is the change in the 2-year U.S. Treasury yield between the closing of the business day before and the day after each monetary policy meeting of the U.S. Federal Reserve. The rationale for this measure, proposed by Hanson and Stein (2015), is that the actual federal funds rate changes are infrequent and often anticipated by the market. Moreover, relevant information could be presented at each meeting about the course of monetary policy that would be missed if one used only the contemporaneous federal funds rate. For these reasons, the authors proposed using a relatively short-maturity yield for capturing changes in the stance of future monetary policy that could arise from information released during FOMC meetings. MPM_t^i is the analogous variable for local monetary policy, i.e., the change in the local-currency 2-year yield sovereign bond around monetary policy meetings of the local central bank.

RP_t is a global risk-on event, defined as a date on which the VIX had a daily variation (either positive of negative) larger than two standard deviations (computed on the daily average change in the period January 2003 through December 2019). Then, I defined the risk-on shock as the 2-day differential in the VIX around those days. c_i and τ_t are currency and year fixed effects, respectively, that control for common events that could affect yields. $\epsilon_{i,t}$ are clustered standard errors around currency and year.

The left-hand side of Equation (9) is the change in the local-currency convenience yield between the close of the business day after and the day before each monetary policy meeting and risk-on event. As before, this is the convenience yield on the 5-year local-currency sovereign bond.

Between December 2007 and March 2021, there were 103 FOMC meetings of the Fed, and an average of 144 local monetary policy meetings in emerging markets (most of which hold monthly meetings, whereas the Fed only conducts eight meetings a year). There were 1,073 risk-on events on the daily sample.

To interpret the results as causal forces affecting the local-currency convenience yield, the three events defined above must not overlap and should not be contaminated by other economic releases. Albagli et al. (2022), for a larger sample of emerging markets, showed that less than 2% of local monetary policy meetings overlapped with FOMC meetings, and less than 5% overlapped with risk-on events. Similarly, Albagli et al. (2019) showed that economic data releases in the U.S. and emerging markets (including inflation, industrial production, and unemployment new data releases) overlapped at most with 6% of local and U.S. monetary policy meetings.

Table 4 shows the results. Columns provide different specifications for the fixed effects included in the estimation. The effect of local monetary policy is robust: both measures of the local-currency convenience yield significantly increase around local monetary policy tightening, and the effect is larger for the convenience yield measured in domestic currency.

Risk-off events have a negative impact on both measures, although for the countries considered for the domestic convenience yield is not significant. This supports the finding that global events reduce the safety value investors attach to these sovereign bonds.

In addition, these event studies are able to capture the isolated impact of the federal funds rate: U.S. monetary policy tightening increased the value of the convenience service of local sovereign bonds. This suggests that the U.S. federal funds rate has an impact through the supply of dollar liquidity, which is different from its effect through risk perception.

3.4 Inspecting the Mechanism

This subsection explores possible mechanisms behind the loss of safety status of EMEs' sovereign bonds during global shocks by analyzing 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 triggered a sell-off of sovereign bonds both in the U.S. and in emerging markets.

Table 4: Determinants of Convenience yields - Event Studies

	Dep. var.: Δ dollar CY		Dep. var.: Δ domestic CY	
	(1)	(2)	(3)	(4)
MPM_t^i	0.185***	0.184***	0.335***	0.336***
	(0.0585)	(0.0576)	(0.1017)	(0.1013)
MPM_t^{US}	0.401*	0.403*	0.340	0.358
	(0.212)	(0.210)	(0.336)	(0.340)
RP_t	-1.055***	-1.074***	-1.040	-1.033
	(0.293)	(0.286)	(1.068)	(1.0733)
Constant	-1.497	-2.313	-1.027	0.150
	(1.506)	(1.568)	(1.586)	(1.733)
Currency FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Month FE	N	Y	N	Y
Observations	22,695	22,695	17,414	17,414
R-squared	0.007	0.009	0.007	0.008

Notes: Data are at daily frequency. Standard errors are double-clustered by country and year. Column 4 excludes crises (January 2010-December 2019). MPM^i stands for local central banks' meetings, MPM^{US} stands for U.S. Fed's FOMC meetings. RP_t are risk-on events measured by the VIX intraday variation. *** p<0.01, ** p<0.05, * p<0.1

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 an increase in risk and a capital inflow reversal for EMEs, but 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) and in the fact that it also drove a sell-off of U.S. Treasuries.

In Table 5 I use the dollar-investor convenience yield on the left-hand side and I interact the shocks with the explanatory variables to differentiate among possible channels. In the case of the Taper Tantrum, the coefficient of the interaction between the shock and the local monetary policy rate is statistically significant. The monetary policy rate proxies the price of alternative private safe and liquid assets, such as local currency and private deposits. As the central bank tightens, the price of these other assets increases, driving up the price on close substitutes, such as government debt. Interestingly, the positive sign of this coefficient suggests that the convenience yield actually *increased* during the Taper Tantrum. This can be explained by the fact that there was no flight to safety, so local investors still valued the safety/liquidity of the local government bonds. Lastly, the coefficient of the interaction between U.S. debt supply and the Taper Tantrum measures any change in the slope of the demand for global safe assets. This coefficient is not significant, which is again consistent with the lack of a flight to safety episode.

Column 2 shows that the Covid shock significantly reduced the local-currency convenience yield. The interaction with debt supply was significantly negative, suggesting that the demand for global safe assets became significantly steeper. This is consistent with a global flight to the safety of U.S. Treasuries, and with local investors preferring this safe asset over the local one. Another mechanism at work was the overall risk aversion, as shown by the interaction with the VIX.

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 debt, and specially so during downturns. However, if financial repression drives down local yields and it is likely to be enforced during recessions, then it would show up in the data as a countercyclical convenience yield. Another one is inflation risk, since economic activity in EMEs is more likely to face adverse supply shocks. However, this and other risks are already part of the decomposition of local convenience yields in Section 2.

Of course, the mechanism highlighted in this section still leaves questions open. If it is true that the local-currency convenience yield is driven by the existence of alternative safe assets, it still needs to be explained what precise feature of the local-currency sovereign bond makes it a good hedge against shocks like the Taper Tantrum but less preferred than the alternatives during global shocks involving a flight to safety. This question goes beyond the scope of this paper, but it certainly represents a venue for future research.

3.5 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 data on local assets spreads show that 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 a reserve currency country. 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 risk aversion. A comparison between the Taper Tantrum and the Covid shock suggests that the mechanism works through the availability of alternative global safe assets, and is at play for shocks involving global flights to safety.

In the Appendix I ran a series of robustness tests for Sections 3.1-3.4. First, I ran the same regressions but with credit risk as a dependent variable, which is another component of CIP de-

Table 5: Effects of Taper Tantrum and Covid-19 Shocks

Dep. var: $cy_{i,t}$	(1)	(2)
MP rate$_{t-1}$	0.748***	0.838***
	(0.279)	(0.289)
$\log(\frac{\text{US debt to GDP}}{\text{Debt to GDP}})_{t-1}$	-10.82***	-11.49***
	(3.338)	(3.440)
vix$_{t-1}$	-0.361*	-0.405
	(0.203)	(0.262)
$(\frac{DebtInfl}{GDP})_{t-1}$	3.028	2.919
	(2.682)	(2.679)
$(\frac{EqtInfl}{GDP})_{t-1}$	1.629	2.042
	(5.474)	(5.401)
TT$_{t-1}$	3.191	
	(2.671)	
MP rate$_{t-1}$ $\times$ TT	1.899***	
	(0.632)	
$\log(\frac{\text{US debt to GDP}}{\text{Debt to GDP}})_{t-1} \times$ TT	0.328	
	(0.479)	
vix$_{t-1}$ $\times$ TT	-0.554	
	(0.461)	
$(\frac{DebtInfl}{GDP})_{t-1} \times$ TT	0.328	
	(0.479)	
$(\frac{EquityInfl}{GDP})_{t-1} \times$ TT	-3.952	
	(14.18)	
Covid-19$_{t-1}$		-21.38***
		(5.394)
MP rate$_{t-1}$ $\times$ Covid-19		-2.387
		(1.510)
$\log(\frac{\text{US debt to GDP}}{\text{Debt to GDP}})_{t-1} \times$ Covid-19		-2.824***
		(0.623)
vix$_{t-1}$ $\times$ Covid-19		0.722***
		(0.267)
$(\frac{DebtInfl}{GDP})_{t-1} \times$ Covid-19		-2.636
		(5.972)
$(\frac{EquityInfl}{GDP})_{t-1} \times$ Covid-19		-15.80
		(15.02)
Constant	43.91**	47.48**
	(17.11)	(18.38)
Observations	1,137	1,137
R-squared	0.686	0.688

