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 an investor that measures returns in dollars and from an investor that measures returns in the domestic currency. In a sample of 9 EMEs, I find a sizable convenience yield that is robust to both measures. I characterize the dynamics of this premium along both the local and the global financial cycle. The main difference with respect to the safety premium of U.S. Treasuries shows up in the latter: the convenience yield is procyclical with respect 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 this procyclicality is driven by the availability of alternative global safe assets like the U.S. Treasury. In an extension of the real-small open economy model where both a foreign and a local sovereign bond work as safe assets, I find that demand for safety and procyclical convenience yields increase business cycle volatility.

Keywords: convenience yields, sovereign bonds, emerging markets.

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1 Introduction

Investors pay a premium for the liquidity and safety of certain assets, and to hold them they are willing to accept a lower yield compared to alternative investments that offer the same cash flows. The investors' valuation of these non-pecuniary benefits, therefore, drives a "convenience yield" on safe/liquid assets. In the case of the U.S., for example, U.S. Treasuries enjoy such a safe asset status: their safety and liquidity makes them trade at a significantly lower yield than debt from highly-rated, comparable U.S. companies (Krishnamurthy and Vissing-Jorgensen, 2012). Do local-currency sovereign bonds in emerging market economies (EMEs) share this safe asset status in their local economy? I estimate local-currency convenience yields in nine EMEs between 2007 and 2021 and find that investors pay a sizable premium for their safety and liquidity. I also find that this local-currency convenience yield is procyclical with respect to the global financial cycle, which I show can increase EME's business cycle volatility.

This question is particularly relevant as local-currency bonds now represent the lion's share of outstanding sovereign external debt in EMEs. 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, to this date there is no empirical work on the role of their local debt as safe asset and their interaction with global safe assets.

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 comes from the perspective of an investor that measures his returns in dollars. This is a relevant measure as foreign investors have increased their participation in EME local-currency sovereign bonds (see recent trends in Appendix A). I assume this investor has access to 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. This 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) the risk of losses produced by regulations imposed by the EME government (such as taxes on capital outflows or currency convertibility restrictions), (3) the response of the currency during these events, and (4) the differential convenience yield. After accounting for the first three, I obtain the latter as a residual. Data is available for 9 EMEs and I consider assets with 5-year maturity.

The second measure assumes an investor that measures his returns in domestic currency. This investor compares the local-currency sovereign bond to a domestic private local-currency asset with the same maturity but which does not provide as much safety and liquidity services, such as a term deposit on a local commercial bank. I show that the spread between the two assets measures the safety/liquidity premium on the local-currency sovereign bond, in the same way as the analysis for the U.S. in Krishnamurthy and Vissing-Jorgensen (2012). Reliable daily data for domestic private local-currency assets is available for a smaller number of 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).

I find a sizable convenience yield for EME local-currency sovereign bonds, and this is robust to the measure used. The dollar measure shows an average of more than 30 basis points, which amounts to 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, the local financial cycle: the cyclical variations in the supply and demand for local-currency liquidity in the domestic economy, whose main determinant is the local central bank. Results show that local investors value the convenience services of local sovereign bonds along the business cycle, and this is in line with evidence for advanced economies. Second, along the global financial cycle, whose main determinant is global risk appetite as measured by the VIX and drives capital inflows. The main finding here is that, unlike U.S. Treasuries, the EME local-currency convenience yield drops during episodes of high global risk aversion. I analyze two exogenous adverse shocks to EMEs (the Taper Tantrum and the Covid pandemic) to gain insight into the mechanism. 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 the standard real small open economy model to include demand for safe assets by households (beyond standard precautionary savings demand). Safety demand can be satisfied with foreign bonds (whose price is world-determined) and local bonds (issued by the government and financed with taxes). The model (i) matches the procyclicality of the EME local-currency convenience yield, and (ii) it quantifies the role of safety demand on a small open economy's business cycle. 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 it is calibrated as in Kekre and Lenel (2021). The larger foreign convenience yield increases the expected excess return of the local assets (both capital and the local bond) and, as the household increases its holdings of the foreign bond, there is a drop in consumption, a drop in the local convenience yield, and a drop in the price of capital. Therefore, capital and the local bond have a negative realized return. The result is that the foreign bond ends up paying well in a "bad" state of the world, which endogenously makes it an effective global safe asset.

The responses of the convenience yields to the safety shock have implications for business cycle volatility in the local economy. The yield of the foreign bond trades below the international interest rate (in this context, the international rate can be thought of as the rate on a foreign bond that does not enjoy a safe asset status), with the spread equal to the foreign convenience yield. Similarly, the yield of the local bond also trades below this non-safe international interest rate, with the spread equal to the local convenience yield. The international rate is assumed to be exogenous, so a safety shock that increases the foreign convenience yield can only be accommodated through a drop in the yield of the foreign bond. Regarding the local bond, this shock produces a *drop* in the local-currency convenience yield, which can only be accommodated by an *increase* in the local interest rate. The quantitative exercise shows that, compared to a standard SOE model with no convenience yields and no safety shocks, the current model increases the volatility of the local interest by 4.6%. Notice that this is due to the procyclicality of the convenience yield. In turn, this explains around 2% of the output volatility and 3.1% of investment volatility in the small open economy.

Related Literature. To my knowledge, this paper is the first to estimate the safe asset status of local-currency sovereign bonds in EMEs and to analyze their determinants and implications. 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., 2017, Lenel et al., 2019) and against sovereign bonds of other advanced countries (Du et al., 2018; Jiang, Krishnamurthy, and Lustig, 2021; 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.

This paper is also related to recent empirical analyses of the currency composition of EMEs' sovereign debt. Unlike during the 1990's, today local-currency sovereign debt represents the lion's share of outstanding debt in EMEs, and this has been achieved by increasing foreign participation (Bénétrix et al., 2019; Du and Schreger, 2022; Onen et al., 2023). Stronger institutions and policies, inflation risk, and currency risk have been pointed out as possible explanations (Ottonello and Perez, 2019; Hale et al., 2020; Engel and Park, 2022). However, my paper differs from these results in because I do not look into the determinants of local-currency sovereign issuance. Rather, I take the outstanding local-currency debt as a given and instead ask the question if it is valued for its safety and liquidity.

On the theoretical side, my approach is novel as it is the first to build on the small open economy model and to analyze the interaction of two competing safe assets (local and foreign bonds). Unlike my approach, the literature has focused on the international role of dollar debt as a global safe asset, as modeled by Brunnermeier and Sannikov (2019); Jiang, Krishnamurthy, and Lustig (2019); and Kekre and Lenel (2021). Jiang, Krishnamurthy, and Lustig (2019) analyzed the effects of the supply of dollar safe assets on the nominal dollar exchange rate. However, they did not consider their interaction with safe assets from other countries. Kekre and Lenel (2021) quantified the importance of dollar-safety shocks in a two-country model, where convenience yields on dollar assets were entirely exogenous, and assets from the rest of the world did not share the safe asset status.

Finally, this paper contributes to the literature on the global financial cycle (GFC) and international risk spillovers. Rey (2013) and Miranda-Agrippino and Rey (2021) documented strong global co-movements in capital flows, credit growth, and asset prices, driven by global risk aversion and U.S. monetary policy. Kalemli-Ozcan (2019) highlighted the role of risk spillovers in the transmission of U.S. monetary policy into emerging markets and studied the implications for currency regimes and local monetary policy rate decisions. Brunnermeier et al. (2020) conjectured monetary and macroprudential policy implications for EMEs, but theirs was not a full-fledged international model specific to developing countries. My paper estimates the impact of the GFC on the valuation of local-currency sovereign bonds and its implications for policy.

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 quantitative exercise. Section 6 then concludes.

2 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 "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. The second will be called the "domestic convenience yield", and considers an investor that compares returns of only domestic assets.

2.1.1 Dollar investor's convenience yield

I build on the methodology of Du and Schreger (2016) and Du et al. (2018), but extend it to fit emerging economies. Du et al. (2018) calculate 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 capital control risks and large currency depreciation during default or capital controls events.

Consider a dollar investor that has that 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 1. *The yield in period t on a non-Treasury safe dollar bond, y_t^{US}, can be decomposed* *as follows:*

$$y_t^{US} \approx y_{rf,t}^{US} - \lambda_t^{US} + l_t^{US} - \xi_t^{US} \tag{1}$$

where $y_{rf,t}^{US}$ is the dollar risk-free rate; λ_t^{US} measures the marginal safety/liquidity services the dollar investor derives from this 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 (1) highlights that the larger the convenience yield λ_t^{US}, 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 2. *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:

$$y_t^j - \rho_{j,t} \approx y_{rf,t}^{US} - \lambda_t^j + (l_t^j - q_t^j) + (k_t^j - p_t^j) - \xi_t^j - \psi_t^j \tag{2}$$

where $y_{rf,t}^{US}$ is the dollar risk-free rate; λ_t^j is the convenience yield the investor derives from this bond; $l_t^j - q_t^j$ 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 λ_t^j 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 (2) 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 $\lambda_t^j - \lambda_t^{US}$. The two expressions in (1) and (2) can be combined to give an expression for this premium:

$$\begin{aligned}\underbrace{\lambda_t^j - \lambda_t^{US}}_{\text{EME convenience yield}} &= \underbrace{y_t^{US} - (y_t^j - \rho_{j,t})}_{\text{Spread between the two bonds}} \\ &\quad - \underbrace{(l_t^{US} - l_t^j)}_{\text{Differential default risk}} + \underbrace{k_t^j}_{\text{Capital controls risk}} \underbrace{-q_t^j - p_t^j - \xi_t^j - \psi_t^j}_{\text{Covariances}}\end{aligned} \tag{3}$$

Equation (3) 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, $\lambda_t^j - \lambda_t^{US}$. 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, risks of regulations, and other covariances.

