Covered Interest Parity in Emerging Markets: Measurement and Drivers*

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Abstract

We study the behavior of Covered Interest Parity (CIP) deviations – aka the CIP basis - in Emerging Markets (EM). A major challenge in computing the CIP basis in EM's lies in measuring local currency interest rates which are free of local credit risk. To do so, we construct a 'purified' CIP basis for eight major EM currencies using supranational bonds issued in EM local currencies and US dollar going back twenty years. We show that this 'purified' CIP basis aligns well with theory-implied predictions. In the cross-section and the time-series, the basis correlates with fundamental forces driving supply and demand for dollar forwards. Shocks to global dollar funding costs, global intermediary's balance sheet capacity, and the demand for dollar safe assets interact with currency-specific dollar hedging and funding needs in moving the CIP basis in EM's.

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1 Introduction

A growing literature has documented significant deviations from Covered Interest Parity (CIP) in G-10 advanced economies' currency markets. The CIP deviation against the US dollar is typically used to gauge the degree of stress in dollar funding markets. Prior to the Global Financial Crisis (GFC), the CIP deviation in G-10 currencies was very close to zero, implying little potential arbitrage gains as one would expect for an essentially risk-free arbitrage. This changed substantially with the GFC, as documented early on for the dollar/euro swap market by Baba and Packer (2009). Since 2008, the CIP deviation in advanced economies has been fluctuating between 20 and up to 100 basis points or more during stress periods. The common interpretation is that movements in the CIP deviation reflect fluctuations in the capacity of financial intermediaries to expand their balance sheet to take advantage of risk-free arbitrage, see Du and Schreger (2022).

While much work has covered CIP deviations for advanced economies (AEs), far less is known about the CIP deviation in emerging markets (EMs). Even though financial market data necessary to construct CIP deviations (e.g. interbank interest rates or government bond yields, spot and forward exchange rates or cross currency basis swaps) are available for large emerging market FX markets, the measurement and interpretation of deviation from CIP in EM's pose major challenges.

The first challenge is how to obtain a measure of the risk-free yield for emerging market local currency assets. Unlike in the US or other G-10 advanced economies, local currency government bond yields in EMs may reflect substantial and time-varying local currency credit risk. The alternative commonly-used CIP deviation constructed using interbank interest rates such as the LIBOR faces similar challenges as benchmark interbank rates in EM's arguably also price in credit risk, often co-moving with sovereign yields.

Second, institutional features such as capital controls, differential taxation, legal protection and segmentation across EM onshore and offshore markets complicate the interpretation of CIP deviations for these economies. International investors may not have access to the local money markets, or the onshore currency market, while domestic investors may not have the same access to the offshore currency markets and dollar funding as foreign ones. They all face different tax burdens on their onshore and offshore investment which are also subject to different domestic and international laws. Such segmentation implies that conventional measures of CIP deviations in EM's cannot readily be interpreted as limits to arbitrage in the same way as for G10 currencies.

This paper's main contribution is to offer a new and systematic way to construct CIP deviations in EMs that are free of credit and liquidity premia, and at the same time are not subject to the constraints posed by market segmentation. The key insight is to construct the CIP deviation from the market yields of bonds issued offshore by supranational entities in different currencies (that is, in EM local currencies and US dollar), distinguish them from conventional measures and characterize their cross-sectional and time-series evolution, including in interaction with measures for global supply and demand drivers for dollar funding.

Supranational entities are multilateral institutions established and jointly backed by the central governments of a group of countries. An example is the European Investment Bank (EIB), a financing arm of the European Union (EU) that benefits from a joint guarantee from EU members countries and is therefore considered to be essentially credit risk-free. Some sub-national issuers also have impeccable credit records. For instance Germany's Kreditanstalt für Wiederaufbau (KfW) benefits from a full guarantee from the German government and – given the strength of the guarantor – can be considered risk free. In addition, supranational bonds are mostly issued offshore, subject to New York or English law, settled in dollars and not subject to sanctions, providing strong legal protection and ease of settling. Finally, local withholding and capital gain taxes are not applicable on holdings of supranational bonds, irrespective of the currency denomination.

Our approach can thus be described as follows. Imagine that a supranational entity such as the EIB issues simultaneously zero coupon bonds of the same maturity in US dollars and Turkish lira. Then it is straightforward to compare the return between the US dollar bond and the Turkish lira bond issued by the EIB – swapped into dollars using the FX forward premium between the two currencies. This provides us with a measure of the CIP deviation for the lira that is free of any credit risk -unlike the estimates that would be obtained using local currency Turkish government bonds. We call this the 'purified' CIP deviation.[1]

While the above may sound simple in theory, a number of steps must be taken to ensure that we can indeed construct CIP deviations using supranational issuances. First, supranationals typically don't issue zero coupon bonds. Nevertheless, they issue coupon bonds in EM currencies and the US dollar sufficiently frequently that we can construct 'purified CIP' estimates at one year tenor for eight emerging market economies.[2] As a check on our methodology, we also construct purified CIP deviations of major G-10 currencies against the US dollar using supranational bonds issued in G-10 currencies, and confirm that they correspond to conventional CIP deviations for these currencies. Since the local currency bonds in these countries don't suffer from credit risk, the 'purified' CIP and the standard estimates obtained using local government bonds or LIBOR rates should coincide. We find that they do.

A second challenge is how to address the differential liquidity of supranational bonds across different currency markets. Our empirical methodology adjusts for differences in the liquidity

[1] In principle, the argument could be generalized to risky corporate issuers, such as a multinational entities, as long as the credit risk is perfectly correlated on the dollar and local currency bonds. In practice, this may not be the case -depending on the terms of the bond prospectus, issued in different jurisdictions and possibly by different affiliates- a multinational could decide to default on the local currency bond, and not on the US dollar bond. Moreover, the vast majority of international corporate bond offerings are denominated in the four major currencies (USD, GBP, EUR, JPY) and rarely in EM currencies, see McBrady et al. (2010).

[2] The EMs are Brazil, China, India, Indonesia, Mexico, Russia, South Africa and Türkiye.

of the bonds issued by supranationals, using a panel approach that controls for bond-specific, time-varying bid-ask spreads.

Our first main finding is that the purified CIP deviations for EMs is often much smaller in absolute value, and less volatile, than the naive CIP. Averaging across EM currencies, the mean absolute value is 33 bps for the purified basis, while it 112 bps for the government bond yield based CIP basis and 260 bps for the Libor based basis. The standard deviation of the conventional CIP basis is on average also three times larger than that of the purified one.

Second, the purified CIP tends to be algebraically larger than the naive one. Taken together, these findings confirm that the naive CIP contains a significant credit risk element -that tends to make it more negative –as higher local currency government rates reflect higher credit risk (see Du and Schreger (2016)).

However, while smaller, the purified CIP is not identically equal to zero, neither before nor after the 2008 Global Financial Crisis, suggesting that longstanding intermediation frictions prevent risk-free arbitrage for EMs, as they do for AEs since 2008.

To understand the drivers of CIP deviations, we develop a simple but quite general model of the (purified) CIP basis similar in spirit to Ivashina et al. (2015). The model considers a US-based financial intermediary that offers off-balance sheet dollars forward. Because of regulation or risk management, the intermediary needs to be compensated in equilibrium for offering these forwards. The return to the intermediary is precisely the (purified) CIP basis. Therefore the model produces a 'supply curve' for dollars forward. For a given CIP basis, the supply of forward varies with the balance sheet capacity of the intermediary and with the strength of the regulatory or risk constraints. Local and foreign currency investors with foreign and local currency assets and liabilities form a global dollar hedging demand. The equilibrium on the forward market determines the CIP basis.

In the cross section, the model predicts that the sign of the CIP basis depends on the net dollar hedging demand. Countries with large dollar assets need to sell dollar forward for hedging and funding purposes. For these countries, the CIP basis needs to be negative (forward dollars are cheap) to compensate the intermediary. Conversely, countries with dollar liabilities or foreign investors holding local currency assets need to buy dollar forwards to hedge their exposure. For these currencies, the CIP basis needs to be positive (forward dollars are expensive) to compensate the intermediary.

In the time series, the model predicts that fluctuations in funding conditions widen the basis. When funding conditions tighten, the CIP basis becomes more positive for short dollar countries and more negative for long dollar countries. Hence tighter funding conditions not only widens the basis but also increases the dispersion of the CIP basis across countries. The model also predicts that tighter financial regulation, especially for global intermediaries, will widen the absolute value of the basis and amplify its response to dollar funding shocks.

We test these cross-sectional and time series predictions and find that they indeed hold for our sample of EMs when we use our purified CIP – but not so when using the naive basis. These results provide an external validation that we are capturing the true CIP deviation in EM's which reflects underlying financial frictions. Going forward, our paper's results suggest that researchers and policy makers should leverage this fast-growing but less explored asset class to construct an alternative measure for financial frictions in emerging markets.