Notes: See Table 3. *TT* is a dummy variable taking the value 1 from May to December 2013. Covid-19 is a dummy variable taking the value 1 from March to June 2020. All columns include country and year fixed effects *** p<0.01, ** p<0.05, * p<0.1

viations. If my decomposition in Section 2 accurately disentangled local-currency bond premiums from default risk, then determinants should be different. The results of that exercise confirm this.

In stark contrast with convenience yields, inflows into government debt decrease credit risk and credit risk does not respond to the supply of safe assets. Second, I also addressed the concern that my results might be driven by periods of high illiquidity and mispricing of EME assets (either sovereign bonds, CDS contracts, or interest rate swaps). I reran the regressions by dropping both the 2008 and 2020 crises in order to only capture only "normal" periods. The results there 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's goal is to (1) match the empirical responses of the local convenience yields to the different shocks, (2) characterize the effects of safety shocks on small open economies, and (3) 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). The EME faces a financial friction: households can borrow up to a fraction of their holdings of U.S. Treasuries and EME local-currency sovereign bonds. Therefore, when the constraint binds, they pay a premium (or "convenience yield") for both sovereign bonds.

The model features three shocks: standard productivity shocks in both countries and a safety shock: an exogenous increase in the collateral quality of US sovereign bonds. This resembles an increase in the global demand for foreign bonds, which provide better "convenience services" than other assets. Kekre and Lenel (2021) show that shocks to safety/liquidity demand for US Treasuries account for 25% of output volatility in the U.S. and 6% of output volatility in the rest of the world.

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)).

4.1 Households

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

$$\mathbb{U}_t = E_t \sum_{i=0}^{\infty} \beta^i \left(\frac{C_{t+i}^{1-\gamma}}{1-\gamma} - \frac{L_{t+i}^{\eta}}{\eta} \right) \tag{10}$$

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: a EME-produced good, $C_{D,t}$, and a US-produced good, $C_{F,t}$. I assume that the index takes the CES form, so

$$C_t = \left[(1-\omega)^{\frac{1}{\theta}} C_{D,t}^{\frac{\theta-1}{\theta}} + \omega^{\frac{1}{\theta}} C_{F,t}^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{11}$$

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:

$$P_t = \left[(1-\omega) P_{D,t}^{1-\theta} + \omega P_{F,t}^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{12}$$

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

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

$$P_t C_t + \frac{Q_t^b}{S_t} b_t + \frac{Q_t^T}{S_t} b_t^{g*} + P_t^b b_t^g \leq \frac{P_t^*}{S_t} b_{t-1} + \frac{P_t^*}{S_t} b_{t-1}^{g*} + P_t b_{t-1}^g + W_t L_t \tag{13}$$

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

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

$$C_t + \frac{q_t^b}{\mathcal{E}_t} b_t + \frac{q_t^T}{\mathcal{E}_t} b_t^{g*} + p_t^b b_t^g \leq \frac{1}{\mathcal{E}_t} b_{t-1} + \frac{1}{\mathcal{E}_t} b_{t-1}^{g*} + b_{t-1}^g + w_t \tag{14}$$

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

$$\mathcal{E}_t = \frac{S_t P_t}{P_t^*} \tag{15}$$

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

$$P_t^* = \left(\omega^*(P_{D,t}^*)^{1-\theta} + (1-\omega^*)(P_{F,t}^*)^{1-\theta}\right)^{\frac{1}{1-\theta}} \tag{16}$$

US households can trade the dollar bond. Their budget contraint in real terms is given by

$$C_t^* + q_t^b b_t^* \leq b_{t-1}^* + w_t^* L_t^* \tag{17}$$

where b_t^* is the number of US bonds held by US 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 (12) and (16), 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:

$$\mathcal{E}_t = \left(\frac{1-\omega^*}{1-\omega} + \frac{(\omega^* - \omega)(p_{F,t})^{1-\theta}}{1-\omega}\right)^{\frac{1}{\theta-1}} \tag{18}$$

According to this expression, a depreciation of the real exchange rate, $\mathcal{E}_t$, lowers the relative price of US goods facing EME households when there is consumption home bias, $\omega^* > \omega$. Notice that home bias is the only source of real exchange rate fluctuation in the model. 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 on both countries. The intuition behind this result is that P_t and P_t^* are consumer-based price indexes, while home bias implies that the US (EME) preference puts higher weight on US (EME) goods than EME (US) preference does.

Financial friction and safety shock. The world credit market is imperfect. Lenders in the US require EME households to guarantee their debt by offering domestic and foreign assets as collateral. The collateral constraint takes the form of the margin requirement proposed by Aiyagari and Gertler (1999) and described in Bianchi and Mendoza (2020):

$$\frac{q_t^b}{\mathcal{E}_t} b_t \geq -(\kappa_t^* q_t^T b_t^{g*} + \kappa_t p_t^b b_t^g) \tag{19}$$

Thus, households can borrow internationally up to a fraction κ_t^* of the market value of US 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 constraint like (19) can be endogenously modeled.

Collateral qualities, captured by κ_t^* and κ_t, follow exogenous process. The safety shock is modeled as an exogenous increase (decrease) in the parameter κ_t^* (κ_t), which affects the relative convenience yields. In particular, these parameters follow an AR(1) process whose statistical moments are calibrated as in Kekre and Lenel (2021),

$$\log \kappa_t = (1 - \rho^s) \log \kappa + \rho^s \log \kappa_{t-1} + \sigma^s \epsilon_t^s \tag{20}$$

This exogenous process captures the impact of global demand for dollar safe assets, on which the small open economy has little influence.

The households' optimality conditions with respect to bond holdings yield the following Euler equations for the foreign and the local sovereign bond, respectively:

$$q_t^T = \beta E\left[\frac{\lambda_{t+1}}{\lambda_t}\right] + \kappa_t^* \frac{\mu_t}{\lambda_t} \tag{21}$$

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

where λ_t and μ_t are the Lagrange multipliers for the budget constraint and the collateral constraint, 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 fo 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 soveregin bond with respect to the foreign sovereign bond is given by:

$$E[R_{t+1}^b - (\mathcal{E}_t/\mathcal{E}_{t+1})R_{t+1}^T] = -\frac{cov(\lambda_{t+1}, R_{t+1}^b - (\mathcal{E}_t/\mathcal{E}_{t+1})R_{t+1}^T)}{E[\lambda_{t+1}]} + \frac{\mu_t(\kappa_t^* - \kappa_t)}{E[\lambda_{t+1}]} \tag{23}$$

On the right-hand side, the first term captures the risk coming from fluctuations in the real exchange rate, which is common in international economics models. The second term corresponds to the differential convenience yield between the two bonds, which depends on how binding the collateral constraint is, μ_t, and the quality as collateral.