The main challenge is to estimate the variables of capital control risk and the covariances in Equation (3). I rely on the spread between the synthetic bond and the bond denominated in foreign-currency issued offshore.

Proposition 3. *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,*

$$\begin{aligned}\Phi_t^{FC} &\equiv y_t^j - \rho_{j,t} - \hat{y}_t^j \\ &\approx (\hat{\lambda}_t^j - \lambda_t^j) + (l_t^j - \hat{l}_t^j - q_t^j) + (k_t^j - p_t^j) - \xi_t^j - \psi_t^j\end{aligned} \tag{4}$$

where $\hat{\lambda}_t^j$ 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 $\hat{\lambda}_t^j \approx \lambda_t^j$, the expression Φ_t^{FC} will be approximate equal to the term on capital control risk plus covariances in (3). 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 (3) to obtain the following:

$$\lambda_t^j - \lambda_t^{US} = y_t^{US} - (y_t^j - \rho_{j,t}) + (l_t^j - l_t^{US}) + \Phi_t^{FC} + \xi_t^{US} \tag{5}$$

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 (5). The empirical analysis in section 3 will be run using $\lambda_t^j - \lambda_t^{US}$ as the dependent variable.

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.

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 (5): 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.

2.1.2 Domestic convenience yield

The derivation is the same as in Krishnamurthy and Vissing-Jorgensen (2012), but without distinguishing between the safety and the liquidity premiums. As shown in that paper, the spread between the yield of a local-currency domestic private asset of country j, $y_t^{pv,j}$, and the yield of a local-currency sovereign bond of country j, y_t^j, of the same maturity, captures the safety and liquidity premia investors are willing to pay for the latter.

As explained in Krishnamurthy and Vissing-Jorgensen (2012), the intuition is that, since maturity is the same and standard credit risk and liquidity are comparable, the above spread captures the premium investors pay for the safety and liquidity of government debt.

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.

2.2 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 ($\lambda_t^j - \lambda_t^{US}$ in Equation (5)), and Columns 4-6 do the same for the domestic convenience yield ($y_t^{pv,j} - y_t^j$ in Section 2.1.2). The last Column shows the correlation between the two measures.

Overall, both measures show positive and sizable averages. The domestic convenience yield measure shows a larger mean 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. This supports the view that both measures capture the same phenomena and thus enhances the robustness of the derivation of convenience yields.

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, and 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 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

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

sharply in recent years

Figure 1 shows the evolution of the dollar-investor's convenience yield computed for the 5-year maturity. Many patterns consistent with safety/liquidity premia stand out. 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.

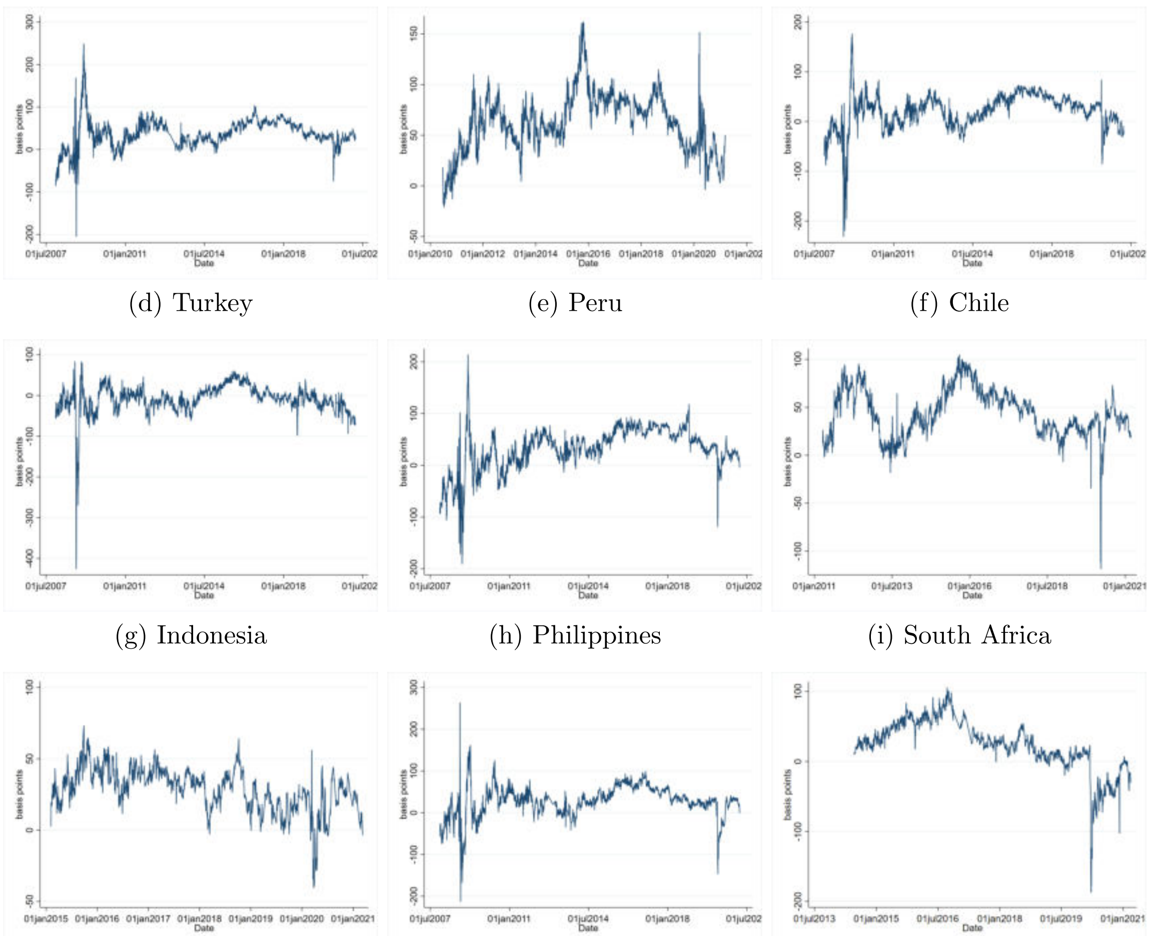
The Appendix shows how economically relevant are these magnitudes by showing this the local-currency convenience yield as a proportion of the total yield of the local-currency bond. In addition, in the Appendix I perform additional analysis on the evolution of the EME convenience

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



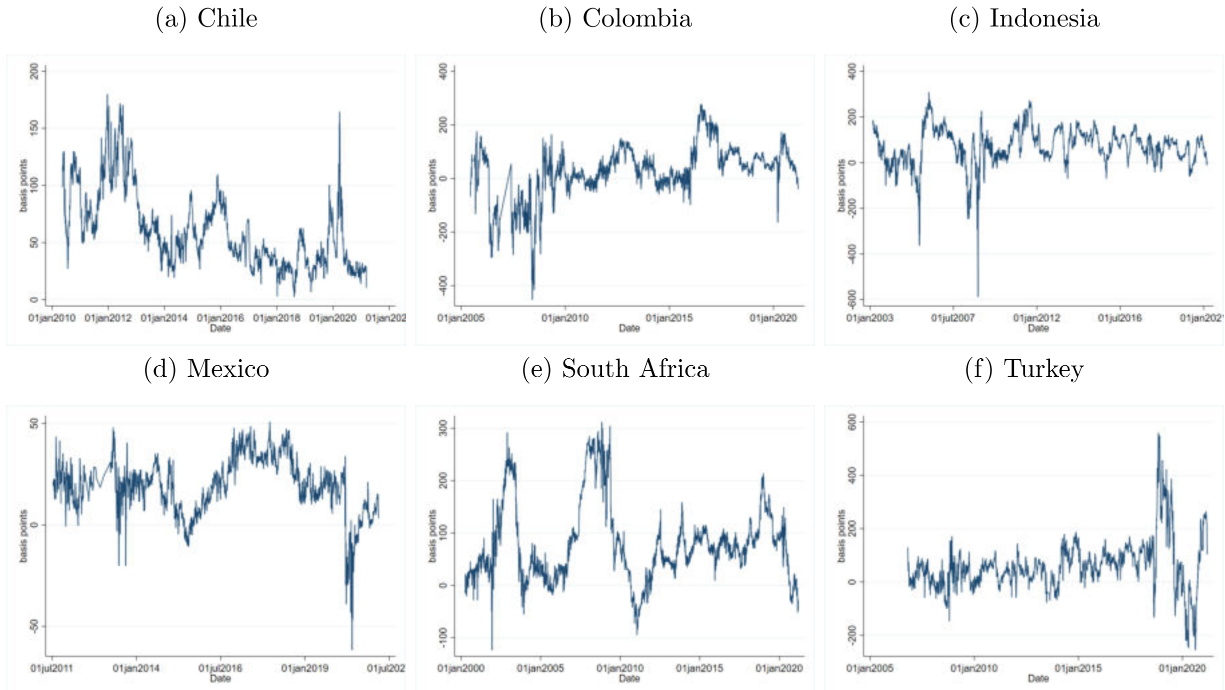
yield computed against the convenience yield of the U.S. Treasury (the U.S. Treasury premium as computed in Du et al. (2018) for G10 countries).