Relation to the literature Our paper builds and expands on a growing body of work at the intersection of international finance and intermediary asset pricing that explores CIP deviations, mostly in advanced economies, after the GFC. The interest in this topic stems from the notion that the CIP is a fundamental no-arbitrage condition, whose violation indicate either market inefficiency or regulatory constraints inhibiting arbitrage, or both. Du and Schreger (2022) provide a comprehensive overview of the literature. Two leading explanations for the emergence of a negative CIP basis in advanced economies have emerged. For one, intermediary's tightening balance sheet constraints due to post-GFC banking regulation reforms and internal risk-management have widened the shadow costs of banks' arbitrage trades such as the CIP trade. This explanation puts emphasis on the supply side of global dollar liquidity and typically interprets variation in the CIP basis of G-7 currencies as reflecting fluctuations in intermediation capacity of global banks (Du et al. (2018b) and Avdjiev et al. (2019)). Complementary to this supply-side view is the alternative emphasis on global demand for dollar safe assets highlighted by Jiang et al. (2020), Krishnamurthy and Lustig (2019) and Devereux et al. (2023). Fluctuations in global demand for dollar safe assets can also result in deviations from CIP, often in the form of the so-called Treasury basis, which is computed as the CIP basis using non-US government bond yields swapped into dollar, relative to the dollar yield of maturity-matched U.S. Treasuries. These measures of supply and demand shocks for dollar liquidity tend to correlate with each other and with the dollar exchange rate, are mutually reinforcing, and together give rise to the global dollar cycle (Obstfeld and Zhou (2022)). Our purified CIP basis in EM's lends itself to the analysis of how both global supply and demand drivers affect FX markets in EM's. By doing so, we show that it responds to these inter-related supply and demand forces for dollar liquidity, as predicted by theory.

While the vast majority of the literature focuses on CIP deviations in AE's, Du and Schreger (2016) were the first to systematically analyze corresponding measures of CIP deviations in EM's. Using conventional interbank interest rates and bond yields to construct the CIP deviation, they showed how the conventional CIP basis largely reflects variations in local currency credit risk in these markets. Our paper is the first to systematically construct a purified CIP deviation using supranational yields for all available emerging market currencies and using the full range of supranational issuers, with the idea going back to Du and Schreger (2016), who first constructed a cross-currency basis for the Brazilian Real and Turkish Lira using KfW and EIB bonds. In addition to expanding the currencies, issuers and time period relative to their paper, we also introduce an empirical adjustment for differential market liquidity for supranational bonds using bid-ask spreads.

One recent paper that also studies the CIP basis in EM's is Cerutti and Zhou (2024). That paper also uses conventional local currency interest rates to construct the CIP basis in EM's, with a focus on onshore and offshore forward market segmentation. While they also document some correlation of the conventional CIP basis with global factors driving dollar intermediation as we do, they do not find a relationship between the CIP basis and measures of hedging demand, a key result of our paper and one that only emerges with the purified CIP basis. On the theory side, a closely related paper to ours is Liao and Zhang (2020), which also emphasizes the hedging channel of CIP and exchange rate determination. We build on their insight but expand both the theoretical and empirical analysis to broader forces governing the CIP and go beyond advanced economies thanks to the newly constructed “purified" CIP basis.

Finally, our paper also contributes to the literature on the use of capital flow, macroprudential, and exchange rate policies in the presence of various externalities and frictions in emerging markets, as reviewed in Bianchi and Lorenzoni (2022). Basu et al. (2023) combine key ingredients from this literature in an integrated framework to derive the optimal mix of policy instruments in small open economies, highlighting the role of FX mismatches and FX market shallowness. Our paper provides conceptual and empirical measures for both of these frictions: the purified CIP basis is a wedge that proxies for time-varying FX market shallowness and resulting intermediation frictions, while our measure of underlying hedging demand captures each currency's exposure to these frictions resulting from FX mismatches in external positions. Our paper is also the first to show that purified CIP deviations for EM's constructed with supranational bonds verify theoretical predictions about global dollar hedging supply and demand.

The rest of our paper is organized as follows. Section 2 presents some stylized facts for the conventional measures of CIP deviation, both for AE and EM currencies. To help frame ideas, section 3 presents our theoretical framework. This may be skipped on a first read if the reader is mostly interested in the details of our 'purified' CIP. Section 4 presents the details of our estimation method while section 5 presents our empirical results on the drivers of CIP for EMs. Section 6 concludes with some observations on future research and policy implications.

2 Stylized facts for conventional measures of CIP deviations

In this section, we establish some key stylized facts about CIP deviations in EMs, including in comparison to CIP deviations in AEs. We highlight their trend evolution and cyclical variation, differences across countries, composition and other statistical properties. We measure the CIP deviation (aka the CIP basis) $\tau_{i,n,t}$ for the currency of country i at maturity n and time t according to the standard formula:

$$\tau_{i,n,t} = y^{rf}_{USD,n,t} + \rho_{i,n,t} - y^{rf}_{i,n,t} \tag{1}$$

where $y^{rf}_{i,n,t}$ is the country i risk-free interest rate (often measured by an inter-bank money market rate or annualized yield on a zero-coupon sovereign bond in country i in its own currency) with maturity n at time t, and $\rho_{i,n,t}$ is the annualized forward premium that converts currency of country i into US dollar at time t and back at time $t+n$. Defined this way, the basis measures the return from a zero wealth investment strategy that borrows in the local currency and invests in the dollar cash market, hedging the currency risk. It is positive when the cash dollar interest rate exceeds the synthetic dollar rate constructed from domestic currency interest rate and currency hedges. In a frictionless and riskless setting any return should be arbitraged away, yielding the classic CIP condition: $\tau_{i,n,t} = 0$. One important assumption and condition for CIP to hold is that both the dollar $y_{USD,n,t}$ and the domestic interest rates $y_{i,n,t}$ are risk-free. Otherwise, deviations from CIP could reflect variations in the relative risk priced in different currencies over time.

2.1 Advanced Economies vs Emerging Markets differences

In general, LIBOR and government bond based CIP deviations are comparable, especially at shorter tenors, and track each other closely (see Appendix B). Looking at the daily LIBOR basis for major advanced economies' currencies, that is G-7 currencies comprising the Euro (EUR), Swiss Franc (CHF), Japanese Yen (JPY), British Pound (GBP), Australian dollar (AUD), and Canadian dollar (CAD) in Figure 1, we make the following observations.

First, as documented in the literature, the LIBOR basis has widened after the GFC, with the introduction of various regulatory constraints such as Basel III leverage and liquidity coverage ratio. Second, CIP deviations are mostly negative, except for the AUD. Given our convention, a negative CIP basis means the direct/cash dollar interest rate is lower than the synthetic dollar rate (the cost of borrowing in country i's currency, exchange for USD in the spot market and cover the exchange rate risk with a forward that matures at the same time as the local currency loan). Lastly, the CIP basis widens sharply /becomes more negative during stress episodes and crises. In other words, the synthetic dollar rate (foreign interest rate swapped into dollar) is higher than the cash dollar rate for most advanced economies' currencies, and this difference widens in stress episodes.

For Emerging Markets (EMs), the CIP deviation computed in the same way is more difficult to interpret because of capital controls and/or credit risk.

We show first the LIBOR-based CIP basis in EM's with the deepest markets for dollar

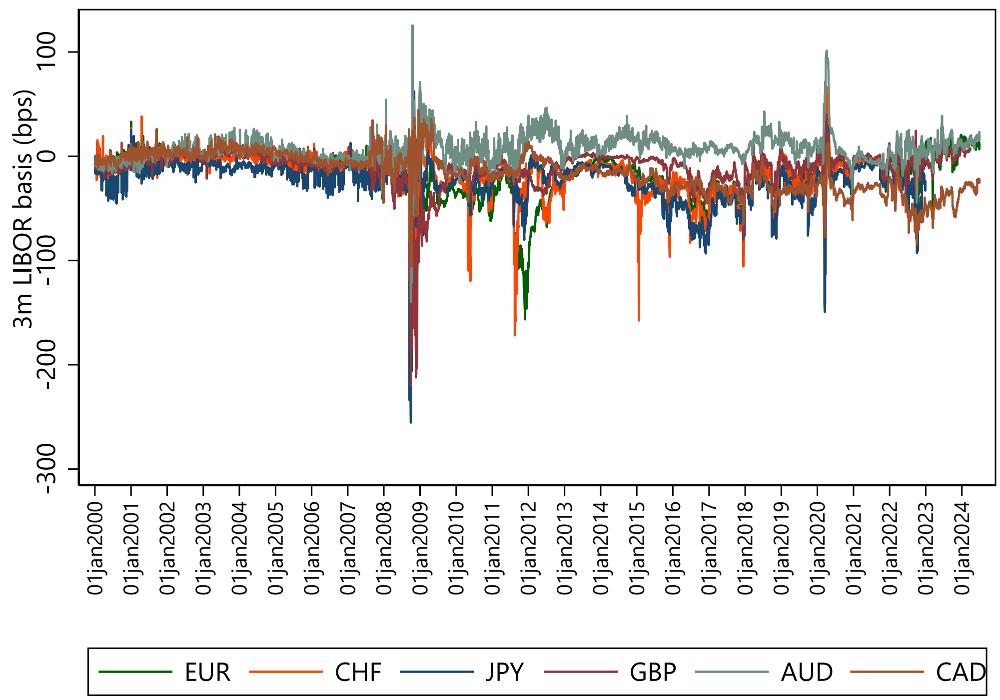


Figure 1: LIBOR-based CIP deviation in major AEs.

forwards in Figure 2, which are typically those with deliverable offshore forwards: Mexican Peso (MXN), South African Rand (ZAR), Turkish Lira (TRY) and Israeli Shekel (ISL). Brazil (BRL) offshore forwards are non-deliverable (NDF), but there is an active onshore market for FX forwards and futures that are settled in Real. These derivatives in turn, are priced in close lockstep with the offshore NDF. We therefore show Brazil together with other countries with deliverable forwards for this presentation of EM's with well-developed FX forward markets.