The expected excess return for the non-sovereign foreign bond and the local soveregin bond is given by a very similar expression (with $R_{t+1} \equiv 1/q_t^b$):

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

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 (24)). 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 (24)) captures both: it arises from the comparison of the local-currency sovereign bond against non-sovereign assets denominated in foreign goods and, since the EME households in the model are borrowing in foreign goods, this makes them more sensitive to returns measured in the foreign price index.

The convenience yields in the model captures the main empirical properties found in Section 3. First, the convenience yield lowers the equilibrium yield of the bonds, below the level that would be 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 expected future consumption (through $1/E[\lambda_{t+1}]$) which represents a wealth effect.

Equations (23) and (24) make clear that interest rate parity does not hold in this model. Deviations are proportional to the differential convenience yield. This is similar to what happens in the models of Jiang, Krishnamurthy and Lustig (2021) and Engel and Wu (2023), where fluctuations in convenience yields produce deviations from the uncovered interest parity condition.

4.2 Firms

There is a single industry in each country, and each industry is populated by a continuum of identical firms distributed on the interval $[0, 1]$. A representative US firm hires labor L^*_t to produce 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

$$\max_{D^*_{t+i}} \mathbb{E}_t \sum_{i=0}^{\infty} \beta^i \frac{\lambda^*_{t+i}}{\lambda^*_t} \frac{D^*_{t+i}}{P^*_{t+i}} \tag{25}$$

s.t.

$$D^*_t = P^*_{D,t} F(A^*_t, L^*_t) - W^*_t L^*_t \tag{26}$$

where: λ^*_t is the stochastic discount factor of the firms' shareholders. The firms' shareholders are US households, so $\lambda^*_t = C^{*-\gamma}_t$.

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

$$\max_{L^*_{t+i}} \mathbb{E}_t \sum_{i=0}^{\infty} \beta^i \frac{\lambda^*_{t+i}}{\lambda^*_t} \left\{ p^*_{D,t+i} F(A^*_{t+i}, L^*_{t+i}) - w^*_{t+i} L^*_{t+i} \right\} \tag{27}$$

Similarly, a representative EME firm solves

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

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

Production Functions and Productivity Processes. I assume that production functions are Cobb-Douglas: $F(A, L) \equiv AL^{1-\alpha}$, with $1 > \alpha \geq 0$. I also assume that log productivity in each country follows a stationary $AR(1)$ process:

$$\log A^*_t = \rho \log A^*_{t-1} + \epsilon^*_t \tag{29}$$

and

$$\log A_t = \rho \log A_{t-1} + \epsilon_t \tag{30}$$

with $1 > \rho > 0$, where ϵ^*_t and ϵ_t are i.i.d. productivity shocks.

4.3 Government

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

Every period, the government issues new bonds and adjusts the tax rate in order 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 $b^g_{ss} = b^g_t / Y_t$ ($b^{*g}_{ss} = b^{*g}_t / Y^*_t$) at all times. As explained in Bohn (1995), this is an example of a simple policy that stabilizes the debt-GDP ratio over time, which I consider to be representative of both countries.

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

$$\tau_t + p^b_t b^g_{t+1} = b^g_t \tag{31}$$

and

$$\tau^*_t + q^T_t b^{g*}_{t+1} = b^{g*}_t \tag{32}$$

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

4.4 Discussion

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

For the same reason, I abstract from an explicit modeling of financial intermediaries. Akinci and Queralto (2022) use the SOE limit of the two-country model to analyze the effect of US monetary policy spillovers to EMEs, but they do not feature convenience yields. The spillovers work through the incentive constraints of currency-mismatched global intermediaries, which are made binding by dollar appreciations that follow a monetary policy hike in the US. Local and global financial intermediaries could be easily included in my model to analyze the interaction of specific financial frictions with convenience yields.

Finally, there are alternative ways of achieving a convenience yield in a tractable model. For example, Kekre and Lenel (2021) use a bond-in-the-utility-function specification. The convenience yield in this case comes from an unmodeled demand for safety, and convenience yields are exogenous. 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 increased their demand for government bonds, which they could sell to take idiosyncratic investment opportunities. However, to solve the model they make constraint always binding. In contrast, in my model the constraint is occasionally binding in the ergodic set, allowing for states of the world where convenience yields are zero.

4.5 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) fucntions of two exogenous state variables (A_t^* and A_t) and three endogenous state variables, K_t^*, K_t and b_{t-1}. The US bond is in zero neto supply, so $b_t^* - b_t = 0$ by market clearing. Thus b_{t-1} identifies the EME net foreign asset position at the start of period t.

A sequential competitive equilibrium consists of stochastic sequences of allocations

$$\{C^*_{D,t}, C^*_{F,t}, \chi^*_t, b^*_t, L^*_t, C_{D,t}, C_{F,t}, \chi_t, b_t, L_t\}$$

and prices

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

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

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

and

$$Y_t = A_t L^{1-\alpha}_t = C_{D,t} + \frac{1-n}{n} C^*_{F,t} \tag{34}$$

The non-sovereign bonds are in zero net supply, so $0 = b_t + b^*_t$.

I solve for the recursive equilibrium using policy-function iteration, a global method developed by Cao, Luo, and Nie (2023). The method suits dynamic stochastic general equilibrium (DSGE) models with portfolio choices. As the borrowing constraint is tied to the price of capital and the price of the local bond, a shock that reduces asset prices tightens the collateral constraint, leading to deleveraging and reductions in both investment and working capital, so the effect of the shocks gets amplified. The collateral constraint is occasionally binding 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 is able to 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: $\omega^* \to 1$. On the other, I also assume that the US is arbitrarily large relative to the EME, $n \to 1$. The rationale for these assumptions is that the EME is very small in size relative to the United States, and which therefore has negligible weight in US consumption and investment baskets. This implies that the US behaves effectively like a closed economy. I choose to model a small open economy in this way because it allows for a more transparent analysis of both the global and the local safe asset and their effects on convenience yields (see De Paoli (2009) and Akinci and Queralto (2022) for other applications of this framework).

Table 6: Externally Set Parameters

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
κ^*	Foreign collateral	1.4
κ	Local collateral	1.05
ρ^s	Safety persistence	0.4
σ^s	Safety volatility	0.29

5 Macroeconomic Implications

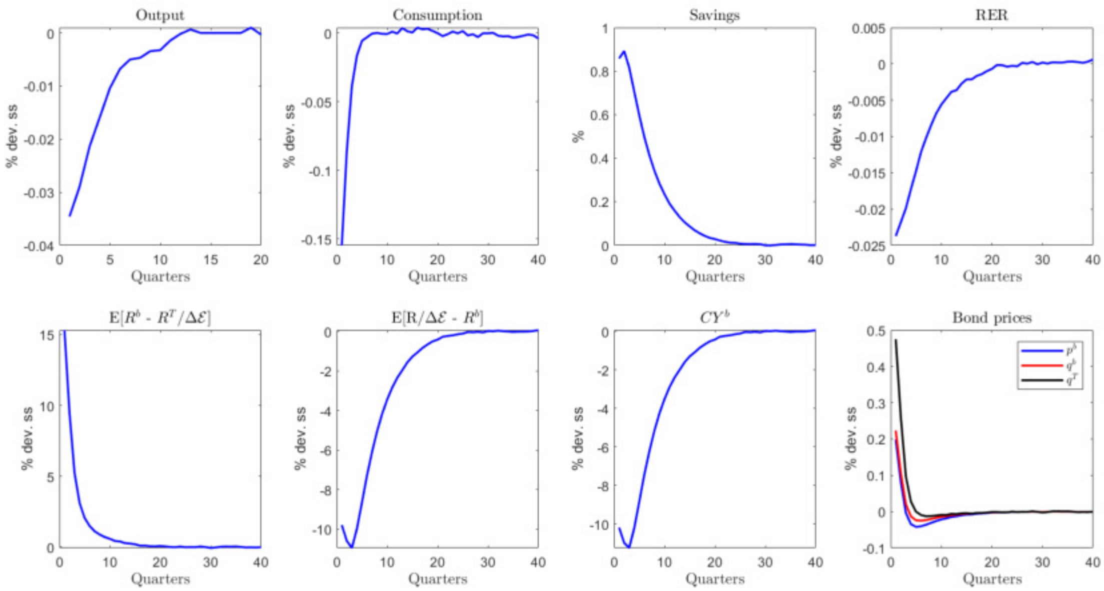
I calibrate the parameters with standard values for the small open economy literature (see Table 6). The parameters specific to this paper that need a more careful discussion are the ones related to the safety shocks and to the collateral constraint.