Figure 2 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.

2.3 The Role of Safety/Liquidity Services

This section provides formal empirical evidence that the two measures of the convenience yield capture a premium for safety/liquidity services. I follow Krishnamurthy and Vissing-Jorgensen (2012) and regress the convenience yields against variables that proxy the price and the supply of safe and liquid assets. The intuition here is as follows: if the estimated convenience yields capture

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



a demand for safety/liquidity services, then they should respond positively to the price of liquidity, and negatively to the supply of safe/liquid assets.

Accordingly, I proceeded by estimating panel regressions of the following form:

$$cy_{i,t} = \beta_1 i^{MP}_{t-1} + \beta_2(\text{Safe Asset supply/GDP})_{t-1} + \beta_3 i^{US}_t + c_i + \tau_t + \epsilon_{i,t} \tag{6}$$

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 intends to capture the price of overall liquidity in local currency set by the local central bank. (Safe Asset supply/GDP) is the supply of safe and liquid assets. Here I added both the local-currency sovereign debt supply as well as U.S. government debt supply. It is well known that U.S. Treasuries are the global safe asset, and in a small open economy their supply should have an impact on the price of liquidity attached to local-currency bonds. Both quantities are net of central bank holdings. Finally, I added the level of the U.S. federal funds rate, i^{US}_t. If dollar-denominated debt is the global safe asset, then also the price of dollar liquidity should have an impact on the local-currency convenience yield. The independent variables are lagged one month to avoid endogeneity and reverse causality as much as possible (I address endogeneity more formally in Section 3.3). 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 price of liquidity as proxied by the level of the monetary policy rate. This is consistent with EME local-currency convenience yields arising from liquidity and safety benefits. The intuition behind this results, drawn from the closed-economy literature (see, for example, Nagel 2016), is that as central banks tighten the stance of monetary policy, liquidity in the form of currency and private deposits becomes scarcer and drives up the price investors are willing to pay for all other liquid assets, such as government debt.

The local monetary policy rate has a positive effect on both measures, although its magnitude is larger for the domestic convenience yield. This is according to intuition as the domestic convenience yield measures the premium in local-currency terms. Similarly, the U.S. monetary policy rate has a large effect on the convenience yield measured in dollar terms, but not a significant effect on the convenience yield measured in local currency.

Regarding the supply variable, in Columns 1 and 4 the supply of government debt has a negative effect on the convenience yield. The negative coefficient on the relative supply of U.S. Treasuries is a key result; 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.

While the supply of local-currency bonds in each EME has a large negative effect on the domestic convenience yield, the supply of U.S. government debt has a negative effect on the dollar-investor's convenience yield. Again, this can be explained by the way both convenience yields are estimated: the former measures returns in local currency, while the latter measures returns in dollars.

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 make sure the two measures of the convenience yield are not capturing standard default risk. However, the CDS spread is also used in the calculation of the dollar-investor convenience yield, so the coefficient in Column 2 can be misleading. This warning does not apply to the coefficient in Column 5 because default risk was not used to compute the domestic convenience yield.

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 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.

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 ends in March 2021 for all. Both U.S. debt and EME local-currency debt-to-GDP variables are net of central bank's holdings. "Local share" is the share of EME debt owned by domestic investors (central bank, banks and non-banks). 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). *** $p<0.01$, ** $p<0.05$, * $p<0.1$

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. The next subsection will test if this is robust to considering the global financial cycle.

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.

The role of global uncertainty. 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 have an impact on 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. In Columns 1 and 3 I added the VIX index. The coefficient on the VIX is negative and statistically significant for the dollar-investor convenience yield. This suggests that the safety status of local-currency sovereign bonds decreases during periods of high risk aversion. This is a striking result as it is the opposite of the response of convenience yields in advanced economies. 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.

The role of capital inflows. 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

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

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). There are two important results in this exercise. First, 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).

Second, capital inflows into bank debt significantly reduce the dollar-investor convenience yield. A likely explanation for this negative effect is that investors can potentially find buyers more easily when foreign investors are bringing funding to the local economy. This increases the liquidity of the market and therefore decreases the premium investors are willing to pay, reducing the 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.

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 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:

$$\Delta cy_{i,t} = c_i + \tau_t + \gamma \times MPM_t^i + \beta \times MPM_t^{US} + \delta \times RP_t + \epsilon_{i,t} \tag{7}$$

In Equation (7), 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 (7) 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

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

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. 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

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

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 deviations. 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, the level of the monetary policy rate increases 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 aim of this section is to build a model that achieves two goals: to match a procyclical convenience yield on local bonds and to quantify the role of safety on a small open economy's business cycle. The model builds on the standard SOE-RBC model. Three important extensions are needed to achieve the stated goals. First, the representative household has a preference for safe assets, which goes beyond the standard precautionary demand for consumption smoothing. This preference is introduced through a bonds-in-the-utility function specification. Second, safe assets include a local bond, issued by the local government and financed by taxes, and a foreign bond, whose price is world-determined. And third, I introduce a shock to safety demand as in Kekre and Lenel (2021), which they showed accounted for a sizable portion of output volatility in the United States and the rest of the world.

Finally, I add two financial frictions which are not central to safety demand but their role is to match well known business cycle facts in EMEs: output shows larger volatility than advanced economies, and consumption is more volatile than output (Schmitt-Grohe and Uribe, 2017). These frictions are an endogenous collateral constraint on foreign borrowing for households, and working capital constraints for firms.

4.1 Households

The small open economy is inhabited by a large set of identical, infinitely lived households. The preference specification is:

$$E_0\left[\sum_{t=0}^{\infty}\beta^t[u(c_t - N(L_t)) + v(b_t^{\$}, b_t; \zeta_t)]\right] \tag{8}$$

In this expression, $u(.)$ and $v(.)$ are standard twice-continuously differentiable and concave period utility functions. Following GHH (1988), $u(.)$ is defined in terms of the excess of consumption relative to the disutility of labor, with the latter given by the twice-continuously differentiable convex function, $N(.)$. This assumption eliminates the wealth effect on labor supply by making the marginal rate of substitution between consumption and labor independent of consumption.

The function $v(.,.)$ captures unmodeled transaction or collateral services from holding bonds, in the same spirit as much of the literature on convenience yields. These non-pecuniary services will drive a wedge between the returns of the bonds and the international return of other non-safe assets. $v(.)$ is defined in terms of the holdings of two type of bonds: foreign, $b_t^{\$}$, whose price fluctuates exogenously and which admits either short or long positions by the household, and local bonds, b_t, issued by the local government and for which the restriction $b_t \geq 0$ applies. The latter means that the household cannot borrow from the local government. Both bonds are 1-period bonds. ζ_t captures an exogenous shock to the demand for safety and liquidity of the foreign bond.

Households choose sequences of consumption and labor supply. Investment opportunities are domestic capital, k_{t+1}; local 1-period bonds, b_{t+1}; and foreign 1-period international bonds, $b_{t+1}^{\$}$. Decisions maximize (8) subject to the following period budget constraint:

$$(1+\tau_t)c_t + q_t k_{t+1} + q_t^b b_{t+1}^{\$} + p_t^b b_{t+1} = (d_t + q_t)k_t + w_t L_t + b_t^{\$} + b_t + T_t \tag{9}$$

Households take as given the dividend rate on capital holdings, d_t; the market price of capital, q_t; the wage rate, w_t; the price of the local bond, $p_t^b \equiv 1/R_t^b$; the price of the foreign bond, $q_t^b \equiv 1/R_t^{\$}$; and the stochastic international gross yield that drives expected excess returns, $R_t = Rexp(\epsilon_t^R)$. This international yield can be understood as coming from a foreign asset that does not provide safety/liquidity services. ϵ_t^R is an interest rate shock that follows a Markov process joint with the other shocks defined later.

The world credit market is imperfect. Lenders require households to guarantee their debt by offering domestic 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):

$$q_t^b b_{t+1}^{\$} \geq -(\kappa^h q_t k_{t+1} + \kappa^b p_t^b b_{t+1}) \tag{10}$$

Thus, households can borrow internationally up to a fraction κ^h of the market value of their capital and a fraction κ^b of the market value of the local 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 (10) can be endogenously modeled.

4.2 Government

The government collects taxes on consumption and borrows from households. This borrowing determines the supply of the local safe asset. I assume government debt 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 $b_{ss} = b_t/Y_t$ 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 EMEs.

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

$$\tau_t + p_t^b b_{t+1} = b_t \tag{11}$$

Equation (11) implies that tax rates 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 rates are going to be procyclical, which is consistent with evidence for emerging markets (Vegh and Vuletin, 2013; Frankel et al., 2013). Concurrently, lower demand for the local bond will encourage the government to raise the tax rate.

Results and policy implications in the next section do not rely on the procyclicality of the supply of local bonds. These insights will be robust to alternative specifications, such as a constant tax rate or bond supply.

4.3 Driving Forces

Productivity $A_t = exp(\epsilon_t^A)$ is subject to a random shock ϵ_t^A that follows an AR(1) process with first-order autocorrelation ρ^A and standard deviation σ^A, which I calibrate according to the parameterization in Mendoza (2010).

The safety shock is modeled as an exogenous increase in the parameter ζ_t, which affects the convenience yield of the foreign bond. In particular, ζ_t follows an AR(1) process whose statistical moments are calibrated as in Kekre and Lenel (2021). This exogenous process captures the impact of global demand for dollar safe assets, on which the small open economy has little influence.