The main observation from Figure 2 is that CIP deviations are much more volatile in EM's than AE's, with the scale of the vertical axis being ten times as large for the former than the latter, especially for BRL and TRY. They also vary more between positive and negative values, both across and within countries. Unlike for AE's, there is no visible regime shift after the GFC; CIP deviations in EM's have always been relatively large and volatile. If anything, the CIP deviation in AE's have become more similar to those in EM's after the GFC.

These stylized facts for daily CIP deviations carry over to the monthly frequency, to the alternative government-based CIP basis and to the longer tenor of 12-months, as summarized in Table 12 in Appendix B. The difference in magnitude and volatility of CIP deviations in EM relative to AE is particularly pronounced at 12-month maturity, where it is roughly one order of magnitude larger. On average, the post-GFC interest rate differential has opposite signs in AE's and EM's (positive for the former and negative in the latter group). However, in each group the interest rate differential is partly or fully offset by a forward premium of opposite sign: negative for AEs – with these countries priced to appreciate against the US dollar, and

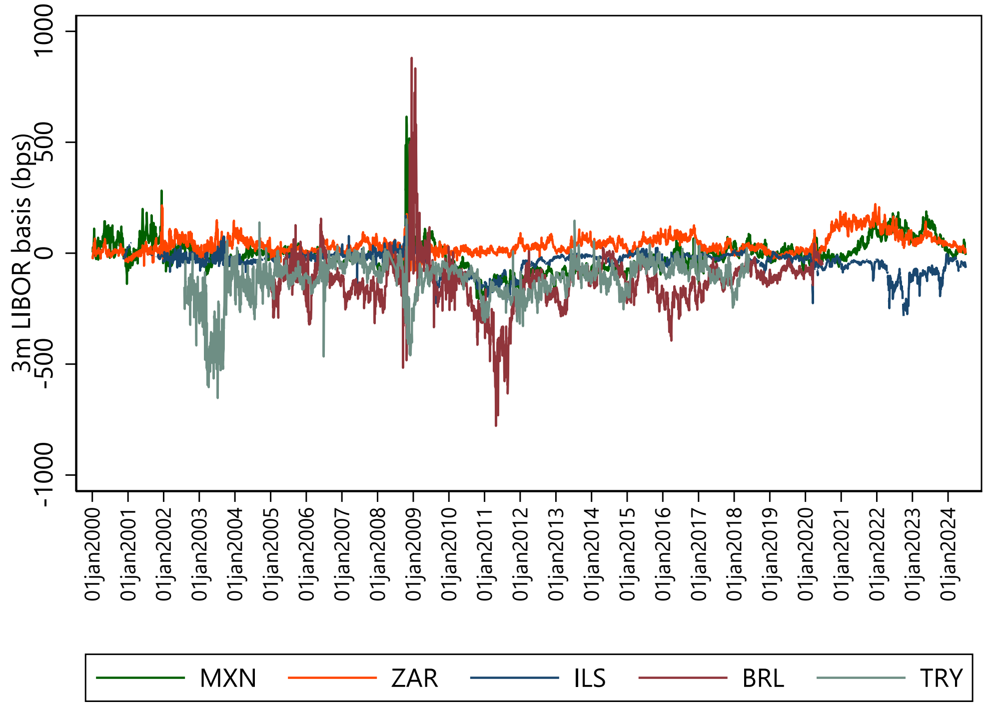


Figure 2: LIBOR-based CIP deviation in EM's with offshore deliverable forwards and Brazil.

positive for EMs – priced to depreciate against the US dollar.

2.2 CIP basis components

As a matter of accounting, variations in the CIP basis can be driven by two components: the interest rate differential between US dollar and local currency rates $y_{USD,n,t} - y_{i,n,t}$ and the forward premium $\rho_{i,n,t}$ equal to the log difference between the forward and the spot exchange rate. We decompose the evolution of the LIBOR CIP basis in AEs and EM's into these two components over time.

Figure 3 decomposes the daily 3-month CIP deviation into the interest differential and forward premium components, averaged over AE's with negative CIP basis. The interest rate differential in this decomposition is defined as the difference between the currency i and the dollar 3-month Libor rate, so that the CIP basis equals the forward premium minus this interest differential (red line minus blue line). Up until the GFC, the forward premium always completely offset the interest rate differential between the USD money market and the corresponding AE money market, so that CIP largely held. Since the GFC, however, the basis in most AE's became negative as the interest differential between major AE's and the US was not sufficiently offset by a large enough forward premium.

Importantly, since the GFC, the time series volatility of the LIBOR CIP deviation has been primarily driven by volatility in the forward premium, as interest differentials tend to

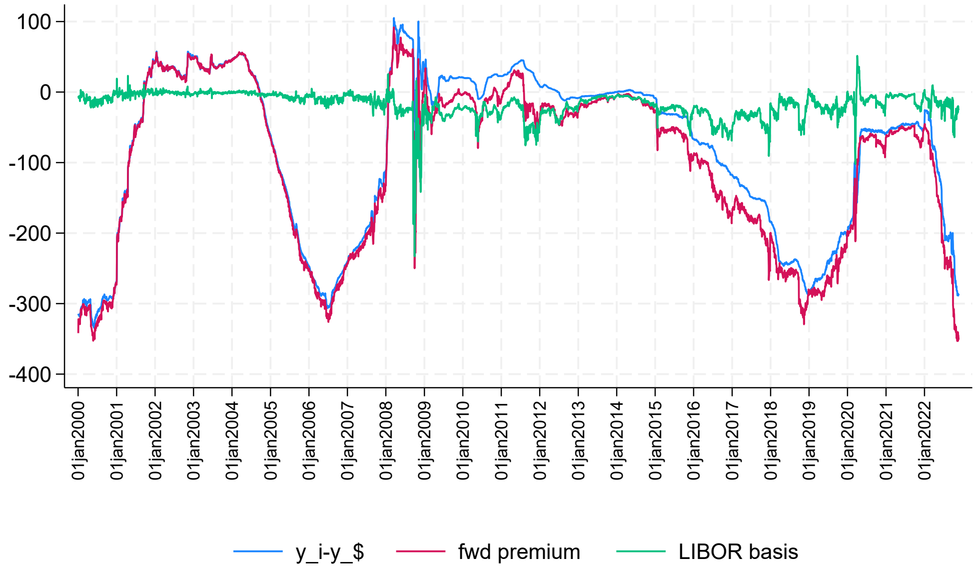
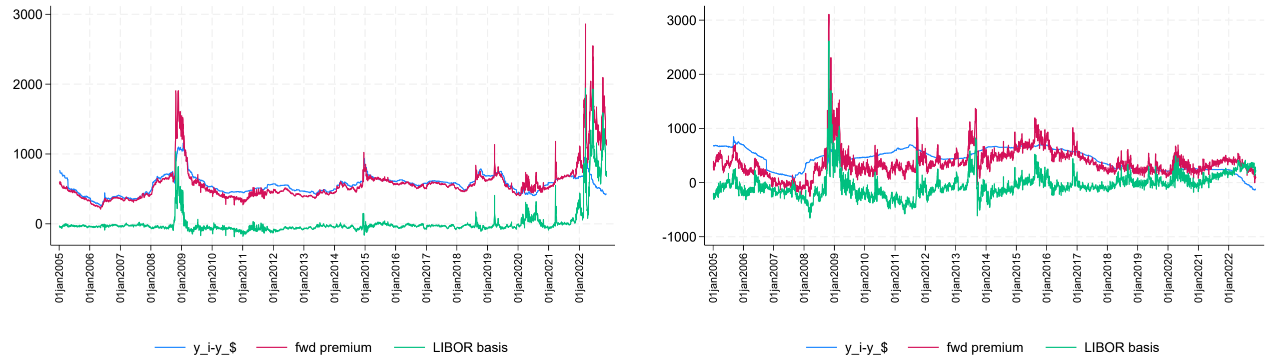


Figure 3: Decomposition of 3-month LIBOR CIP basis in AEs into interest rate differential and forward premium; simple average across EUR, CHF, JPY, GBP in bps.

be slow-moving, resulting in much smoother series than exchange rates. This excess volatility of the forward premium has continued to persist throughout the sample period: while the trend in the interest differential are offset by the trend in the forward premia (reflected in the clear trend co-movement between the blue and red lines in Figure 3), high-frequency volatility in the LIBOR basis is mainly driven by variation in the forward premium, especially during stress episodes. That is, the typical negative spike in the CIP basis of these AE currencies in stress episodes is driven by a spot dollar appreciation/forward dollar discount in excess of what is predicted by the increase in interest differential. Across AE currencies, the correlation coefficient between the change in LIBOR basis and change in forward premium is on average 0.87 while it is only 0.27 for the interest differential. Similarly, a bivariate regression of the change in 3-month LIBOR basis in AE's on the change in the forward premium delivers an R-squared of 77 percent, while the same regression on the change in interest differential yields an R-squared of 7 percent.