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

The parameters ρ^s and σ^s govern the persistence and volatility of the safety shock. I take the persistence of the safety shock to be $\rho^s = 0.4$, as in Kekre and Lenel (2021). However, I change their estimation of its volatility. They estimate the moments of the US Treasury premium, which is the differential convenience yield of the US Treasury against sovereign bonds of G10 countries, which is not exactly the same empirical counterpart to the safety shock in the model. I set $\sigma^s = 0.29$ because that is the volatility of the convenience yield of the US Treasury against highly-rated US corporate bonds.

The parameters κ^* and κ determine the drift in the exogenous process for the two collateral qualities. I calibrate them to match both the cross-section average and standard deviation of the dollar-investor's convenience yield for the 9 countries in my sample. The average convenience yield is 31 basis points and the standard deviation is 0.442. This calibration gives values of $\kappa^* = 1.4$ and $\kappa = 1.05$.

Figure 3: Impulse Responses to a Safety Shock



5.1 Impulse responses to a safety shock

Safety shocks are an important contributor to global macroeconomic volatility. Kekre and Lenel (2021) show that safety shocks account for around 25% of output volatility in the U.S. and around 6% of the volatility in the rest of the world. In this section I quantify the importance of demand for safety for business cycles in EMEs.

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

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

The bottom row shows the response of asset prices. The expected excess return of the local sovereign bond relative to the US sovereign bond increases on impact. The reason is the higher convenience yield of the US sovereign bond. As a result, the expected return on the US sovereign bond drops.

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

This is the more interesting result, as this is the model counterpart of the dollar-investor's convenience yield of the empirical section. Accordingly, the model successfully matches the drop of the convenience yields against a safety shock, captured by the negative effect of the VIX index on the dollar-investors' convenience yield. There are two reasons why this convenience yield of the local sovereign bond falls on impact. First, on the demand side, there is a move towards the foreign sovereign bond, which is a better collateral. In addition, the drop in consumption reduces the wealth effect and reduces the convenience yield.

Although the shock to collateral quality is exogenous, the endogenous responses of asset prices to a safety shock makes the local sovereign bond a not-safe asset against safety shocks. To see this, notice that the local sovereign bond has a negative realized excess return to the two other bonds. Although all three bonds pay one unit of consumption, the real exchange rate appreciation increases the realized return of the two foreign bonds. Therefore, the local sovereign bond is paying "badly" in a bad state of the world, since consumption also falls. Therefore, the local sovereign bond endogenously loses its safety status when safety shocks hit. .

The effect of the safety shock is markedly different from the effect of interest rate shocks, as commonly studied in the small open economy literature (Uribe and Yue, 2006; Mendoza, 2010). Interest rate shocks in those papers consist of an exogenous drop in the world interest rate, and they increase borrowing, consumption, investment and decrease net exports. Farhi and Werning (2012) give a risk premium interpretation this shocks: interest rate drops would resemble more risk taking from global financial intermediaries.

In contrast, a safety shock, although world interest rates drop (see the fourth panel in the bottom row), produces a foreign-good appreciation, a drop in consumption (via more savings in the global safe asset), and an improvement in the trade balance. This suggests that more research will be needed to better understand these shocks and how small open economies can handle them.

5.2 Business cycle volatility

Convenience yields and the safety shock have implications for the business cycle in the local economy. 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

Table 7: Output and local interest rate volatility

	Model	No safety shocks	$\kappa = 0$
σ_Y	3.65	3.6	3.69
σ_C	1.8	1.63	2.03
σ_{R^b}	3.76	1.96	3.26

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

foreign sovereign bonds. Similarly, the yield on the local bond, R_t^b, trades below the international rate R_t, and this spread corresponds to the convenience yield of the local sovereign bond.

The responses of the convenience yields due to safety shocks will be accommodated by changes in the real exchange rate and in the yields of the two sovereign bonds. Since the safety value of the local bond is procyclical, the local convenience yield drops. This drop is accommodated by an increase in local yields and an appreciation of foreign goods, which negatively impact borrowing costs of EME households. Therefore, the model implies that convenience yields increase the volatility of EMEs' business cycles. The reason is the procyclicality of the local-currency convenience yield, which compounds the adverse effect compared to an economy with a countercyclical convenience yield.

Table 7 summarizes the quantitative exercise. Column 1 shows the volatility of output, consumption, and the local interest rate in the model. Column 2 shows the moments in a model with no safety shocks. The third column shows the moments in a version of the model where the local sovereign bond has no value as collateral ($\kappa = 0$), but where safety shocks are present. Overall, my model implies that safety shocks account for 2% and around 9% of output and consumption volatility, respectively. The third column shows that if the local bond has no value as collateral, output and consumption volatility are also higher. Interest rate volatility is lower, which is driven again by the relevance of safety shocks and the procyclical response of convenience yields.

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

Compared to their framework, my exercise can be understood as exploring the role of one source of movements in world interest rates, i.e., those coming from safety demand and flight to safety episodes. Uribe and Yue (2006) find that U.S. interest rate shocks explain about 20% of movements in aggregate economic activity in emerging economies. Table 7 suggests that demand for safety explains about 10% of that effect on output.

Similarly, Uribe and Yue (2006) explore the role of shocks to country spreads. The country spreads in their paper correspond to the financing cost of dollar-denominated debt in emerging markets. Again, convenience yields arising from safety/liquidity benefits can be understood as one component of country spreads, along with sovereign default risk and others. They find that country spread shocks explain about 12% of the business cycle in emerging economies. Table 7 suggests that convenience yields explain about 17% of that effect on output.

6 Conclusion

This paper has aimed to show that local-currency convenience yields due to safety/liquidity services exist and are relevant for EMEs. A significant difference with sovereign bonds of advanced economies is that, although the local bond provides safety/liquidity against the local cycle, the local-currency convenience yields for global investors drop during periods of high global risk aversion. Evidence suggests that the explanation rests on the competition such bonds face from alternative sources of safety and liquidity, such as U.S. Treasuries.

I extended the standard open economy-real business cycle model to include demand for safety and the existence of two alternative safe assets. The model is purposely simple and aims to match the responses of local convenience yields, characterize the effects of safety shocks, and their role in business cycle volatility in small open economies.

Given the relevance of demand for safety, more research is needed on convenience yields in EMEs. Empirically, it would be relevant to know what specific feature of local-currency sovereign bonds drives this premium (either credit risk, primary surpluses, inflation, 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. Finally, the estimated local-currency convenience yields can be used as an input in fiscal capacity analysis for EMEs.