Finally, I add an interest rate shock, ϵ_t^R, that drives the dynamics of the non-safe international yield, $R_t = Rexp(\epsilon_t^R)$. This shock resembles the one used in previous papers that study the role of exogenous interest rate and local output shocks in small open economies. For example, Uribe and Yue (2006) find that these shocks explain around 20% of output variability in small open economies. I add this shock to match second moments and to highlight the differences with respect to a safety shock. An exogenous increase in the world interest rate produces a capital inflow reversal, an increase in the current account, and a drop in output and investment. Importantly, this shock affects both the foreign and the local bond in a similar way.

The shocks are modeled as a joint discrete Markov process that approximates the statistical moments of their actual times-series processes. Each shock has two realizations equal to plus/minus one standard deviation of each shock in the data, so I have eight possible shock combinations. I allow for a statistically significant correlation between ϵ_t^A and ϵ_t^R. The simple persistence rule produces an 8×8 matrix π which approximates autocorrelations in line with the data.

The firm's problem and optimization is standard and not related to the demand for safety, and are described in Appendix H.

4.4 Equilibrium

There are three endogenous states variables, $\{k_t, b_t^{\$}, b_t\}$, and three exogenous states that correspond to the three exogenous shocks that work as driving forces (productivity, global safety, and interest rate shocks). A competitive equilibrium for the small open economy is defined by decision rules $\{c_t, L_t, k_{t+1}, b_{t+1}^{\$}, b_{t+1}, z_t\}$ and prices $\{q_t, d_t, w_t, p_t^b, \Lambda_t\}$ such that: (a) households maximize (8) subject to (9) and (10), taking as given dividends, wages, equity and bond prices, and the world interest rate; (b) firms maximize their value subject to (40) and (41), taking as given wages, the world interest rate, and the household stochastic discount factor; and (c) the capital, bonds, labor, and goods markets clear.

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

$$q_t^b = \beta E\left[\frac{\lambda_{t+1}}{\lambda_t}\left(1 + \frac{v_{F,t+1}}{\lambda_{t+1}}\right)\right] + \frac{\mu_t}{\lambda_t} \tag{12}$$

$$p_t^b = \beta E\left[\frac{\lambda_{t+1}}{\lambda_t}\left(1 + \frac{v_{L,t+1}}{\lambda_{t+1}}\right)\right] + \frac{\mu_t \kappa^b}{\lambda_t} \tag{13}$$

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. v_i represents the first derivative of the $v(.,.)$ function in (8) with respect to $i \in \{L, F\}$, which stand for "local" and "foreign" bonds, respectively. 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. This demand for safety is captured in a reduced-form way by the convenience yield, $CY_{i,t+1} \equiv \frac{v_{i,t+1}}{\lambda_{t+1}}$, $i \in \{L, F\}$. This term measures the marginal non-pecuniary convenience service of an extra bond.

This convenience yield drives a spread with respect to a bond that provides no safety/liquidity services. This means that both $R_t^{\$}$ and R_t^b will be lower than the international interest rate, $R_t \equiv 1/q_t^c = \beta E(\frac{\lambda_{t+1}}{\lambda_t})$, where q_t^c would be the price of a foreign bond that does not provide safety/liquidity services. Put in a different way, the foreign and the local bond will have higher prices than this non-safe bond, depending on the magnitude of their convenience yields; respectively:

$$q_t^b - q_t^c = \beta E\left[\frac{v_{F,t+1}}{\lambda_t}\right] \tag{14}$$

$$p_t^b - q_t^c = \beta E\left[\frac{v_{L,t+1}}{\lambda_t}\right] \tag{15}$$

Even though it is a reduced-form specification, this 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 (through $v_{i,t+1}$), and positively on expected future consumption (through $1/\lambda_{t+1}$) which represents a wealth effect. Additionally, this specification has the benefit of making the equilibrium convenience yields fully endogenous (unlike, for example, the specification in Kekre and Lenel, 2021).

Equations (12) and (13) make clear that the introduction of the bonds in the utility function serves two important purposes. First, it allows a model counterpart for the convenience yields found in the empirical section. Second, it disentangles the prices of the two bonds. If $v_F = v_L = 0$, I would face the common issue with small open economy models where the local interest rate is equal to the world interest rate by arbitrage. Importantly, p_t^b would be exogenously determined, and thus I could not analyze the behavior of the local interest rate along the global financial cycle.

The expected excess return of capital with respect to the foreign bond is given by:

$$E[R_{t+1}^k - R_{t+1}^{\$}] = \frac{\mu_t(1-\kappa^f) - cov(\lambda_{t+1}, R_{t+1}^k) + cov(\lambda_{t+1}, CY_{F,t+1})}{E[\lambda_{t+1}]} \tag{16}$$

On the right-hand side, the first term in the numerator is the direct effect of the collateral constraint on the equity premium: The binding constraint increases the shadow price of borrowing by μ_t, and the fact that capital holdings allow one to borrow more reduces this cost by $\kappa\mu_t$. The second term is the standard covariance between consumption risk and capital return. Since this covariance is negative, consumption risk increases the equity premium. The third term captures the convenience service provided by the foreign bond, so it represents the foreign convenience yield. Therefore, expected excess return of capital is the sum of consumption risk premia, safety premia, and the risk of sudden stops.

4.5 Functional Forms

The functional forms for preferences and technology are the following:

$$u(c_t - N(L_t)) = \frac{\left[c_t - \frac{L_t^\omega}{\omega}\right]^{1-\sigma} - 1}{1-\sigma} \tag{17}$$

$$F(k_t, L_t) = A_t k_t^\gamma L_t^{1-\gamma} \tag{18}$$

$$\Psi\left(\frac{z_t}{k_t}\right) = \frac{a}{2}\left(\frac{z_t}{k_t}\right) \tag{19}$$

$$v(b_t^\$, b_t) = \alpha \frac{Q_t^{1-\sigma_v}}{1-\sigma_v} \tag{20}$$

where Q_t is the real stock of liquid assets that the household draws service flow from. As is now common in the literature (see Nagel, 2016), I assume this stock is a CES aggregate:

$$Q_t = \left[\theta\zeta_t(\max\{0, b_t^\$\})^\rho + (1-\theta\zeta_t)(b_t)^\rho\right]^{1/\rho} \tag{21}$$

The utility function in (17) is standard from DSGE-SOE models. The parameter σ is the coefficient of relative risk aversion, and ω determines the wage elasticity of labor supply. The Cobb-Douglas technology (18) is the production function for gross output, and Equation (19) is the net investment adjustment cost function.

Equation (20) is the preference function for safe assets and represents the utility of holding bonds for unmodeled transaction or collateral purposes. As explained above, ζ_t is exogenous and captures demand for global safe assets. Equation (20) assumes that demand for safety can be satisfied by the two available bonds. The parameter ρ controls the elasticity of substitution between the foreign and the local bond. With $\rho = 1$, both bonds are perfect substitutes. In the Cobb-Douglas limiting case, $\rho \to 0$, foreign and local bonds are neither substitutes nor complements. For any values $0 < \rho \leq 1$, they will be imperfect substitutes. The parameter θ is the relative weight of both bonds. Notice that only positive values of $b_t^\$$ enter into Equation (20), since it makes sense that foreign bonds only satisfy demand for safety when the household is holding an asset. Whenever

$b_t^{\$} < 0$, the household is borrowing abroad (representing capital inflows, in this case denominated in dollars), and therefore should not satisfy safety demand.

4.6 Discussion

Empirical counterparts. Most of the model elements can be justified as a way to match the empirical results in the previous section. Since the numeraire in the model is the tradable good, the convenience yield in the model, v_L/λ_{t+1}, represents the dollar-investor convenience yield of the empirical section. In this case, the non-Treasury U.S. safe dollar bond in the data corresponds to the implied non-safe bond in the model, whose price is q_t^c. The effect of the VIX index, which is a proxy for global risk aversion, is captured in the model by the effect of the exogenous safety shock that affects the convenience yield of the foreign bond. As documented in Rey (2013), increases in the U.S. federal funds rate lead to increases in the VIX and to a reduction in capital and credit inflows. Capital inflows in the model are endogenous and correspond to negative values of $b_t^{\$}$.

Although the regressions included the local monetary policy rate, there is no explicit monetary policy rate in the model. This is because, as shown in Cuevas (2022), the effect of the monetary policy rate on convenience yields works through the supply of liquid assets (under a scarce reserve system). An increase in the interest rate induces commercial banks and financial intermediaries to reduce the supply of deposits and other alternative liquid assets, decreasing the overall supply and increasing the convenience yield on all remaining liquid assets. This effect in the model is well captured by the $v(.,.)$ function. Adding an explicit monetary policy rate would not add new intuitions, and to keep the model as simple as possible, I abstracted from it. Therefore, the $v(.,.)$ function should be broadly understood as a device to capture the effect of the overall supply of liquid assets in different areas of the economy.

Other modeling choices There are alternative ways of achieving a convenience yield in a tractable model. For example, Del Negro et al. (2017), for a closed-economy model, did not rely on bonds-in-the-utility-function. Rather, they achieved a convenience yield on government bonds by adding a resaleability constraint on risky equity. When a shock reduced the resaleability of equity, entrepreneurs increased their demand for government bonds, which they could sell to take idiosyncratic investment opportunities. My model can be seen as an open-economy extension of Del Negro et al. (2017), as the function $v(.,.)$ is a "reduced form" way to capture the same dynamics. A second advantage is that my strategy simplifies the simulation of an ergodic set with local and global shocks and an occasionally binding constraint. In contrast, Del Negro et al. (2017) achieved tractability by making entrepreneurs always binding in their collateral constraint, so they were only able to simulate a one-time reduction in the resaleability of equity, holding all other shocks constant.