In EM's, these patterns of relative volatility and co-movement are even more pronounced. We distinguish two groups of EM's: one with deliverable offshore forwards, and the other group with non-deliverable forwards (NDFs) which are typically EM's with capital controls and other FX trading restrictions, and use the corresponding offshore forward price to construct the CIP basis. Figure 4 shows the decomposition of the average CIP basis for EM's with deliverable forwards (MXN, ZAR, ILS, TRY and RUB, panel (a)) and those with offshore NDFs (BRL, IDR, CNY, MYR, panel (b)). In both groups, we see the volatility in the CIP basis overwhelmingly driven by the forward premium while the interest differential is relatively smooth. The average correlation coefficient between the change in the 3-month LIBOR basis and the change in the



(a) MXN, ZAR, ILS, TRY, RUB average (b) BRL, IDR, CNY, MYR average

Figure 4: Decomposition of 3-month LIBOR CIP basis into IR differential and forward premium: simple average EMs currencies with offshore deliverable (left) and non-deliverable forwards (right).

forward premium is 0.96, while it is only 0.15 for change in interest rate differential. The forward premium remains the dominant source of monthly variation in the 3-month CIP basis, as shown in Table 1, but the interest differential becomes more correlated with the CIP basis change as the tenor increases to 6-months and 12-months. The same correlation pattern holds for the CIP basis based on government bond yields.

The decomposition above shows that across currencies, the deviation from CIP is driven by time-variation in the forward premium. However, this is a purely statistical decomposition and leaves open the question of which economic forces are driving the variation in the CIP basis and its components. As we will show in this paper, variation in risk and liquidity premia, as well as in intermediation frictions all contribute to these dynamics.

Another stylized fact is that, in contrast to AE currencies, which typically see the CIP basis spike negatively in times of stress (Figure 3), we observe that the basis spikes into large positive values in EM's and are much more pronounced in absolute values (Figure 4). In those instances, the forward premium for the dollar rises in excess of what is implied by the change in interest rate differential. This asymmetry in cyclical deviation from CIP across AE and EM currency markets is an under-explored stylized fact, as also noted by Cerutti and Zhou (2024).

International funding imbalances combined with intermediation frictions will turn out to be key for the asymmetry in the cyclical variation of the CIP basis noted above. The fact that, in stress periods such as the GFC, the forward premium becomes large and positive in EM's while it becomes large and negative in AE's reflects excess demand for dollar forwards in the former and an excess supply of dollar forwards (or a spot dollar shortage) in the latter, when dollar liquidity becomes scarce. Our paper provides a theoretical framework for this asymmetry and an empirical test of the key predictions of this model using our new purified measure of the CIP basis in emerging markets.

Table 1: Change in Libor CIP basis and components: correlation coefficients

Panel A: AE	3m			6m			12m		
	ΔCIP	$\Delta(y_\$ - y_i)$	$\Delta\rho$	ΔCIP	$\Delta(y_\$ - y_i)$	$\Delta\rho$	ΔCIP	$\Delta(y_\$ - y_i)$	$\Delta\rho$
ΔCIP	1			1			1		
$\Delta(y_\$ - y_i)$	0.096	1		0.117	1		0.179	1	
$\Delta\rho$	0.398	-0.875	1	0.353	-0.888	1	0.309	-0.880	1
Panel B: EM									
ΔCIP	1			1			1		
$\Delta(y_\$ - y_i)$	0.014	1		0.011	1		0.235	1	
$\Delta\rho$	0.929	-0.357	1	0.886	-0.453	1	0.677	-0.556	1

Tenor: 3m, 6m, 12m.

Notes: Entries in the table indicate correlation coefficients between the monthly change of the Libor-based CIP basis and its components at the 3-month, 6-month, and 12-month maturities: the change in interest differential and the forward premium. Panel A shows the correlation pattern for the 10 AE currencies and panel B the corresponding pattern for 19 EM currencies for which monthly Libor CIP at the various maturities can be constructed.

3 Constrained intermediation and CIP deviations: some elements of theory

This section sketches a simple but quite general model where CIP deviations capture the balance sheet constraints of financial intermediaries. It is a special case of the more general model in Dao et al. (2025) where both covered and uncovered interest parity deviations are jointly determined.

The model considers the balance sheet of a US dollar funded financial intermediary j with US dollar (USD) and local currency (LC) assets and liabilities. USD positions (assets or liabilities) are denoted with an asterisk.

At time t, the intermediary has an initial USD net worth given by $W^*_{j,t} > 0$. It can issue $D^*_{j,t}$ US dollar liabilities, with a (gross) borrowing rate of R^*_t, and $D_{j,t}$ local currency liabilities with a (gross) borrowing rate R_t. We can think of R^*_t and R_t as the USD and local currency interbank rates respectively, but equivalently, we can think of them as the funding rates with a tenor of one period. Since the period here is arbitrary, all our results apply whether we look at short or long tenors.

On the asset side, the intermediary holds $B^*_{j,t}$ in USD, with an associated gross return $\tilde{R}^*_t$, or local currency assets $B_{j,t}$ with gross return $\tilde{R}_t$. For reasons that will become clear shortly, we can think of $B^*_{j,t}$ as holdings of USD *reserves* and of $B_{j,t}$ as a local currency risk-free investment.

Denoting the nominal exchange rate $\mathcal{E}_t$ as the price of the USD in local currency, so that an increase represents a depreciation of the local currency, the balance sheet of the financial intermediary at time t, expressed in USD, satisfies:

$$W_{j,t}^* + D_{j,t}^* + \frac{D_{j,t}}{\mathcal{E}_t} = B_{j,t}^* + \frac{B_{j,t}}{\mathcal{E}_t} \tag{2}$$

In addition, the financial intermediary can engage in off-balance sheet transactions, selling $F_{j,t}^*$ one-period ahead US dollars forward at price $\mathcal{F}_t$ in local currency. The gross USD return on these forwards is given by $(\mathcal{F}_t/\mathcal{E}_{t+1} - 1)$. When $F_{j,t}^* > 0$ the intermediary is short in dollars forward, implying that the rest of the market is long dollars forward. When $F_{j,t}^* < 0$, the intermediary is long USD forward, implying that the rest of the market is short dollars forward.

Under these assumptions, and with minimal algebra, the wealth of the intermediary next period can be expressed as:

$$\begin{aligned} W_{j,t+1}^* = & R_t^* W_{j,t}^* + \left(\frac{\tilde{R}_t^*}{R_t^*} - 1\right) R_t^* B_{j,t}^* + \left(\frac{\tilde{R}_t}{R_t} - 1\right) R_t^* \frac{B_{j,t}}{\mathcal{E}_t} \\ & + \left(\frac{R_t^*}{R_t}\frac{\mathcal{F}_t}{\mathcal{E}_t} - 1\right) F_{j,t}^* + \left(1 - \frac{R_t^* \mathcal{E}_{t+1}}{R_t \mathcal{E}_t}\right) \frac{1}{\mathcal{E}_{t+1}} \left(\tilde{R}_t B_{j,t} - R_t D_{j,t} + \mathcal{F}_t F_{j,t}^*\right) \end{aligned} \tag{3}$$

The first term on the right hand side of eq. (3) represents the gross return on net worth at the USD interbank rate R_t^*.

The second term represents the excess return on USD reserves $(\tilde{R}_t^*/R_t^* - 1)$. When $\tilde{R}_t^* \leq R_t^*$, as will be the case in equilibrium, this term is negative and represents the *opportunity cost* of holding USD reserves.

The third term represents the excess return on local currency assets vs. liabilities $(\tilde{R}_t/R_t - 1)$. The fourth term represents the risk-free return on the Covered Interest Rate strategy that invests in USD and borrows in local currency at the interbank rates R_t^* and R_t respectively, covering the FX risk with forwards. The return is given by the *CIP basis* $(R_t^* \mathcal{F}_t/(R_t \mathcal{E}_t) - 1)$.[3]

Finally, the last term represents the return on the net local currency exposure $(\tilde{R}_t B_{j,t} - R_t D_{j,t} + \mathcal{F}_t F_{j,t}^*)$, taking into account the off-balance sheet position $F_{j,t}^*$. When this expression is positive, the intermediary has an open long position in local currency (combined on and off balance-sheet) and the dollar excess return on that position (the carry) is given by $(1/\mathcal{E}_{t+1} - R_t^*/(R_t \mathcal{E}_t))$.