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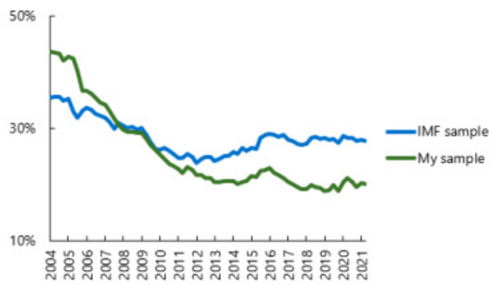
Appendix A Trends in EME's Local-Currency Sovereign Bonds

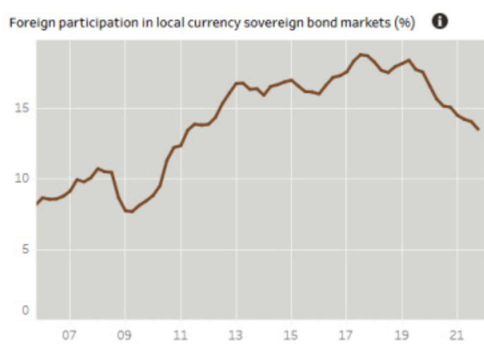
Figure 4 shows an upward trend in local-currency denomination of sovereign debt, and an increase in foreign ownership of these bonds. This evidence is consistent with evidence shown in Du and Schreger (2022) on currency denomination of sovereign external debt in EMEs.

Figure 4: EME Sovereign Debt, 2004-2021

(a) % of debt denominated in foreign currency



(b) % of local-currency debt owned by foreigners



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

Appendix B Proofs of Propositions in Section 2

Proof of Proposition 1. This proof is very 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 of country j for a price P_t^j, her real holdings $\theta_{j,t}$ rise by P_t^j/Q_t. The first order condition for this bond holdings is then

$$-\frac{P_t^j}{Q_t} + \beta E_t\left[\frac{P_{t+1}^j}{Q_{t+1}} u'(C_{t+1})\right] + \frac{P_t^j}{Q_t} v_d'(\theta_{j,t}/\mathrm{GDP}_t; \zeta_t) u'(C_t) = 0 \qquad (35)$$

Define the pricing kernel for nominal payoffs as

$$M_{t+1} = \beta \frac{u'(C_{t+1})}{u'(C_t)} \frac{Q_t}{Q_{t+1}} \tag{36}$$

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

$$P_t^j = E_t[M_{t+1} P_{t+1}^j] \Lambda_t^{j,d} \tag{37}$$

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

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

$$P_t^j = \pi_t^j E_t[M_{t+1} \Lambda_t^{j,d} (1 - L_{t+1}^j) | \text{Default}] + (1 - \pi_t^j) E_t[M_{t+1} P_{t+1}^j \Lambda_t^{j,d} | \text{No Default}] \tag{38}$$

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

$$\begin{aligned} e^{-y_t^j} = P_t^j &= E_t[M_{t+1} \Lambda_t^{j,d}] - E_t[M_{t+1}] E_t[\tilde{L}_{t+1}^j] - \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^j] - \text{cov}_t[\Lambda_t^{j,d}, \tilde{L}_{t+1}^j] \\ &\approx e^{\lambda_t^{j,d} - \pi_t (E_t[L_{t+1}^j] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^j]/E_t[M_{t+1}]) - \text{cov}_t[\lambda_t^{j,d}, \tilde{L}_{t+1}^j]/E_t[M_{t+1}]} E_t[M_{t+1}] \end{aligned} \tag{39}$$

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

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

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

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

$$y_t^p \approx y_{rf,t}^j - \lambda_t^{p,d} + l_t^p - \xi_t^{p,d} \tag{41}$$

Take the spread between the two yields to get:

$$y_t^p - y_t^j \approx (\lambda_t^{j,d} - \lambda_t^{p,d}) + (l_t^p - l_t^j) \tag{42}$$

assuming that the differential covariance term is negligible.□

Proof of Proposition 2. Denote the US price level at date t as Q_t, and let j = US. 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

$$-\frac{P_t^{US}}{Q_t} + \beta E_t\left[\frac{P_{t+1}^{US}}{Q_{t+1}}u'(C_{t+1})\right] + \frac{P_t^{US}}{Q_t}v_f'(\theta_t^{US}/\mathrm{GDP}_t;\zeta_t)u'(C_t) = 0 \tag{43}$$

Define the pricing kernel for nominal payoffs as

$$M_{t+1} = \beta\frac{u'(C_{t+1})}{u'(C_t)}\frac{Q_t}{Q_{t+1}} \tag{44}$$

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

$$\begin{aligned} P_t^{US} &= E_t[M_{t+1}P_{t+1}^{US}] + P_t^{US}v_f'(\theta_t^{US}/\mathrm{GDP}_t;\zeta_t) \Rightarrow \\ P_t^{US} &= E_t[M_{t+1}P_{t+1}^{US}]\Lambda_t^{US,f} \end{aligned} \tag{45}$$

where $\Lambda_t^{US,f} \equiv 1/(1 - v_f'(\theta_t^{US}/\mathrm{GDP}_t;\zeta_t))$ captures the marginal benefits investor f derives from these non-Treasury safe bonds. A positive marginal value of convenience, $v_f'(\cdot)$, 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

$$P_t^{US} = \pi_t E_t[M_{t+1}\Lambda_t^{US,f}(1 - L_{t+1}^{US})|\text{Default}] + (1-\pi_t)E_t[M_{t+1}P_{t+1}^{US}\Lambda_t^{US,f}|\text{No Default}] \tag{46}$$

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 default. Then, the expression for the price of the bond is

$$\begin{aligned} e^{-y_t^{US}} = P_t^{US} &= E_t[M_{t+1}\Lambda_t^{US,f}] - E_t[M_{t+1}]E_t[\tilde{L}_{t+1}^{US}] - \mathrm{cov}_t[M_{t+1}, \tilde{L}_{t+1}^{US}] - \mathrm{cov}_t[\Lambda_t^{US,f}, \tilde{L}_{t+1}^{US}] \\ &\approx e^{\lambda_t^{US,f} - \pi_t(E_t[L_{t+1}^{US}] + \mathrm{cov}_t[M_{t+1},\tilde{L}_{t+1}^{US}]/E_t[M_{t+1}]) - \mathrm{cov}_t[\lambda_t^{US,f},\tilde{L}_{t+1}^{US}]/E_t[M_{t+1}]}E_t[M_{t+1}] \end{aligned} \tag{47}$$

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

$$y_t^{US} \approx y_{rf,t}^{US} - \lambda_t^{US,f} + l_t^{US} - \xi_t^{US,f} \tag{48}$$

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 and let $j \neq$ US. Let the price of the sovereign bond of country j be P_t^j. If the investor purchases one unit, her real holdings θ_t^j rise by $P_t^j/Q_t \times 1/S_t$, where S_t is the nominal exchange rate. The first order condition for holdings of the synthetic bond is

$$-\frac{P_t^j}{Q_t}\frac{1}{S_t} + \beta E_t\left[\frac{P_{t+1}^j}{Q_{t+1}}\frac{1}{F_{t+1}}u'(C_{t+1})\right] + \frac{P_t^j}{Q_t}\frac{1}{S_t}v_f'(\theta_{j,t}/\text{GDP}_t;\zeta_t)u'(C_t) = 0 \tag{49}$$

As before, for simplicity, assume one-period bonds, so $P_{t+1}^j = 1$ 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:

$$\begin{aligned} P_t^j\frac{F_t^1}{S_t} &= E_t[M_{t+1}] + P_t^j v_f'(\theta_{j,t}/\text{GDP}_t;\zeta_t) \Rightarrow \\ P_t^j\frac{F_t^1}{S_t} &= E_t[M_{t+1}]\Lambda_t^{j,f} \end{aligned} \tag{50}$$

where $\Lambda_t^{j,f} \equiv 1/(1 - v_f'(\theta_t^j/\text{GDP}_t;\zeta_t))$ captures the marginal benefits investor f derives from the bond issued by the sovereign j.

Recall that the sovereign of country j can default next period with probability π_t^j, and L_{t+1}^j 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 i loses L_{t+1}^j and still needs to unwind the swap position with unmatched local currency j cash flows. In the case of positively correlated default and currency risk, the local-currency depreciates more upon default relative to the nondefault state. The investor i holding the synthetic bond has a net long position in dollars in the event of default, which corresponds to additional currency gains. As a consequence, in the default state, the bond pays $[1 - L_{t+1}^j + L_{t+1}^j(1 - F_{t+1}/S_{t+1})]$.