An alternative to my modeling strategy would be to add a banking sector that uses the two bonds as collateral, with the difference that the local bond faces a resaleability shock that reduces the proportion that can be sold for cash. This would replace the need for a reduced-form function $v(.,.)$ in the utility function of households. However, in such an alternative framework the intuition and mechanisms would be the same as in the current model. The model would be more complex but with little gain in intuition.

Although the current model relies on an unmodeled demand for safe assets and on an exogenous preference shock (the safety shock), it is important to notice that the covariance between the return of the bonds and the cycle is endogenous. The model still achieves an endogenous positive covariance of the foreign bond and a negative covariance of the local bond against the safety shock, justifying the role of the foreign bond as a global safe asset.

In addition, the positive covariance between the return of the foreign bond and the business cycle can be achieved through the introduction of the real exchange rate. This is the modeling choice in Maggiori (2017), for whom U.S. bonds are safe because the dollar appreciates in bad times. A real exchange rate can be added to my model by including a non-tradable sector. I abstract from this in order to highlight the dynamics of convenience yields alone. My approach is closer to Kekre and Lenel's (2021), who introduced a shock to the demand for safety. However, many differences remain: Theirs was a two-country model, the convenience yield was fully exogenous, there was no role for the supply of safe assets, and their model did not account for the existence of two safe assets.

4.7 Calibration

Externally set parameters. I rely on the calibration Mendoza (2010) completed for the Mexican economy. I do not intend this paper to be restricted to the Mexican case, but rather I take these parameters as representative of a developing economy. The parameters taken from this source are listed in Table 6.

Calibrated parameters. Parameters left to be calibrated are related to the convenience yield, which comes from Equation (20). Parameters that need to be calibrated are α, σ_v, θ, and ρ. The first target is the proportion of the local-currency convenience yield to the total local-currency yield. In the model, this target will correspond to the mean convenience yield as a proportion of the local interest rate, $R_t^b \equiv 1/p_t^b$. The other targets are the standard deviation of the local-currency convenience yield, the U.S. Treasury premium (the difference between the foreign- and local-currency convenience yield), and the procyclicality of the EME local-currency convenience yield with respect to output. The latter is especially important as it captures the main empirical difference between EMEs and advanced economies.

Both θ and ρ have a more direct influence on the U.S. Treasury premium and the procyclicality. The local-currency convenience yield will be more procyclical the closer substitutes the two bonds

Table 6: Externally Set Parameters

Parameter	Value	Notes
β	0.97	
σ	2	
ω	1.846	
γ	0.306	
δ	0.088	
a	2.75	
ϕ	0.26	
κ	0.2	
ρ^A	0.537	
σ^A	1.34	

Notes: Parameters are from Mendoza (2010)'s calibration for the Mexican economy.

are and the larger the weight of foreign bonds in the liquidity aggregate. At the same time, the U.S. Treasury premium will be lower the lower the relative weight of the foreign bond. Parameters α and σ_v will more directly affect the mean proportion of convenience yield to total yield and the standard deviation. At the end, all four parameters affect the different targets, so I minimize the distance with respect to the empirical moments.

I solved the model with the global non-linear method of Cao et al. (2023). 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.

Quantitative performance. Table 7 shows the results. The calibration was able to match fairly well the mean convenience yield as a proportion of the local yield. The standard deviation is somewhat lower than in the data, but still substantial compared to real variables. In addition, the parameterization matched the procyclicality of the EME local-currency convenience yield. Interestingly, the calibration matched these moments with a value of θ below 0.5, which is consistent with some degree of home bias in bond holdings.

Impulse responses to a safety shock. To gain intuition, I show the response of the model to an exogenous increase in ζ_t, which increases the safety value of the foreign bond.

Table 7: Targeted Moments and Calibrated Parameters

Parameter	Value	Moment	Data	Model
α	0.0014	mean(CY_{Lt}/R_t^b)	7.4%	7.35%
σ_v	1.9	std(CY_{Lt})/mean(CY_{Lt})	0.518	0.442
ρ	0.6	corr(GDP,CY_{Lt})	0.09	0.15
θ	0.48	mean$(CY_{Ft} - CY_{Lt})$	12 bp	19 bp

Notes: based on the simulation of 50,000 periods, dropping the first 10,000 as burn in. CY_{Lt} corresponds to the EME local-currency convenience yield, and CY_{Ft} to the convenience yield of U.S. Treasuries against comparable U.S. dollar bonds.

Figure 3 shows the impulse responses for a subset of the endogenous variables. The higher foreign convenience yield reduces the return of the foreign bond and, as the household increases its holdings of the foreign bond, consumption and the price of capital drop. In addition, the larger holdings of the foreign bond more than satiate the demand for safety, and thus the convenience yield on the local bond drops. Therefore, both capital and the local bond have a negative realized return against a safety shock. The foreign bond is the only asset paying "well" in this state of the world, which makes it an effective global safe asset.

Given that there is no effect on the international rate R_t, the drop in the local convenience yield translates into an increase in the local interest rate, R_t^b, which tightens the working capital constraint for firms, and so output and investment drop.

Notice that there is a second effect on the price of the local bond: the government reduces the supply of the local bond, which should increase its convenience yield. Therefore, the drop in price of the local bond reflects that this effect is not strong enough given the high substitutability between the two bonds in the current parameterization.

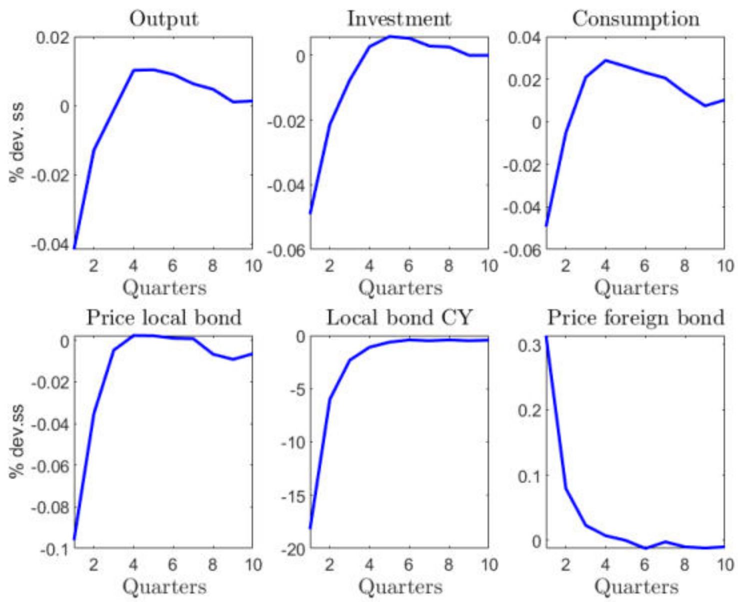
5 Macroeconomic and Policy Implications

Safety shocks are an important contributor to global macroeconomic volatility. Kekre and Lenel (2021) show that safety shocks account for slightly more than 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, and explore policy consequences for unconventional monetary policy in these economies.

5.1 Business cycle volatility

Convenience yields and the safety shock have implications for the business cycle in the local economy. The yield on the foreign bond, $R_t^{\$}$, trades below the international interest rate that governs

Figure 3: Impulse Responses to a Safety Shock



consumption-savings decisions, R_t, and this spread corresponds to the convenience yield of foreign 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 bond. The international rate is exogenously determined, so safety shocks are fully accommodated by changes in the yields of the foreign and the local bond. The yield of the local bond, in turn, will have an effect on output and investment decisions.

In particular, the exogenous increase in the foreign convenience yield is fully accommodated by a drop in the yield of the foreign bond (not by an increase in the international rate). 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, which negatively impact output through the working capital constraints on firms. 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 on output compared to an economy with a countercyclical convenience yield.

Table 8 summarizes the quantitative exercise. Column 1 shows the volatility of output, investment, and the local interest rate in the model. Column 2 shows the moments in a model with $\alpha = 0$ and therefore no demand for safe assets. Overall, my model implies that these added features account for 2% and 3.1% of output and investment volatility, respectively. The third row explores the role of the local interest rate, which is influenced by the local-currency convenience yield. In line with intuition, my model increases the volatility of the local interest rate by 4.6% compared to a model with no safety shocks and no convenience yields.

Table 8: Output and local interest rate volatility

	Model	Model w/$\alpha = 0$	% explained
σ_Y	3.9	3.85	2%
σ_I	13.76	13.42	3%
σ_{r^b}	2.05	1.96	4.6%

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

As a reference, Uribe and Yue (2006) estimate that U.S. interest rate shocks explain about 20% of movements in aggregate activity in emerging economies. These shocks do not distinguish among sources of movements in the U.S. interest rates. Compared to this, my results explore the role of one source of movements in interest rates, and therefore it can be said that demand for safety accounts for around 10% of the effect of interest rate shocks found in Uribe and Yue (2006).

6 Conclusion

This paper shows that local-currency sovereign bonds in emerging market economies work as safe assets. However, a significant difference with sovereign bonds of advanced economies is that the local-currency convenience yields in EMEs 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 reduced-form and aims to match the empirical results and carry a quantitative exercise to show that demand for safety increases business cycle volatility in small open economies.