If the financial intermediary cannot take open local currency positions this last term must be equal to zero:

$$\tilde{R}_t B_{j,t} + \mathcal{F}_t F_{j,t}^* = R_t D_{j,t} \tag{4}$$

In other words, the intermediary's position in local currency must be hedged, with the local

[3]This is the gross CIP basis. The net CIP basis obtains by taking logs: $\tau_t = i_t^* - i_t + f_t - e_t$, where $i_t^* = \ln R_t^*$, $i_t = \ln R_t$, $f_t = \ln \mathcal{F}_t$ and $e_t = \ln \mathcal{E}_t$.

currency payable at time $t+1$, $R_t D_{j,t}$ equal to the local currency receivable at time $t+1$, $\tilde{R}_t B_{j,t} + \mathcal{F}_t F^*_{j,t}$.

There are two equivalent interpretations of eq. (4). First, given local currency assets $B_{j,t}$ and local currency liabilities $D_{j,t}$, the intermediary must sell $(R_t D_{j,t} - \tilde{R}_t B_{j,t})/\mathcal{F}^*_t$ US dollars forward to offset the local currency exposure (or buy the corresponding amount of dollar forwards when the expression is negative). Alternatively, and this is our preferred interpretation, in order to supply $F^*_{j,t} > 0$ US dollars forward to the market, the intermediary needs to borrow $D_{j,t} = \mathcal{F}_t F^*_{j,t}/R_t$ in local currency today and invest the proceeds in dollar assets, while to buy $-F^*_{j,t} > 0$ US dollars forward from the market (ie. sell $-F^*_{j,t}\mathcal{F}_t$ local currency forward), it needs to borrow in dollar and invest $B_{j,t} = -\mathcal{F}_t F^*_{j,t}/\tilde{R}_t > 0$ in local currency assets.

In what follows, we impose the restriction that the intermediary is not allowed to carry any local currency exposure, i.e. eq. (4) holds. The wealth of the intermediary W^*_{t+1} becomes riskless and given by:[4]

$$W^*_{j,t+1} = R^*_t W^*_{j,t} + \left(\frac{\tilde{R}_t}{R^*_t} - 1\right) R^*_t B^*_{j,t} + \left(\frac{\tilde{R}_t}{R_t} - 1\right) R^*_t \frac{B_{j,t}}{\mathcal{E}_t} + \left(\frac{R^*_t}{R_t}\frac{\mathcal{F}_t}{\mathcal{E}_t} - 1\right) F^*_{j,t} \tag{5}$$

The intermediary wants to maximize next period's wealth, but is subject to a regulatory or internal liquidity management constraint that takes the following form:

$$B^*_{j,t} \geq \alpha_t \left|F^*_{j,t}\right|. \tag{6}$$

This constraint states that the intermediary needs to hold some reserves $B^*_{j,t}$ against the absolute value of its off-balance sheet book $|F^*_{j,t}|$, with α_t capturing the intensity of the constraint. When α_t is high, off-balance sheet positions 'consume' more reserves, while when α_t is low, fewer reserves are required. The constraint eq. (6) can be interpreted as a constraint imposed by the regulator, or equivalently as a self-imposed constraint imposed by a financial intermediary concerned about counterparty risks or other Value-at-Risk consideration. The key idea is that the intermediary incurs costs to expand its off-balance sheet position, even if no risk is involved. This way of modeling frictions in derivative markets follows Ivashina et al. (2015) and Garleanu and Pedersen (2011).

We assume further that the tightness of the regulatory constraint facing the individual atomistic intermediary j is increasing in the overall off-balance sheet exposure of the aggregate intermediary sector, that is, the aggregate net forward dollar supply of all intermediaries, $\bar{F}^*_t = \sum_j F^*_{j,t}$, relative to their aggregate balance sheet space dedicated to that currency $\bar{W}^*_t =$

[4]This allows us to focus on Covered Interest Parity deviations, which is the object of interest for this paper. In Dao et al. (2025), we explore the case where the intermediary is allowed to take currency risk. This allows to characterize simultaneously Covered and Uncovered interest parity deviations.

$\sum_j W^*_{j,t}$. That is, we posit:

$$\alpha_t = \mathrm{a} \left(\frac{|\bar{F}^*_t|}{\bar{W}^*_t} \right)^{\alpha}, \tag{7}$$

where $\alpha \geq 0$ captures the convexity of the constraint.[5] Under this assumption, the larger is the absolute net forward position of the whole market, relative to aggregate net worth allocated to the currency, the more expensive is a marginal increase in off-balance-sheet exposure.[6] The bank takes the aggregate exposure as given when optimizing over its individual position, in other words, the tightness of the constraint is external to the bank.

Under these assumptions, intermediary j maximizes its net worth $W^*_{j,t+1}$ by choosing reserves $B^*_{j,t}$, local currency assets $B_{j,t}$, and off balance sheet position $F^*_{j,t}$. The equilibrium conditions yield a simple and quite general formula for the CIP basis:

$$\frac{R^*_t}{R_t} \frac{\mathcal{F}_t}{\mathcal{E}_t} - 1 = \mu_{j,t} a \left(\frac{|\bar{F}^*_t|}{\bar{W}^*_t} \right)^{\alpha} \mathrm{sign}(F^*_{j,t}) \tag{8}$$

where $\mu_{j,t} \geq 0$ is the Lagrange multiplier on the regulatory constraint eq. (6) for intermediary j and represents the shadow cost of reserves.[7] In the above expression, since all intermediaries face the same prices (i.e. the left hand side of eq. (9)), they all choose the same side of the market (i.e. $\mathrm{sign}(F^*_{j,t}) = \mathrm{sign}(\bar{F}^*_t)$) and face the same shadow cost of intermediation (i.e. $\mu_{j,t} = \mu_t$). We can thus rewrite the equilibrium condition as:

$$\frac{R^*_t}{R_t} \frac{\mathcal{F}_t}{\mathcal{E}_t} - 1 = \mu_t a \left(\frac{|\bar{F}^*_t|}{\bar{W}^*_t} \right)^{\alpha} \mathrm{sign}(\bar{F}^*_t) \tag{9}$$

Eq. (9) has a number of important features. First, when the regulatory constraint does not bind (either $\mu_t = 0$ or $\mathrm{a} = 0$), CIP holds and the basis is zero:

$$\frac{R^*_t}{R_t} \frac{\mathcal{F}_t}{\mathcal{E}_t} = 1.$$

[5]Such an externality could be due to large aggregate exposure to a currency being associated with higher, or more correlated counterparty risk across banks, giving rise to tighter value-at-risk constraint.

[6]This definition of the constraint is equivalent to the alternative assumption of a distribution of intermediaries j, each with a linear constraint $B^*_{j,t} \geq \alpha_{j,t} \left| F^*_{j,t} \right|$ and subject to a maximum position constraint $\left| F^*_{j,t} \right| \leq F^{max}_j$ as in Dao et al. (2025) and De Leo et al. (2024). In such an environment, intermediaries with lower constraint α_j will serve the market first. A higher demand for currency intermediation relative to aggregate intermediary balance sheet captured by $|\bar{F}^*_t|/\bar{W}^*_t$ moves up the forward supply curve, towards marginal intermediaries with higher balance sheet friction α_j, resulting in a similar functional specification upon aggregation.

[7]For completeness, the remaining equilibrium conditions with respect to $B^*_{j,t}$ and $B_{j,t}$ imply that $\tilde{R}^*_t = R^*_t - \mu_{j,t}$, so that $\mu_{j,t}$ is also the *convenience yield* on USD reserves. Furthermore, in the absence of additional constraints, arbitrage between local currency assets and local currency funding imposes $\tilde{R}_t = R_t$. From eq. (4) this requires that the forward position $F^*_{j,t}$ offsets the net local currency exposure $B_{j,t} - D_{j,t}$: $F^*_{j,t} = R_t(D_{j,t} - B_{j,t})/\mathcal{F}_{j,t}$.

Deviations from CIP only occur because off-balance sheet positions are costly in terms of reserves.

Second, since $\mu_t \geq 0$, the sign of the basis is the same as that of the net off-balance sheet position of the intermediaries $\bar{F}_t^*$. Consider the case where $\bar{F}_t^* > 0$. This means that the intermediaries sell dollars forward. Equilibrium on the forward market implies that the rest of the market buys dollars forward. This happens either if local investors want to hedge dollar liabilities, and/or foreign investors want to hedge local currency assets holdings. According to eq. (9), the hedging demand for dollars translates into a *positive basis*. Intuitively, if the market wants to buy dollars forward, these dollars will be expensive, i.e. $\mathcal{F}_t$ will be high. The positive basis incentivizes the intermediaries to manufacture these dollar forwards and bear the corresponding balance sheet cost on the right hand side of eq. (9).