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

Analogously, assume that the sovereign of country j can enact regulations on local-currency assets with probability $\tilde{\pi}_t^j$ (for example, capital controls or currency convertibility restrictions), and this event imposes a loss of K_{t+1}^j 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 $[1 - K_{t+1}^j + K_{t+1}^j(1 - F_{t+1}/S_{t+1})]$. The hedging error term will be exactly equal to $\frac{\mathrm{cov}_t(1-K_t^j, 1/S_{t+1})}{E_t(1-K_{t+1}^j)E_t(1/S_{t+1})}$, term which I will denote as p_t^j and refer to it as the covariance between capital control risk and currency risk.

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

$$\begin{aligned} e^{-y_t^j + \rho_{j,t}} = P_t^j \frac{F_{t+1}}{S_t} &= E_t[M_{t+1}\Lambda_t^{j,f}] - E_t[M_{t+1}]E_t[\tilde{L}_{t+1}^j] - E_t[M_{t+1}]E_t[\tilde{K}_{t+1}^j] \\ &- \mathrm{cov}_t[M_{t+1}, \tilde{L}_{t+1}^j] - \mathrm{cov}_t[M_{t+1}, \tilde{K}_{t+1}^j] - \mathrm{cov}_t[\Lambda_t^{j,f}, \tilde{L}_{t+1}^j] - \mathrm{cov}_t[\Lambda_t^{j,f}, \tilde{K}_{t+1}^j] \\ &\approx e^{\lambda_t^{j,f} - \pi_t^j(E_t[L_{t+1}^j] + \mathrm{cov}_t[M_{t+1}, \tilde{L}_{t+1}^j]/E_t[M_{t+1}]) + q_t^j - \tilde{\pi}_t^j(E_t[K_{t+1}^j] + \mathrm{cov}_t[M_{t+1}, \tilde{K}_{t+1}^j]/E_t[M_{t+1}])} \\ &\times e^{p_t^j - \mathrm{cov}_t[\Lambda_t^{j,f}, \tilde{L}_{t+1}^j]/E_t[M_{t+1}] - \mathrm{cov}_t[\Lambda_t^{j,f}, \tilde{K}_{t+1}^j]/E_t[M_{t+1}]} \times E_t[M_{t+1}] \end{aligned} \tag{51}$$

Taking logs on both sides gives:

$$y_t^j - \rho_{j,t} \approx y_{rf,t}^{US} - \lambda_t^{j,f} + (l_t^j - q_t^j) + (k_t^j - p_t^j) - \xi_t^{j,f} - \psi_t^{j,f} \tag{52}$$

where $y_{rf,t}^{US} = -\log M_{t+1}$; $\lambda_t^{j,f} \approx v_f'(\theta_{j,t}/\mathrm{GDP}_t; \zeta_t)$ is the convenience yield on the local-currency bond; $l_t^j = \pi_t^j(E_t[L_{t+1}^j] + \mathrm{cov}_t[M_{t+1}, \tilde{L}_{t+1}^j]/E_t[M_{t+1}])$ and $k_t^j = \tilde{\pi}_t^j(E_t[K_{t+1}^j] + \mathrm{cov}_t[M_{t+1}, \tilde{K}_{t+1}^j]/E_t[M_{t+1}])$ are the extra yield demanded for default and regulatory losses; and $\xi_t^{j,f} = \mathrm{cov}_t[\Lambda_t^{j,f}, \tilde{L}_{t+1}^j]/E_t[M_{t+1}]$ and $\psi_t^{j,f} = \mathrm{cov}_t[\Lambda_t^{j,f}, \tilde{K}_{t+1}^j]/E_t[M_{t+1}]$ 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 a EME sovereign bond issued offshore in dollars, $\hat{P}_t^j$, is given by:

$$\hat{P}_t^j = E_t[M_{t+1}\hat{P}_{t+1}^j]\hat{\Lambda}_t^{j,f} \tag{53}$$

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

$$e^{-\hat{y}_t^j} = \hat{P}_t^j = E_t[M_{t+1}\hat{\Lambda}_t^{j,f}] - E_t[M_{t+1}]E_t[\tilde{L}_{t+1}^j] - \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^j] - \text{cov}_t[\hat{\Lambda}_t^{j,f}, \tilde{L}_{t+1}^j]$$
$$\approx e^{\hat{\lambda}_t^{j,f} - \hat{\pi}_t(E_t[\hat{L}_{t+1}^j] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^j]/E_t[M_{t+1}]) - \text{cov}_t[\hat{\lambda}_t^{j,f}, \tilde{L}_{t+1}^j]/E_t[M_{t+1}]} E_t[M_{t+1}] \tag{54}$$

Taking logs on both sides gives:

$$\hat{y}_t^j \approx y_{rf,t}^{US} - \hat{\lambda}_t^{j,f} + \hat{l}_t^j \tag{55}$$

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 (52)) and the yield on the foreign currency-denominated bond (Equation (55)). Then,

$$\begin{aligned}
\Phi_t^{FC} \equiv & y_{i,t} - \rho_{j,t} - \hat{y}_t^j \\
& \approx (y_{rf,t}^{US} - \lambda_t^{j,i} + (l_t^j - q_t^j) + (k_t^j - p_t^j) - \xi_t^{j,i} - \psi_t^{j,f}) - (y_{rf,t}^{US} - \hat{\lambda}_t^{j,f} + \hat{l}_t^j) \\
& = (\hat{\lambda}_t^{j,f} - \lambda_t^{j,f}) + (l_t^j - \hat{l}_t^j - q_t^j) + (k_t^j - p_t^j) - \xi_t^{j,f} - \psi_t^{j,f}
\end{aligned} \tag{56}$$

□

Appendix C Data Sources

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

$$\lambda_t^{j,f} - \lambda_t^{US,f} = y_t^{US} - (y_t^j - \rho_{j,t}) + (l_t^j - l_t^{US}) + \Phi_t^{FC} + \xi_t^{US} \tag{57}$$

The sources for each component are the following:

Bond yields and forward premia. For yields of non-Treasury safe dollar bonds, I used data of the Resolution Funding Corporation (Refcorp) bonds for various maturities. 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 rate 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 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 10 developed and

18 developing countries with respect to U.S. Treasuries. The data are at 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 for 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 ($l_t^{US} - l_t^j$). 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 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 incidence of default on domestic-currency debt is comparable with the incidence of external foreign-currency defaults.

Spread between swapped local-currency bond and foreign-currency bond ($\Phi_t^{FC,i}$). I used the data from Du and Schreger (2016). For $\hat{y}_t^j$, I used the Bloomberg Fair Value curves (BFV) for the prices of foreign-currency sovereign bonds for each EME. These curves are at par yield curves, so they needed to 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 individual bond and computing the overall zero-coupon yield curve using the methodology of Nelson and Siegel (1987).

To calculate the 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 8. All yields are for the 1-year maturity except for Mexico where only the 9-month maturity was available.

Table 8: 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 D Robustness for estimation of Section 2.1.1

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

D.1 The role of regulatory risk

As explained in the main text, local-currency bonds in EMEs carry the risk of the local government imposing capital controls, taxes on outflows, or currency convertibility restrictions. The term $\Phi_t^{FC,i}$ in Equation (2.3) intends to account for the risk by taking the spread between sovereign bonds issued under international vs. domestic law. The former does not give regulatory freedom to the EME government, and therefore this spread should account for most of these regulatory risks.