This paper has aimed to show that local-currency convenience yields exist and are relevant for EMEs. As a result, more research is needed on them. 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 microfounded specification of the convenience yield. Theoretically, the model's simplicity in this paper tried to highlight the primary mechanisms, but it came at the cost of leaving many issues unaddressed. For example, it is necessary 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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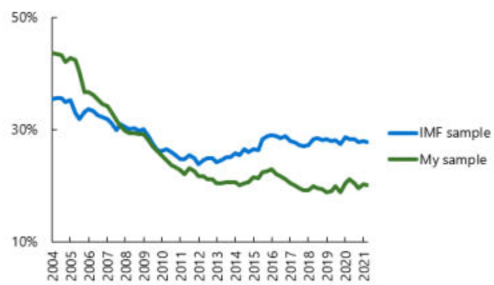
Appendix A Trends in EME's Local-Currency Sovereign Bonds

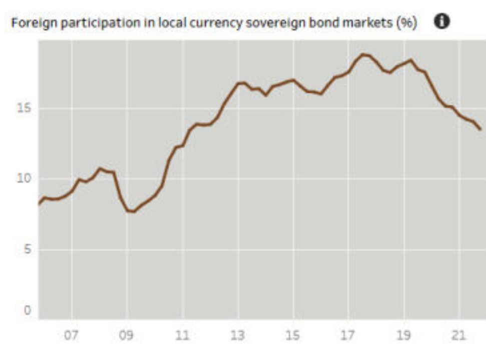
Figure 4 shows an upward trend in local-currency denomination of sovereign debt, and an increase in foreign ownership of these bonds. This evidence is consistent with evidence shown in Du and Schreger (2022) on currency denomination of sovereign external debt in EMEs.

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

I articulate the theory behind the Propositions in Section 2 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). The representative investor of country i maximizes

$$E \sum_{t=1}^{\infty} \beta^t u(C_t) \tag{22}$$

Suppose that C_t is the sum of an endowment of c_t plus "convenience" benefits:

$$C_t = c_t + \nu_i(\theta_t^j, \mathrm{GDP}_t; \zeta_t) \tag{23}$$

The benefits are a function of the real holdings of convenience assets from country j, θ_t^j. One example is that the function $\nu_i(\cdot)$ captures the notion that holding more sovereign bonds from country j reduces costs that would otherwise be incurred by transacting in a less liquid security. The argument θ_t^j is the market value of the agent's real holdings of sovereign bonds of country j. Notice that $\nu_i(\cdot)$ varies with i, allowing for investors of different countries to have different valuations on the convenience of bonds depending on the country they were issued. The term ζ_t is a preference shock that affects how much utility is derived from convenience assets. The dollar 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 θ_t^j. Thus define $v_i\left(\frac{\theta_t^j}{\mathrm{GDP}_t}; \zeta_t\right)\mathrm{GDP}_t \equiv \nu_i(\theta_t^j, \mathrm{GDP}_t; \zeta_t)$. Assume that the convenience function is increasing in $\theta_t^j/\mathrm{GDP}_t$ for all j, but the marginal convenience benefit is decreasing in $\theta_t^j/\mathrm{GDP}_t$, and $\lim_{\theta_t^j/\mathrm{GDP}_t \to \infty} v_i'(\theta_t^j/\mathrm{GDP}_t; \zeta_t) = 0$.

The convenience function $v_i(\cdot)$ is a reduced-form way to capture how superior liquidity and the certainty of nominal repayment of an asset will lead investors to pay a higher price for that asset, as in Krishnamurthy and Vissing-Jorgensen (2012).

Henceforth, for simplicity, assume the representative investor, regardless of her country of origin i, cares about the returns in dollars.

Proof of Proposition 1. Denote the 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

$$-\frac{P_t^{US}}{Q_t} + \beta E_t\left[\frac{P_{t+1}^{US}}{Q_{t+1}} u'(C_{t+1})\right] + \frac{P_t^{US}}{Q_t} v_i'(\theta_t^{US}/\mathrm{GDP}_t; \zeta_t) u'(C_t) = 0 \tag{24}$$

Define the pricing kernel for nominal payoffs as

$$M_{t+1} = \beta \frac{u'(C_{t+1})}{u'(C_t)} \frac{Q_t}{Q_{t+1}} \tag{25}$$

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

$$\begin{aligned} P_t^{US} &= E_t[M_{t+1} P_{t+1}^{US}] + P_t^{US} v_i'(\theta_t^{US}/\mathrm{GDP}_t; \zeta_t) \Rightarrow \\ P_t^{US} &= E_t[M_{t+1} P_{t+1}^{US}] \Lambda_t^{US,i} \end{aligned} \tag{26}$$

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

$\Lambda_t^{US,i}$, 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

$$P_t^{US} = \pi_t E_t[M_{t+1}\Lambda_t^{US,i}(1 - L_{t+1}^{US})|\text{Default}] + (1-\pi_t)E_t[M_{t+1}P_{t+1}^{US}\Lambda_t^{US,i}|\text{No Default}] \tag{27}$$

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

$$\begin{aligned} e^{-y_t^{US}} = P_t^{US} &= E_t[M_{t+1}\Lambda_t^{US,i}] - E_t[M_{t+1}]E_t[\tilde{L}_{t+1}^{US}] - \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^{US}] - \text{cov}_t[\Lambda_t^{US,i}, \tilde{L}_{t+1}^{US}] \\ &\approx e^{\lambda_t^{US,i} - \pi_t(E_t[L_{t+1}^{US}] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^{US}]/E_t[M_{t+1}]) - \text{cov}_t[\lambda_t^{US,i}, \tilde{L}_{t+1}^{US}]/E_t[M_{t+1}]} E_t[M_{t+1}] \end{aligned} \tag{28}$$

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

$$y_t^{US} \approx y_{rf,t}^{US} - \lambda_t^{US,i} + l_t^{US} - \xi_t^{US,i} \tag{29}$$

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); $\lambda_t^{US,i}$ is the convenience yield (how much the total yield is reduced because of the marginal services provided by the bond); and $\xi_t^{US,i} = \text{cov}_t[\lambda_t^{US,i}, \tilde{L}_{t+1}^{US}]/E_t[M_{t+1}]$ denotes the covariance between default risk and the convenience yield. □

Proof of Proposition 2. Again, denote the price level at date t as Q_t and let $j \neq$ US. Let the price of the sovereign bond in local currency j be P_t^j. If the investor purchases one unit, her real holdings θ_t^j rise by $P_t^j/Q_t \times 1/S_t$. The first order condition for holdings of the synthetic bond is

$$-\frac{P_t^j}{Q_t}\frac{1}{S_t} + \beta E_t\left[\frac{P_{t+1}^j}{Q_{t+1}}\frac{1}{F_{t+1}}u'(C_{t+1})\right] + \frac{P_t^j}{Q_t}\frac{1}{S_t}v_i'(\theta_t^j/\text{GDP}_t;\zeta_t)u'(C_t) = 0 \tag{30}$$

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:

$$\begin{aligned} P_t^j \frac{F_t^1}{S_t} &= E_t[M_{t+1}] + P_t^j v_i'(\theta_t^j/\text{GDP}_t;\zeta_t) \Rightarrow \\ P_t^j \frac{F_t^1}{S_t} &= E_t[M_{t+1}]\Lambda_t^{j,i} \end{aligned} \tag{31}$$

where $\Lambda_t^{j,i} \equiv 1/(1 - v_i'(\theta_t^j/\text{GDP}_t; \zeta_t))$ captures the marginal benefits investor i derives from the bond issued by the sovereign 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). 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 $\frac{\text{cov}_t(1-K_t^j, 1/S_{t+1})}{E_t(1-K_{t+1}^j)E_t(1/S_{t+1})}$, 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

$$
\begin{aligned}
e^{-y_t^j + \rho_{j,t}} = P_t^j \frac{F_{t+1}}{S_t} &= E_t[M_{t+1}\Lambda_t^{j,i}] - E_t[M_{t+1}]E_t[\tilde{L}_{t+1}^j] - E_t[M_{t+1}]E_t[\tilde{K}_{t+1}^j] \\
&\quad - \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^j] - \text{cov}_t[M_{t+1}, \tilde{K}_{t+1}^j] - \text{cov}_t[\Lambda_t^{j,i}, \tilde{L}_{t+1}^j] - \text{cov}_t[\Lambda_t^{j,i}, \tilde{K}_{t+1}^j] \\
&\approx e^{\lambda_t^{j,i} - \pi_t^j(E_t[L_{t+1}^j] + \text{cov}_t[M_{t+1}, \tilde{L}_{t+1}^j]/E_t[M_{t+1}]) + q_t^j - \tilde{\pi}_t^j(E_t[K_{t+1}^j] + \text{cov}_t[M_{t+1}, \tilde{K}_{t+1}^j]/E_t[M_{t+1}])} \\
&\quad \times e^{p_t^j - \text{cov}_t[\Lambda_t^{j,i}, \tilde{L}_{t+1}^j]/E_t[M_{t+1}] - \text{cov}_t[\Lambda_t^{j,i}, \tilde{K}_{t+1}^j]/E_t[M_{t+1}]} \times E_t[M_{t+1}]
\end{aligned}
\tag{32}
$$