Consider now the case where $\bar{F}_t^* < 0$. This means that the intermediaries buy dollars forward (sells local currency). Equilibrium in the forward market implies that the rest of the market buys local currency forward (or sells dollars). This happens either if local investors want to hedge dollar assets, and/or foreign borrowers want to hedge local currency liabilities. According to eq. (9), the hedging demand for local currency translates into a *negative basis*. Intuitively, if the market wants to buy local currency forward, the local currency will be expensive, i.e. $\mathcal{F}_t$ will be low. The negative basis incentivizes the intermediaries to manufacture these local currency forwards and bear the corresponding balance sheet cost.

Finally, the size of the CIP basis is directly related to the size of the off-balance sheet exposure $|\bar{F}_t^*|$, scaled by the net worth of the intermediaries $\bar{W^*}_t$ and the strength of funding conditions(μ_t). A stronger hedging demand translates into a larger absolute equilibrium CIP basis, for a given degree of financial tightness. Weaker or less well capitalized financial intermediaries, or tighter funding conditions, translate into a proportionately larger CIP basis for a given hedging demand.

We can think of eq. (9) as tracing out the supply of dollar forwards as a function of the basis. As the demand for dollar hedging fluctuates, so does the equilibrium basis necessary to clear the market. In addition, shifts in the tightness of the intermediary's balance sheet (shocks to μ_t) or to its financial wealth $\bar{W}_t^*$ translate into supply shifts and require an adjustment in the equilibrium basis.

The model outlined so far describes how the CIP basis for a single foreign currency against the dollar is pinned down. In practice, there are many currencies that trade against the dollar in the spot and derivative markets, along with each of their CIP basis. Conceptually, we can think of the intermediaries as partitioning their aggregate wealth and balance sheet into different segments/currency desks, each indexed by the currency i. Such balance sheet segmentation can result from frictions within large banking organizations which prevent perfect reallocation of balance sheet capacity across trading desks. The segmentation assumption can also be validated by the empirical finding that banks tend to specialize across different FX markets, possibly due to sticky counterpart relationships and local information advantage (see Moskowitz et al. (2024)).

Aggregating across intermediaries, we denote $\bar{W}_{it}^*$ the intermediaries' aggregate balance sheet allocated to trading currency i. Each currency desk is subject to its own balance sheet constraint and maximizes its own profit, but all face the same shadow cost of dollar reserves μ_t, across currency pairs.[8] In other words, for each currency i, the CIP basis would satisfy:

$$\frac{R_t^*}{R_{it}} \frac{\mathcal{F}_{it}}{\mathcal{E}_{it}} - 1 = \mu_t a \left(\frac{|\bar{F}_{it}^*|}{\bar{W}_{it}^*} \right)^\alpha \text{sign}(\bar{F}_{it}^*) \tag{10}$$

where $\bar{F}_{it}^*$ denotes the aggregate net supply of dollar forwards from intermediaries against currency i.

Applied to a cross section of currencies, eq. (10) implies that the net demand for dollar forwards vis-a-vis each currency will determine the cross-sectional variation in the CIP basis. Countries with net long dollar exposure, that is $\bar{F}_{it}^* < 0$ – either because they hold dollar assets, or because foreign investors hold local currency liabilities– will have a negative CIP basis. Conversely, countries with short dollar exposure, that is $\bar{F}_{it}^* > 0$ – either because they hold dollar liabilities, or because foreign investors hold local currency assets – will have a positive CIP basis.

In the time series, some of the movements in the CIP basis are likely to be related to shifts in the supply curve, either because of sudden tightening of funding conditions (increases in μ_t or a) or to a deterioration in the net worth of the financial intermediaries (a decrease in $\bar{W}_{it}^*$). For a given hedging demand, tighter funding conditions make a negative CIP basis *more negative*, and a positive CIP basis *more positive*. Hence we should expect *more dispersion* in CIP bases across countries when financial conditions tighten. This insight explains the stylized fact that, subject to financial stress, the CIP basis would spike negatively for major AE currencies (as they have net long dollar exposure and hence $\text{sign}(\bar{F}_{it}^*) < 0$), while EM's, being net borrowers, typically have net short dollar exposure, $\text{sign}(\bar{F}_{it}^*) > 0$) and therefore face a positive spike in CIP basis instead.

Liao and Zhang (2020) document the predicted correlation between the CIP basis and net USD debt position in a cross section of major advanced economies (AE) at the aggregate level. Among major AEs, most countries have a long net USD asset position at the aggregate level and this position is slow-moving. Avdjiev et al. (2019) also document how advanced G-10 countries load on the dollar index with consistently different beta's. Although they do not link these varying beta's to the net dollar position, G-10 countries with large positive USD positions have a large negative beta, consistent with eq. (10).

[8] See footnote 7. The shadow cost of reserves μ_t is the convenience yield on USD reserves and independent of each currency i.

No such correlation has been documented for EM currencies. Our framework offers a unifying explanation for these empirical results from the literature and extends them to the much less explored but rapidly growing market of EM currencies.

Variation in hedging demand can also explain why the CIP basis and local currency interest rates are negatively correlated, as shown by Du et al. (2018b) for advanced economies. Countries with large net USD liability positions tend to have both higher interest rates and higher dollar liabilities. The latter implies a positive basis according to equation (10) to compensate the intermediary for the balance sheet cost of supplying net dollar forwards. Consequently, despite a high local currency interest rate, their swapped dollar rate is low compared to the cash dollar rate. Conversely, countries with net USD asset positions tend to have both lower domestic interest rates (spurring their search for yield) and higher dollar assets, implying a negative basis to compensate the intermediary for the cost of supplying local currency forwards.

To sum up, equation (10) which encapsulates the forward supply curve from our partial equilibrium framework, offers the following main testable implications which we take to the data. First, in the *cross-section* of currencies, long-term differences in net demand for dollar forwards across countries should pin down the sign and average level of the CIP deviation. Second, in the *time-series* within individual currencies, shifts in dollar funding costs and global intermediary's balance sheet capacity should move the CIP basis jointly across currencies, but with the sign and magnitude of the variation depending on their underlying forward demand position.

4 Supranational bonds and the 'purified' CIP basis

4.1 What does the CIP basis measure for EMs?

We unpack further the CIP basis into conceptual components.[9]

Following the decomposition of interest rate parity conditions such as in Du et al. (2018a) or Obstfeld and Zhou (2022), we define the 'naive' CIP constructed using local government yields as:

$$\begin{aligned}
\phi^{Gov}_{i,n,t} &= y^{Gov}_{USD,n,t} + \rho_{i,n,t} - y^{Gov}_{i,n,t} \qquad (11)\\
&= \left(y^{Gov}_{USD,n,t} - y^{rf}_{USD,n,t}\right) - \left(y^{Gov}_{i,n,t} - y^{rf}_{i,n,t}\right) + y^{rf}_{USD,n,t} + \rho_{i,n,t} - y^{rf}_{i,n,t}\\
&= \left(I_{USD,n,t} - \lambda_{USD,n,t}\right) - \left(I^{Gov}_{i,n,t} - \lambda^{Gov}_{i,n,t}\right) + \tau_{i,n,t}\\
&= \hat{\lambda}^{Gov}_{i,n,t} - \hat{I}^{Gov}_{i,n,t} + \tau_{i,n,t}
\end{aligned}$$

[9] As LIBOR rates are not available for tenors above 12 months we will use the government bond CIP basis in the following as the benchmark from which we derive our variables of interest.

where $y^{Gov}_{i,n,t}$ is the yield on country i's local currency zero-coupon government bond with maturity n at time t, and $\rho_{i,n,t}$ is the annualized forward premium that converts currency of country i into USD at time t and back at time $t+n$.

The second line adds and subtract the (possibly unobserved) risk free interest rate at the corresponding maturity $y^{rf}_{i,n,t}$. The third line expresses the local currency spread $y^{Gov}_{i,n,t} - y^{rf}_{i,n,t}$ as the difference between a credit spread $I_{i,n,t}$, and a possible convenience yield for government bonds $\lambda^{Gov}_{i,n,t}$. A higher convenience yield lowers the local currency spread while a higher credit risk increases the spread. $\tau_{i,n,t}$ denotes the 'true' n-year risk-free CIP deviation defined in eq. (1). The last line defines $\hat{\lambda}^{Gov}_{i,n,t} = \lambda^{Gov}_{i,n,t} - \lambda^{Gov}_{USD,n,t}$ as the *relative* convenience yield (country i relative to the US) and $\hat{I}^{Gov}_{i,n,t} = I^{Gov}_{i,n,t} - I^{Gov}_{USD,n,t}$ as the *relative* credit risk.

The observed government bond CIP deviation decreases with relative credit spreads, increases with relative convenience yield and with the true CIP deviation.