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

Recall from Equation (6) that this spread will be larger: (1) the larger the domestic regulatory risk (k_t^j), and (2) the lower the covariance between default and regulatory risk and currency risk (q_t^j and p_t^j). The spread is positive and large at the beginning of the sample. Importantly, this period coincides with the imposition of capital outflows taxes by the Brazilian government. In October 2009 the government introduced a tax on financial transactions (the IOF), of 2% on foreign investment in fixed income instruments. During 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 larger than the risk of capital controls and other regulations.

Figure 5: Local vs. Foreign jurisdiction spread for Brazil

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

D.2 Eurobonds

Eurobonds are securities denominated in a different currency than the local one of the country where the bond is being issued (despite their name, they are not necessarily bonds issued in Europe or in euros). EMEs sovereigns frequently issue eurobonds, and these 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 (2.3) 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 not suitable for eurobonds and Equation (2.3) 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 amount of government bonds issued in international markets in local currency. Although it doesn't distinguish between foreign vs. domestic law, still serves as a proxy for the amount of local currency bonds governed by foreign law.

Table 9 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 9 countries in my sample.

Table 9: 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 total. Even if all these local-currency bonds are governed by foreign law, that still would represent a minimal percentage with the only exception of Peru. However, Peru has no capital controls on foreign investments during the period considered.

D.3 Liquidity risk

The derivation of Equation (2.3) hinges on the comparison between a non-Treasury safe dollar bond and a swapped local-currency EME sovereign bond. Both bonds do not show the same level of liquidity, and the forward contracts used to compute the yield on the swapped local-currency bond are highly illiquid, as most EMEs don't have deep markets for the trading of these derivatives. Investors in the EME swapped local-currency bond have long positions in the actual bond and short positions in the far less liquid swap market, and thus the swapped local-currency bond carries a liquidity premium that comes from shorting the swap contract, not from the actual bond. Therefore, it is possible that the convenience yield on the left-hand side of Equation (2.3) overestimates the "true" convenience yield, with an overestimation equal to the difference between the liquidity risk of the local-currency bond and the liquidity risk of the swap contract.

As a robustness check, I account for the liquidity risk of both instruments. A common proxy for liquidity risk is the bid-ask spread: a larger bid-ask spread is indicative of a less liquid market. In lack of access to historical data of the bid and ask prices for these instruments, I rely on the statistics reported in Du and Schreger (2016) for a selection of EMEs for the period 2005-2014.

Their data, reported in Table IA.II of their online Appendix, includes statistics on bid-ask spreads of local currency sovereign bonds and cross-currency swaps for Brazil, Colombia, Mexico, Peru, Turkey, and the Philippines. I perform a rough exercise consisting of subtracting the differential liquidity risk of these two instruments from the average convenience yield of each country reported in Table 1 in the main text.

Another way to see this adjustment is to think of it as the equivalent of correcting the spread in Equation (2.3) for the differential liquidity risk, in the same way I corrected for differential default risk. If one thinks of default and liquidity risk as the pricing of risk under a standard asset pricing model (where both default and liquidity risk reduce the price of the bond), then the resulting spread after these adjustments corresponds to the safety and liquidity premium that comes from safety and liquidity service flows, beyond the standard present discounted value of risky cash flows.

Table 10 shows, for each country, the reduction in basis points of the average EME local-currency convenience yield. Overall, the adjustment is sizable for Brazil and Indonesia, although a rough comparison of means still leaves them with a positive convenience yield. Since I lack the time series for the bid-ask spreads, I cannot calculate the new mean and standard deviation for the adjusted series.

Table 10: Share of total LC-bonds outstanding issued in international markets

Country	Correction (bps)
Brazil	-26
Colombia	-7
Indonesia	-22
Mexico	2
Peru	-6
Philippines	-9
Turkey	1

Notes: data come from Du and Schreger (2016), Table IA.II. Correction is calculated as half the bid-ask spread of cross-currency swaps minus the bid-ask spread of the local-currency sovereign bond.

However, as explained in the main text, the empirical results of Section 3 are not affected by dropping extreme events where EME securities, and particularly swaps contracts, become highly illiquid. This is shown later in this Appendix by reporting the robustness of the results to dropping the financial crisis of 2008 and the Covid crisis of 2020.

D.4 Market segmentation

Another potential issue with Equation (2.3) in Section 2.1 would be that the market for EME sovereign bonds is segmented. Here I consider two possible dimensions of segmentation: among foreign vs. local investors, and among 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, then the spread in Equation (2.3) would be misleading. The reason is that the two bonds involved 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 greater than 1 year) along currency denomination and foreign/local investor ownership. In Table 11 I report two statistics for the 9 countries in my sample. Column 1 shows the average share of all local-currency government bonds that are owned by foreign investors. Column 2 shows the share of local-currency bonds in foreign investors' portfolios. Both averages are calculated from 2005-2021 at the quarterly frequency.

Table 11: 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, see Onen et al. (2023), and only considers bonds with maturity of 1 year or more.

Table 11 shows no signs of market segmentation in local-currency bonds. Foreigners own a sizable share of these bonds, and they represent a significant share of their portfolio of EMEs. This is specially clear in the case of Brazil and Chile where, although less than ten percent of local-currency bonds are owned by foreigners, 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 afterwards 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 vs. domestic law. In this case, it might be that all the share of local-currency government bonds owned by foreigners correspond to bonds governed by international law (eurobonds), while local investors own only the bonds issued under domestic law. Again, evidence does not show this to be the case. Onen et al. (2023) show that most of the increase in foreign ownership of local-currency sovereign bonds in the past two decades has come from foreigners increasingly participating in the *domestic* market.