Taking logs on both sides gives:

$$
y_t^j - \rho_{j,t} \approx y_{rf,t}^{US} - \lambda_t^{j,i} + (l_t^j - q_t^j) + (k_t^j - p_t^j) - \xi_t^{j,i} - \psi_t^{j,i} \tag{33}
$$

where $y^{US}_{rf,t} = -\log M_{t+1}$; $\lambda^{j,i}_t \approx v'_i(\theta^j_t/\text{GDP}_t;\zeta_t)$ is the convenience yield on the local-currency bond; $l^j_t = \pi^j_t(E_t[L^j_{t+1}]+\text{cov}_t[M_{t+1},\tilde{L}^j_{t+1}]/E_t[M_{t+1}])$ and $k^j_t = \tilde{\pi}^j_t(E_t[K^j_{t+1}]+\text{cov}_t[M_{t+1},\tilde{K}^j_{t+1}]/E_t[M_{t+1}])$ are the extra yield demanded for default and regulatory losses; and $\xi^{j,i}_t = [\text{cov}_t[\Lambda^{j,i}_t,\tilde{L}^j_{t+1}]/E_t[M_{t+1}]$ and $\psi^{j,i}_t = [\text{cov}_t\Lambda^{j,i}_t,\tilde{K}^j_{t+1}]/E_t[M_{t+1}]$ are the covariances of the convenience yield with default risk and regulatory risk, respectively. □

Proof of Proposition 3. Following the same reasoning as in the two previous proofs, the price of a EME sovereign bond issued offshore in dollars, $\hat{P}^j_t$, is given by:

$$\hat{P}^j_t = E_t[M_{t+1}\hat{P}^j_{t+1}]\hat{\Lambda}^{j,i}_t \tag{34}$$

where $\hat{\Lambda}^{j,i}_t \equiv 1/(1-v'_i(\theta^{\hat{j}}_t/\text{GDP}_t;\zeta_t))$ increases with the marginal convenience services provided by this bond. Assume the local government can default on this bond with probability $\hat{\pi}^j_t$, imposing a loss of $\hat{L}_{t+1}$ on the investor. In this case, $\tilde{L}^j_{t+1}$ 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

$$\begin{aligned} e^{-\hat{y}^j_t} = \hat{P}^j_t &= E_t[M_{t+1}\hat{\Lambda}^{j,i}_t] - E_t[M_{t+1}]E_t[\tilde{L}^j_{t+1}] - \text{cov}_t[M_{t+1},\tilde{L}^j_{t+1}] - \text{cov}_t[\hat{\Lambda}^{j,i}_t,\tilde{L}^j_{t+1}] \\ &\approx e^{\hat{\lambda}^{j,i}_t - \hat{\pi}_t(E_t[\hat{L}^j_{t+1}]+\text{cov}_t[M_{t+1},\tilde{L}^j_{t+1}]/E_t[M_{t+1}]) - \text{cov}_t[\hat{\lambda}^{j,i}_t,\tilde{L}^j_{t+1}]/E_t[M_{t+1}]}E_t[M_{t+1}] \end{aligned} \tag{35}$$

Taking logs on both sides gives:

$$\hat{y}^j_t \approx y^{US}_{rf,t} - \hat{\lambda}^{j,i}_t + \hat{l}^j_t \tag{36}$$

where variables have the same interpretation as in the previous two proofs. Now, define $\Phi^{FC,i}_t$ as the spread between the yield of the synthetic bond (Equation (33)) and the yield on the foreign currency-denominated bond (Equation (36)). Then,

$$\begin{aligned} \Phi^{FC,i}_t \equiv& y_{i,t} - \rho_{i,t} - \hat{y}^j_t \\ &\approx (y^{US}_{rf,t} - \lambda^{j,i}_t + (l^j_t - q^j_t) + (k^j_t - p^j_t) - \xi^{j,i}_t - \psi^{j,i}_t) - (y^{US}_{rf,t} - \hat{\lambda}^{j,i}_t + \hat{l}^j_t) \\ &= (\hat{\lambda}^{j,i}_t - \lambda^{j,i}_t) + (l^j_t - \hat{l}^j_t - q^j_t) + (k^j_t - p^j_t) - \xi^{j,i}_t - \psi^{j,i}_t \end{aligned} \tag{37}$$

□

Appendix C Data Sources

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

$$\lambda^{j,i}_t - \lambda^{US,i}_t = y^{US}_t - (y^j_t - \rho_{j,t}) + (l^j_t - l^{US}_t) + \Phi^{FC,i}_t + \xi^{US,i}_t \tag{38}$$

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

Table 9: 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

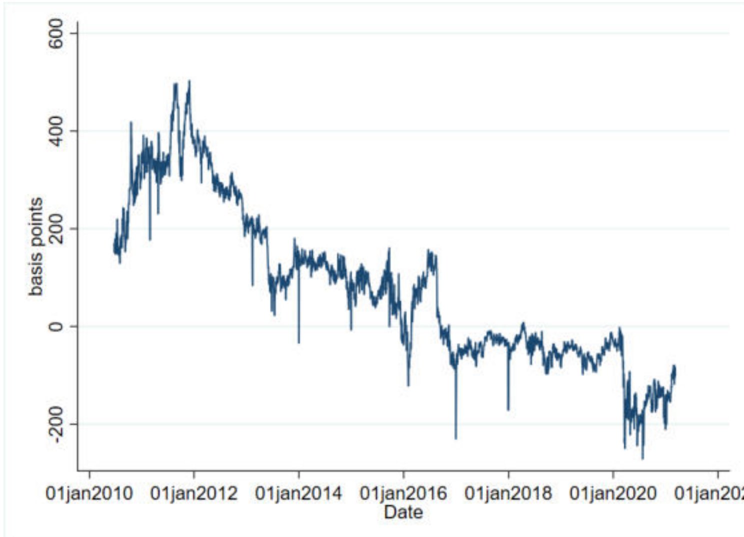
Appendix D Robustness for estimation of Section 2.1.1

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 (5) 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.

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.

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 (4) 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.

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 (5) 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 (5) 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 10 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 10: 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 (5) 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 (5) 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 (5) 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 11 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.

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.

Table 11: 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.

D.4 Market segmentation

Another potential issue with Equation (5) 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 (5) 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 12 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 12 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

Table 12: 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.

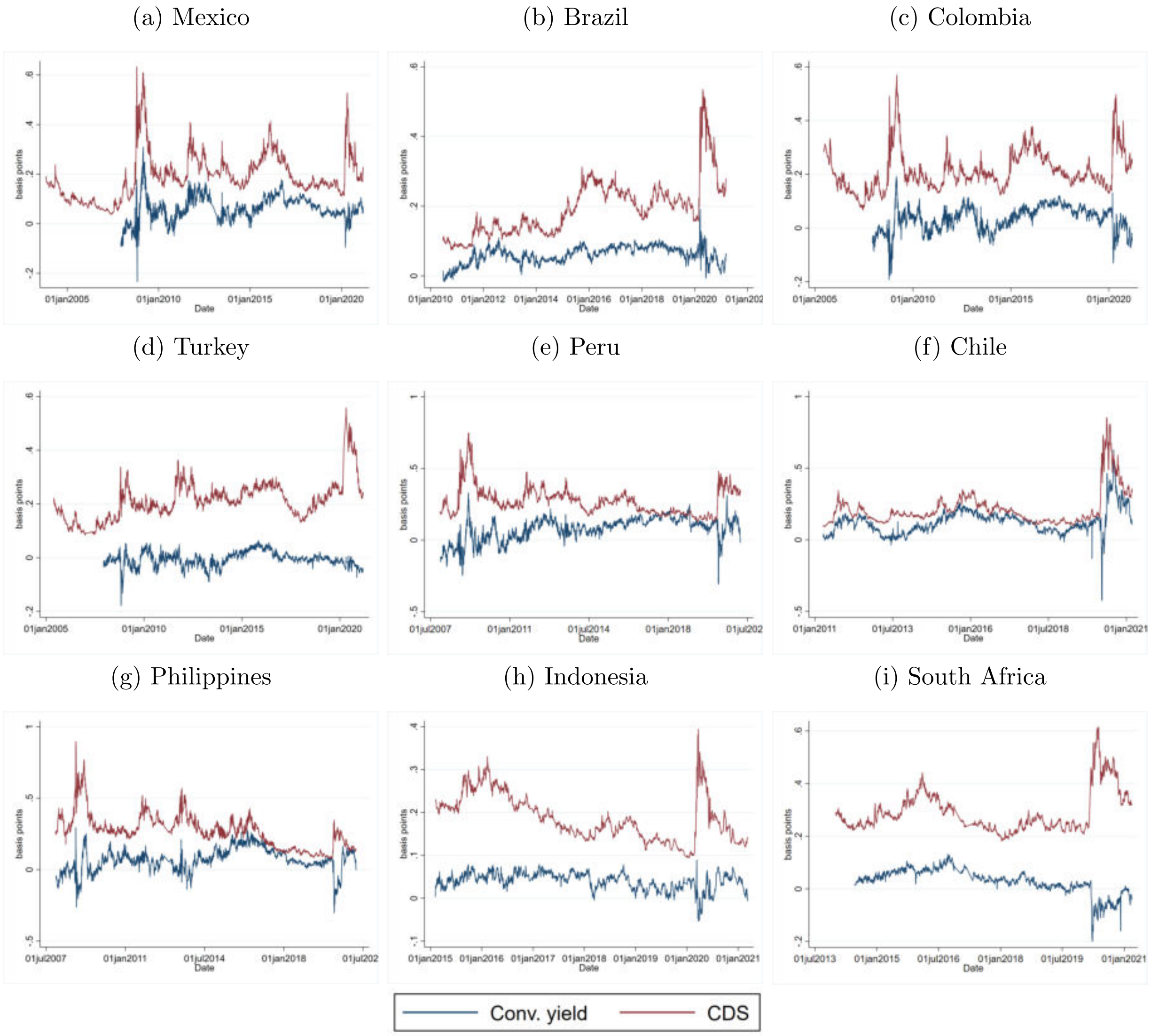
local-currency bonds are owned by foreigners, they still are a relevant component of foreigners' investment in these countries. The time series (not captured in this table) shows an upward trend until the mid-2010s, with a drop afterwards for most countries. Moreover, this share is also sizable when 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