Note that in this derivation, consistent with the derived CIP deviation from our model, the true risk-free CIP deviation $\tau_{i,n,t}$ could also come from a relative convenience yield on the risk-free assets themselves. In particular, to the extent there is a convenience yield on the dollar risk-free asset (the so-called 'specialness' of the dollar), it would be consistent with the dollar being the funding currency of large global intermediaries, and hence a tightening of their balance sheet frictions would be associated with a higher premium on dollar intermediation.[10] In terms of our model notation, such an increase in the dollar convenience yield would be captured by the parameter μ_t, which in turn affects the CIP basis in all countries proportional to the net forward demand (equation 10).

Different authors have made different assumptions about the various components in eq. (11). Du and Schreger (2016) argue that the main source of of CIP deviations in EM is local currency credit risk. This amounts to assuming $I^{Gov}_{USD,n,t} = \hat{\lambda}^{Gov}_{i,n,t} = \tau_{i,n,t} = 0.$, from which one obtains $\phi^{Gov}_{i,n,t} = -I^{Gov}_{i,n,t}$. Instead, Jiang et al. (2020) assume that the naive CIP basis reflects the relative convenience of US Treasuries, i.e. $\phi^{Gov}_{i,n,t} = \hat{\lambda}^{Gov}_{i,n,t}$. It is clear from eq. (11) that all three terms could potentially matter.[11]

We are interested in recovering $\tau_{i,n,t}$. Clearly, for EMs, using government bonds is problematic because there is substantial credit risk: the term $\hat{I}^{Gov}_{i,n,t}$ is non-negligible and varies over time. Moreover, as argued by Du and Schreger (2016), this credit risk cannot be covered using sovereign CDS since the latter only apply to foreign currency/foreign jurisdiction issuance of sovereign bonds and not local-currency bonds, on which the conventional CIP basis measure relies. Estimating true deviations in CIP for EM's is further complicated by the presence of capital controls, differential tax treatment and financial market segmentation in most EM

[10] Obstfeld and Zhou (2022) and Diamond and Van Tassel (2021) derive and estimate such dollar convenience yields.

[11] These different structural sources for the CIP deviation can in turn be reflected in either the interest rate differential and/or the forward premium or a combination of both, as shown in the statistical decomposition in subsection 2.2.

jurisdictions: international and domestic investors/borrowers do not have access to the same currency markets and money markets to conduct arbitrage trades, and face differential tax burdens across onshore/offshore investments. To address these challenges, we propose to use Supranational bonds issued in EM currencies.

4.2 What are supranational bonds?

Supranational bonds are debt securities issued by institutions that are owned or established by central governments of two or more countries. These institutions are usually established by international treaties to pursue specified policy objectives, most commonly to promote economic development and integration of member countries. They form a subset of the so-called *Sovereigns, Supranationals and Agencies (SSA)* fixed-income asset class, which, in addition to supranationals, also include bonds issued by quasi-sovereign entities with explicit government guarantees such as national development banks or sovereign wealth funds, and subnational entities (see e.g. Fitch Ratings SSA Handbook, 2023). The size of the SSA bond market has been growing globally, with the largest 50 SSA issuers having over 4 trillion USD in outstanding debt, and over 600 billion USD in issuance volume in 2021 (Deutsche Bank, 2021).

With the shareholder base being composed of major advanced economies, the large supranational issuers typically enjoy AAA rating and are considered of very low default risk (*S & P Supranationals 2023 Special Edition*). The European Investment Bank (EIB) and the World Bank (IBRD) are the top two supranationals with the largest market shares, and together with the German development bank KfW (Kreditanstalt für Wiederaufbau) make up over 1 trillion USD in debt outstanding (see Figure 5).

The AAA-rated supranational bonds typically have zero risk weighting (for Basel II and III capital requirement), are eligible as high-quality liquid assets (HQLA), and are often associated with sustainability and social impact. They are therefore traded by a broad investor base, but thanks to the quasi risk-free nature, are particularly attractive to central banks, followed by commercial bank treasuries, and insurance and pension funds. We focus on this AAA subgroup of supranationals, whose business goals are described in Table 2.

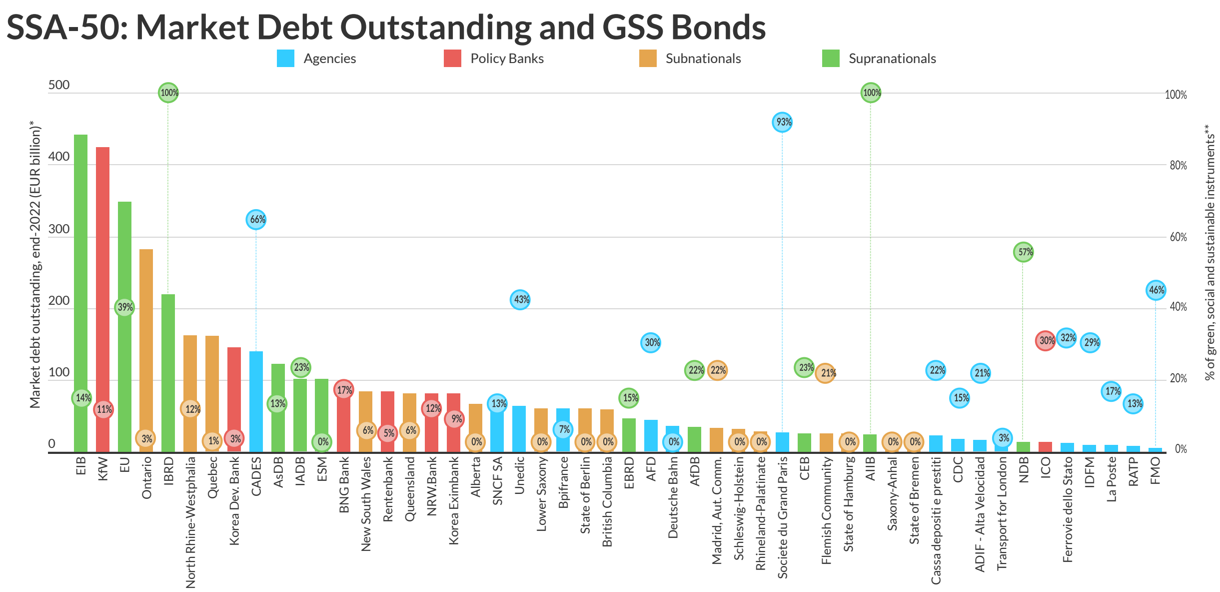
We propose using supranational bonds issued in emerging market local currencies to compute local-currency risk-free interest rates and CIP deviations and test predictions on drivers of the purified CIP basis in emerging markets. The idea goes back to Du and Schreger (2016) who construct cross-currency bases using bonds issued by the European Investment Bank and the KfW in Turkish Lira and Brazilian Real. We expand the construction of CIP basis using supranational bonds to six issuers in eight EM currencies and six advanced economies to test the general validity of the exercise. Moreover, we offer a framework to adjust the supranational basis for differential and time-varying liquidity premia, which have been shown to play an important role for supranational bond yields (see Schwarz (2019)). Table 2 gives an overview of the supranational issuers and their currencies of issuance.

Table 2: Sovereigns, Supranationals and Agencies (SSA) bonds

Issuers	Description	Currencies in Sample
Asian Development Bank (ADB)	Multilateral develoment bank; aids economic and social development in Asia and the Pacific; lends to countries and the private sector.	USD, CHF, JPY, ZAR, TRY, HKD.
African Development Bank (AFDB)	Multilateral development bank; aids economic development and social progress in Africa; lends to eligible (i.e. creditworthy) countries and, to a lesser extent, the private sector.	USD, BRL, IDR, INR.
European Bank for Reconstruction and Development (EBRD)	Multilateral development bank; funds development of market economies in 36 countries from central Europe to central Asia by providing project finance, mainly to the private sector.	USD, BRL, HUF, IDR, INR, MXN, PLN, RUB, TRY, ZAR.
European Investment Bank (EIB)	Development bank of the European Union; mainly engage in financing infrastructure projects in EU countries.	AUD, CAD, CHF, EUR, GBP, JPY, USD, BRL, HUF, PLN, TRY.
Inter-American Development Bank (IADB)	Multilateral development bank established in 1959; lends to Latin American and Caribbean countries making it the world's first regional development bank.	USD, BRL, IDR, INR.
International Bank for Reconstruction and Development (IBRD)	Largest part of World Bank Group; Main goals are to end poverty in middle-income and creditworthy poorer countries, and to promote sustainable economic development.	AUD, CAD, EUR, GBP, JPY, USD, BRL, CNY, HUF, IDR, INR, MXN, PLN, RUB, TRY, ZAR.
International Finance Corporation (IFC)	Part of World Bank Group; development finance for private sector enterprises in developing countries.	JPY, USD, BRL, CNY, HKD, MXN, RUB, TRY, ZAR.
Kreditanstalt fuer Wiederaufbau (KFW)	Germany's flagship federal development bank; activities include financing for SMEs, housing and infrastructure, as well as export and project finance and assistance for developing countries.	AUD, CAD, CHF, EUR, JPY, GBP, USD, BRL, CNY, HKD, MXN, TRY, ZAR.