Appendix E Relevance of the Dollar-Investor's Convenience Yield

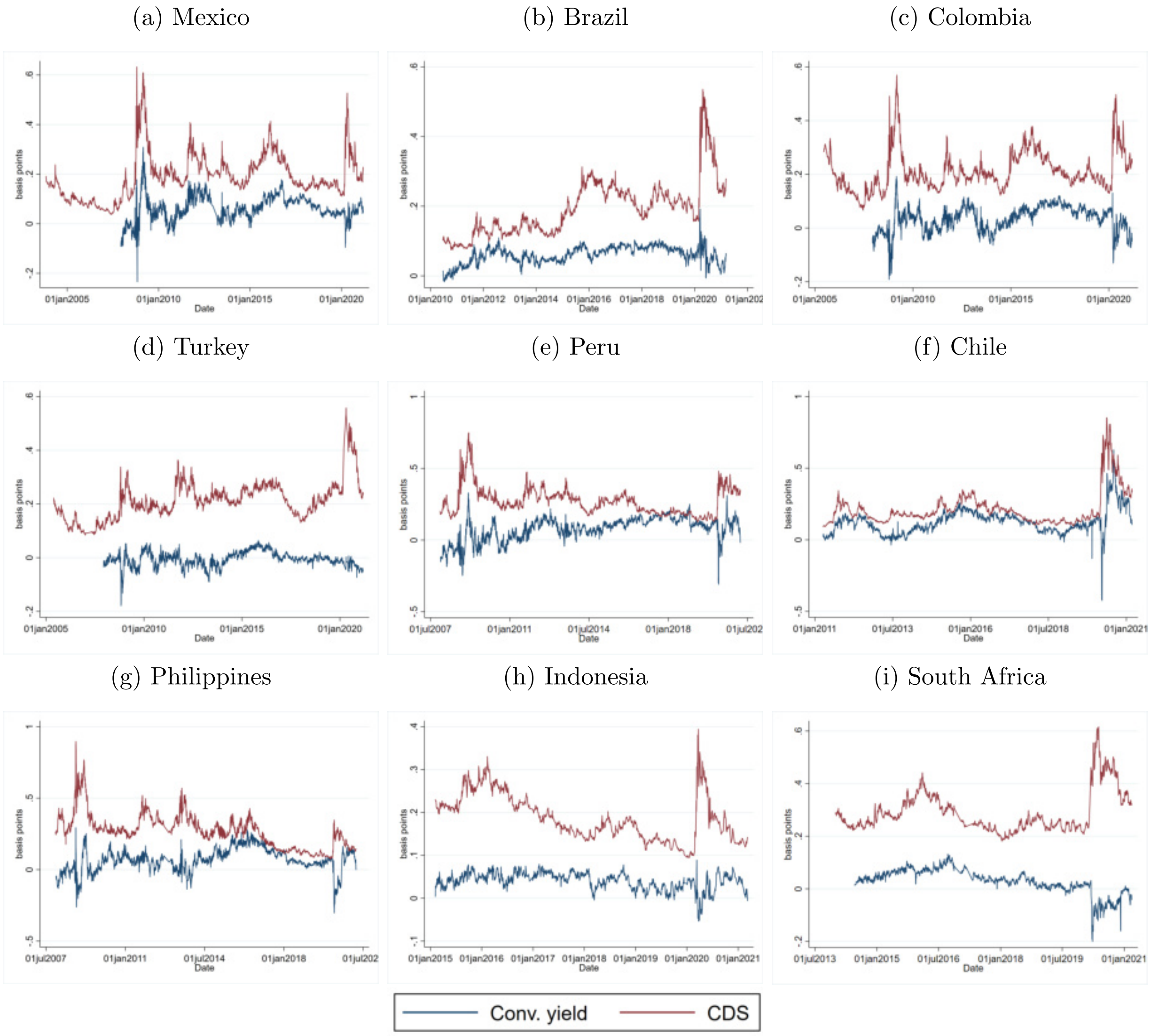
How economically relevant are the magnitudes estimated in Section 2.2? Figure 6 shows the local-currency convenience yield (as showed in Figure 1) as a proportion of the total yield of the local-currency bond. I also add the CDS to compare with the role of credit risk. Although credit risk accounts for a bigger share of the total yield, which is unsurprising for EMEs, local-currency convenience yields account for around 10% of the total yield, with the only exception of Turkey. Countries where it explains a larger proportion are Chile, Peru, and the Philippines. Even though Brazil has the largest mean convenience yield (see Table 1), it is one of the EMEs with the highest yields on its debt; overall, the convenience yield accounts for slightly less than 10% of the total yield.

Appendix F 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 (2.3) 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); and the term $y_t^{US} - y_t^j - \rho_{jt}$ corresponds to the CIP deviation between the two sovereign bonds. Figure 7 compares the evolution of CIP deviations and two of its components, differential default risk and the U.S. Treasury premium.

CIP deviations spiked during crises (i.e., in 2008 and 2020), and this was driven by both an increase in differential default risk and the U.S. Treasury premium. The increase in the U.S. Treasury premium is in line 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

Figure 6: Convenience Yield and Credit Risk as Proportion of Total Yield

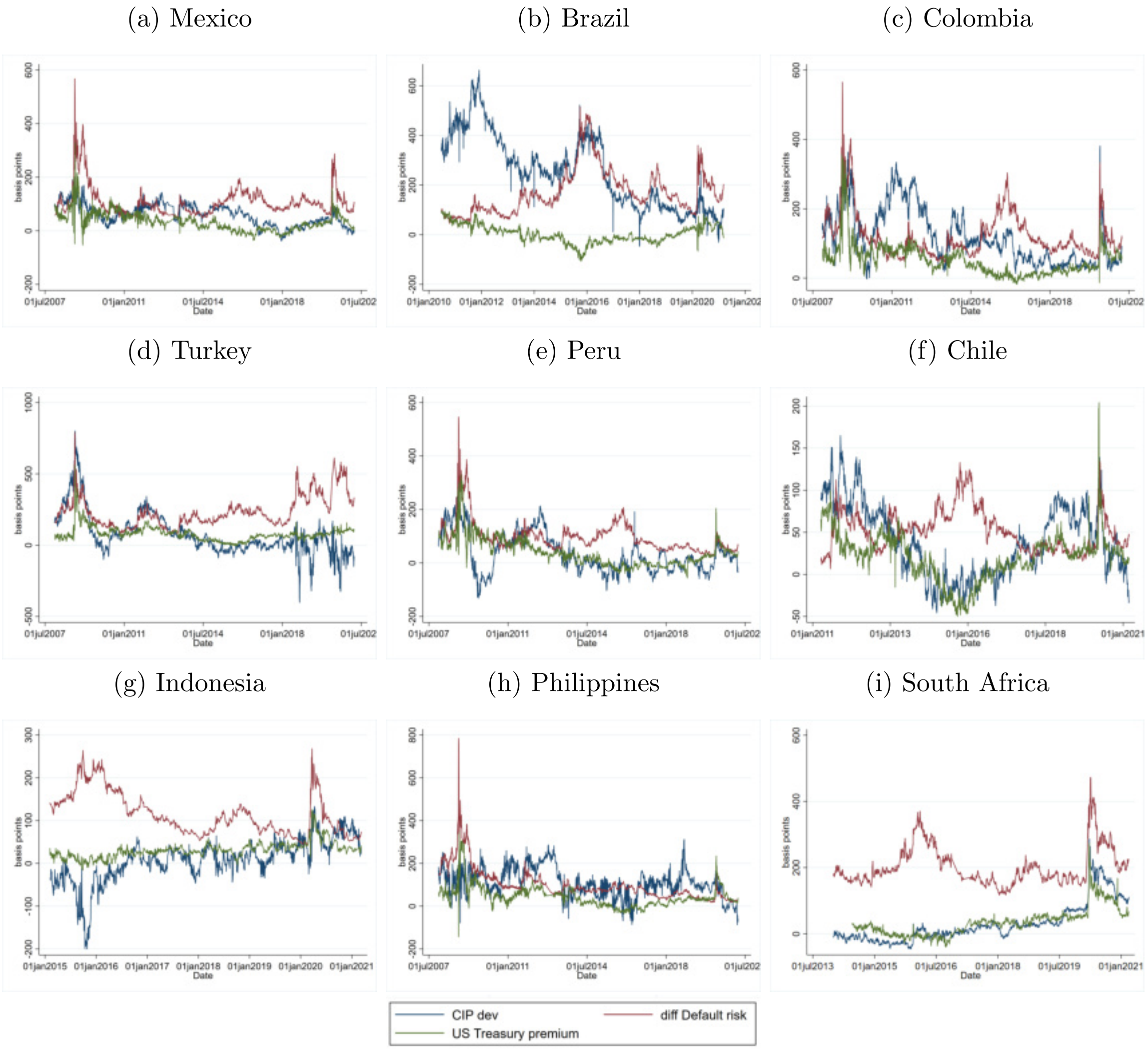


safety and liquidity of U.S. government debt versus comparable debt of EMEs. This premium then increased again until the end of the sample.

These patterns are in stark contrast with the G10 counterparts estimated in Du et al. (2018). 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 when 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 7 shows that this is not the case for EMEs, though. U.S. Treasuries are still seen as a safe asset compared to their EME counterparts.

Surprisingly, CIP deviations outside of financial crises followed closely the dynamics of the

Figure 7: CIP Deviation and Components, 5-Year Local-Currency Sovereign Bonds



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

The role of capital control risk (absent in Du et al., 2018) can be seen in Figure 7 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 (5). 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, but the tax was lifted in June 2013.

Appendix G Robustness for Section 3

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

Table 12 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 due to the fact that 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 not affected by relative safe asset supply, suggesting that the demand for safety and liquidity is accurately captured by the convenience yield. The level of the local monetary policy rate increased credit risk, since it likely increased the cost of servicing the debt. The VIX index also had a positive impact on 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's 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.

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 13 shows that results held 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. This result is likely explained by the absence of any global risk aversion episode in this period. 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 12: 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 13: 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