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

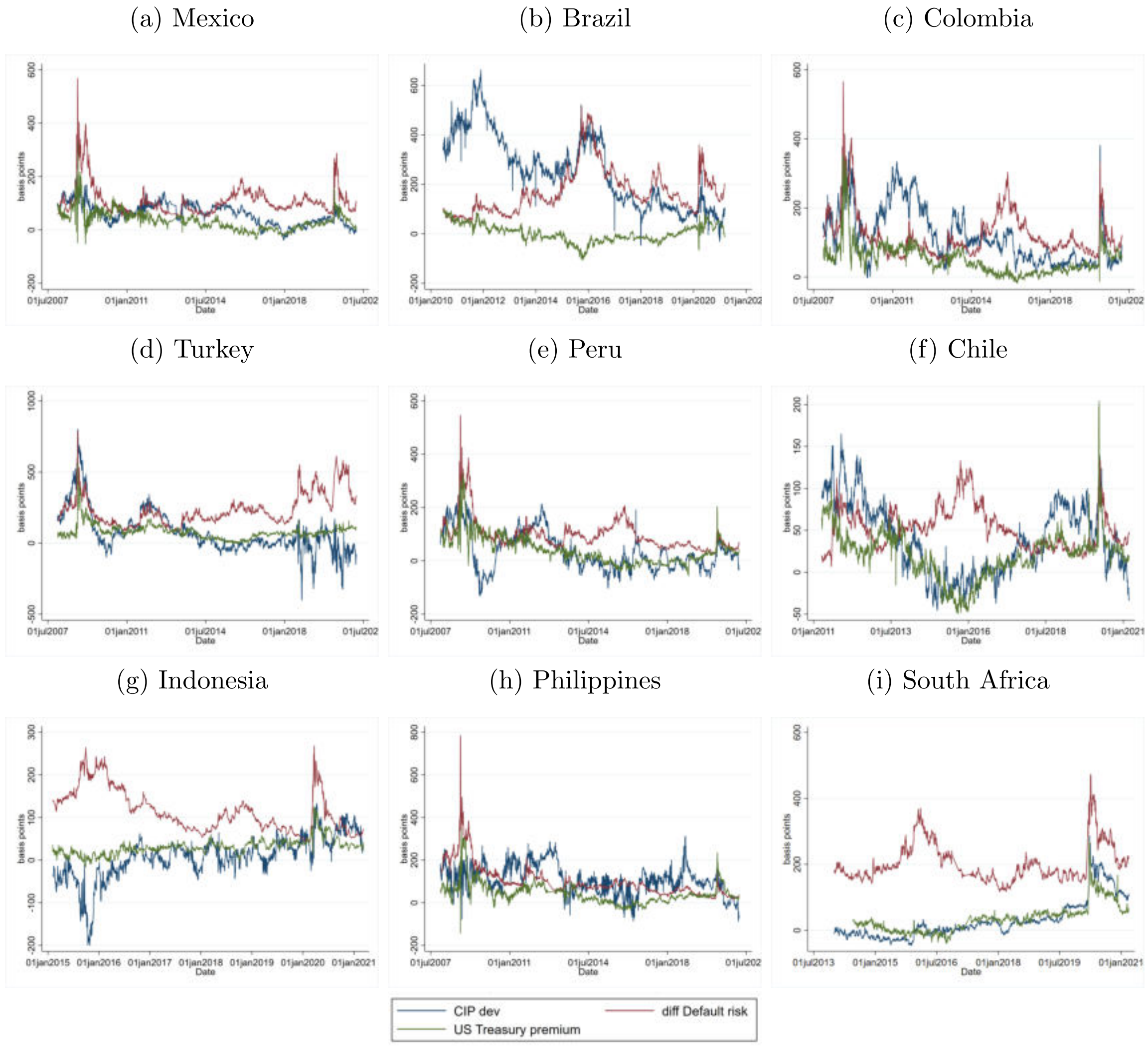


yield.

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 (5) 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

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



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 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 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 (3). 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 13 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

Table 13: 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. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

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

Table 14: 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

of EME assets during those two events.

Table 14 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.

Appendix H Model: Firms side

Firms are owned by households and discount future profits by taking as given the households' stochastic discount factors, Λ_t. Firms produce a tradable good that sells at a world-determined price (normalized to one for simplicity). They make plans for factor demands and investment. Net investment, $z_t = k_{t+1} - k_t$, incurs unitary investment costs determined by the function $\Psi(z_t/k_t)$, which is linearly homogeneous in z_t and k_t. To this, I introduce working capital constraints. In particular, firms need working capital to pay for a fraction ϕ of their labor costs in advance of sales. Firms are required to guarantee working capital loans so working capital financing cannot exceed the fraction κ^f of the value of firms' assets. The role of working capital constraints is to allow for movements in interest rates to have an impact on contemporary output.

The firms' problem is to choose labor demand and investment so as to maximize their value:

$$E_0\left[\sum_{t=0}^{\infty}\left(\prod_{j=0}^{t}\Lambda_j^{j-1}\right)\left(A_tF(k_t,L_t) - w_tL_t - \delta k_t - \phi(R_t^b - 1)w_tL_t - z_t\left[1 + \Psi\left(\frac{z_t}{k_t}\right)\right]\right)\right] \tag{39}$$

subject to the law of motion for capital,

$$z_t = k_{t+1} - k_t \tag{40}$$

and the collateral constraint on working capital financing:

$$R_t^b \phi w_t L_t \leq \kappa^f q_t k_{t+1} \tag{41}$$

Gross output in (39) is defined by a constant-returns-to-scale technology, $A_tF(k_t, L_t)$, that requires capital, k_t, and labor, L_t, to produce the tradable good. The firm makes wage payments, w_tL_t, and payments on the interest of the working capital loans, $\phi(R_t^b - 1)w_tL_t$. Working capital in (41) is a within-period loan contracted at the beginning of each period and paid off after the current output is sold at the end of the period. Hence, lenders set the limit on working capital considering that the market value of the assets offered as collateral must cover interest and principal on working capital loans.

In general equilibrium, the equity market clears and asset prices adjust so that the households' investment plans are consistent with those formulated by firms. On the firms' side, the optimality conditions for k_{t+1} and z_t are:

$$1 + \Psi\left(\frac{z_t}{k_t}\right) + \frac{z_t}{k_t}\Psi'\left(\frac{z_t}{k_t}\right) = \eta_t \tag{42}$$

$$
\begin{aligned}
E_t[\Lambda_t(d_{t+1} + \eta_{t+1})] + \chi_t \kappa^f q_t &= \eta_t \\
d_{t+1} \equiv A_{t+1} F_1(k_{t+1}, L_{t+1}) - \delta + \left(\frac{z_{t+1}}{k_{t+1}}\right)^2 \Psi' \left(\frac{z_{t+1}}{k_{t+1}}\right)
\end{aligned}
\tag{43}
$$

where η_t and χ_t are the Lagrange multipliers on the investment Equation (40) and the working capital constraint (41), respectively.

Notice that, since firms discount at the households' stochastic discount factor, the forward solution of (43) yields asset prices consistent with the households' decision when $\eta_t = q_t$. The optimal choice for z_{t+1} (given k_t and q_t) implied by the firms' optimal investment condition (42) represents the firms' demand for investment resources (i.e., its equity supply function). Since (42) is a standard Tobin's Q relationship, the fact that $\Psi(.)$ is increasing and convex implies that there is a positive relationship between investment demand and the equity price, or that the firms' equity supply function is upward sloping. This is because adjustment costs prevent firms from instantaneously adjusting the stock of capital to its long-run level. Hence, increases in demand for safety ultimately will have an impact on investment, and output, through this channel: Drops in q_t will make firms gradually reduce the capital stock and thus in firm investment.

Finally, the firms' first order condition with respect to labor gives the following expression:

$$
A_t F_2(k_t, L_t) = w_t(1 + \phi(R_t^b - 1) + \phi R_t^b \chi_t) \tag{44}
$$

On the right-hand side, the term $R_t^b \chi_t$ reflects the increase in the effective marginal financing cost of working capital caused by the collateral constraint. This allows shocks to bond yields to have a negative impact on contemporary output and employment.

Fisherian deflation as described in Bianchi and Mendoza (2020) is present in the model and affects all assets that serve as collateral, although it is harder to illustrate it in closed-form equations. When the collateral constraint binds, households respond by fire-selling equity and local bonds. When they sell equity, they meet with firms that feature an upward-sloping supply of equity because of Tobin's Q. These firms thus find it optimal to lower investment given the reduced demand for equity and higher discounting of future dividends, so equilibrium equity prices fall. But this only reinforces the tightness of the constraint, so a second round of sales takes place and Fisher's deflation mechanism is set into motion. In the case of the local bond, this effect can be (partially) offset by an increase in the demand for its convenience services.