Notes. ***AE:*** AUD (Australian dollar), CAD (Canadian dollar), CHF (Swiss Franc), EUR (Euro), GBP (Pound Sterling), JPY (Japanese Yen) and USD (United States dollar). ***EM:*** BRL (Brazilian Real), CNY (Chinese Yuan), HKD (Hong Kong dollar), HUF (Hungarian Forint), IDR (Indonesian Rupiah), INR (Indian Rupee), MXN (Mexican Peso), PLN (Polish Zloty), RUB (Russian Ruble), TRY (Turkish Lira), and ZAR (South African Rand).

Figure 5: Top 50 SSA issuers.



*Except for Transport for London, Alberta, British Columbia, Ontario and Quebec, whose debt outstanding is as of 31 March 2022 (end of FY22); and IBRD, New South Wales and Queensland, whose debt outstanding is as of 30 June 2022 (end of FY22) ** Green, social and sustainable instruments data is per issuers' own classification and may include labelled, as well as non-labelled instruments
Note: Market debt outstanding includes senior bonds and loans. The USD, CAD, AUD, XDR and KRW amounts have been converted into EUR at market rates, source: Bloomberg
Source: Fitch Ratings, as of 15 September 2023

One useful feature of these supranational bonds crucial for our analysis is that they issue in multiple currencies, including emerging market currencies. In addition, they are subject to international law, exempt from local withholding and capital gain taxes, and not subject to international sanctions. Although denominated in EM currency, supranational bonds usually settle in dollar through global platforms such as *Euroclear*. Primary market issuances are placed through global dealer banks who also manage liquidity in secondary markets.[12] As such, supranational bonds in EM currencies offer international investors the exposure to EM currencies without exposure to EM credit risks and with the ease and safety of offshore settlement. For the supranational issuer, EM debt issuance offers financing of local activities and attractive funding costs in hard currency as foreign exchange exposure is often hedged via the same dealer bank.

The size and liquidity of the market for supranational bonds differ across issuers and currencies. Figure 5 shows that the EIB, KfW, IBRD capture almost half of the market of SSA bonds. But also across currencies, there is a wider variation in supranational issuance activity. The distribution of Supranational issuers across EM currencies in our sample spanning the last 25 years is summarized in Table 3.

The euro and US dollar are by far the most common currencies for supranational bond issuance, together making up more than 75 percent of outstanding supranational debt, followed by the British Pound and the Australian dollar. The share of bonds issued in EM currencies

12See institutional and operational details for one of the largest supranational– the IBRD in "Demystifying Supranationals", The World Bank Treasury, November 2014.

Table 3: Percent of total amount outstanding across major currencies by Supranational issuers, 1998-2022

	IBRD	KFW	EIB	IFC	EBRD	ADB	IADB	AFDB	Average
USD	58.0	20.2	22.5	38.9	28.3	63.0	75.4	40.4	35.3
AUD	4.5	2.3	2.6	15.6	4.1	6.6	6.8	11.2	4.1
CAD	3.7	0.6	1.7	2.9	0.1	2.6	3.6	0.1	1.8
CHF	0.0	0.2	0.8	0.0	0.0	0.3	0.0	0.0	0.3
EUR	12.3	66.0	56.6	1.4	15.3	7.3	0.1	24.1	40.8
GBP	9.5	7.7	9.4	7.4	13.1	8.7	9.8	6.7	8.9
JPY	0.0	0.5	0.4	1.7	0.4	0.3	0.0	0.1	0.4
NZD	2.3	0.1	0.1	4.1	0.0	4.1	1.5	0.5	1.0
BRL	0.5	0.0	0.2	2.5	2.3	0.1	0.1	1.2	0.3
CNY	0.5	0.4	0.1	1.5	1.7	1.4	.	1.3	0.5
IDR	0.2	0.0	0.1	0.2	2.5	0.1	1.1	0.1	0.2
INR	0.3	0.0	0.0	2.0	1.3	0.5	0.1	0.3	0.2
MXN	0.8	0.0	0.3	7.8	4.2	0.2	1.0	2.2	0.7
PLN	0.0	0.1	1.7	0.0	1.0	0.3	.	.	0.6
RUB	0.1	0.0	0.0	0.7	2.4	0.1	0.0	0.1	0.1
TRY	0.3	0.0	0.4	4.6	9.3	0.5	0.1	1.4	0.7
ZAR	2.5	0.3	0.7	1.5	7.1	0.6	0.0	5.5	1.1

Source: Bloomberg; IBRD: International Bank for Reconstruction and Development (the World Bank), KfW: Kreditanstalt für Wiederaufbau (German Development Bank), EIB: European Investment Bank, EBRD: European Bank fuer Reconstruction and Development, ADB: Asian Development Bank, IADB: Inter-American Developmen Bank, AFDB: African Development Bank. The average values in the last column report the share of amount outstanding in bonds by all supranational issuers in each currency.

is in the single digit, and is mainly accounted for by issuances in Turkish Lira, South African Rand, the Mexican Peso, and Brazilian Real.

To take an example, we zoom in on supranational issuances in Turkish Lira in Table 4 to provide an overview of the distribution of issuance activity over time and across supranational institutions, as well as the variation in original maturity of these bonds. The Turkish Lira is one of the most commonly used EM currency for supranational issuances. Among them, the EIB is the largest issuer and its bonds have the longest original maturity (of up to 8 years).

To construct the CIP deviation, we have to choose the tenor n which would determine jointly the maturity of the local currency supranational bond, the USD supranational bond, the USD forward premium and other variables that are necessary to construct the basis.[13] In choosing n, we are guided by the data. The goal is to pick the tenor for which the supranational bonds are traded most frequently. Figure 6 plots the distribution of remaining time to maturity of four SSA-currency pairs over the sample period. The horizontal axis denotes the remaining

[13] As discussed in Du et al (2018), there is no liquid market for FX forwards beyond 3 months and we resort to constructing longer-term FX forwards by combining prices for nondeliverable forwards, interest rate swaps and cross-currency swaps.

Table 4: TRY: Amount Issued and Original Maturity 2005-2022

	EBRD		IFC		EIB		IBRD		ADB			
Year	Orig. Mat.	Issued Amt.	Orig. Mat.	Issued Amt.	Orig. Mat.	Issued Amt.	Orig. Mat.	Issued Amt.	Orig. Mat.	Issued Amt.	Total Issued	Avg. Orig. Mat.
2005					4.5	4280	2	73			4353	3.2
2006			3	33	5.6	1452			4	55	1540	4.1
2007					6	4410	4.8	910	3.8	274	5594	4.8
2008	2.7	36	3	313	7	222	2.5	169	3.2	1399	2139	3.6
2009	4.4	1199	3.2	1142	2.5	471	3	312	3.3	872	3996	3.2
2010	5.5	438	5	558	4.5	1395	3.5	811	4.6	763	3965	4.6
2011	4.7	1174	4.7	289	5.1	2627	3	148	4.6	468	4706	4.4
2012	3.8	917	4	215	5	670	3	99	4.2	1824	3725	4
2013	5.1	1931			4.5	3012	4	51	4.1	63	5057	4.4
2014	2.5	85	3	136	6.2	3728	3	409	3	342	4700	3.5
2015	3	553	4.1	1040	4.5	703	3.1	529	3.5	136	2961	3.6
2016	3	7	3.8	144	8	175	3.6	104	4	36	466	4.4
2017	3	1205	4.7	2605	7.5	340	4.1	1381	3.7	545	6076	4.5
2018	2.9	2053	3.1	511	5.2	283	4.2	618	4	280	3745	3.8
2019	3.7	2421	3.1	225			4	25	3.5	422	3093	3.5
2020	4.1	367			2	71	2	204	1.8	409	1051	2.4
2021	3.6	597					4	133	1	156	886	2.8
2022	2.9	431									431	2.9

Notes: Original Maturity are in years and Amount Issued in million dollars. Source: Bloomberg.

years to maturity and the the vertical axis the average amount of bonds observed per day with that remaining maturity. From the distribution of these four currency-issuer pairs as well as more systematically across other pairs in our sample, we can conclude that 1 year is the modal tenor and choose it to be the baseline tenor to construct the purified CIP basis.

4.3 Using Supranational bonds to construct 'purified' CIP deviations

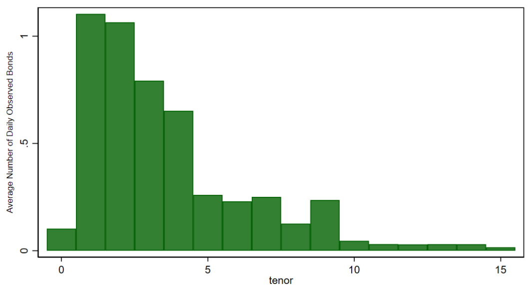
4.3.1 Constructing the supra-specific basis

Suppose we observe the yields for bonds with tenor n issued by supranational j both in currency i and in USD, denoted $y^{Supra}_{i,j,t,t+n}$ and $y^{Supra}_{USD,j,t,t+n}$ respectively. Then we can construct the excess return or supra-specific CIP basis as:

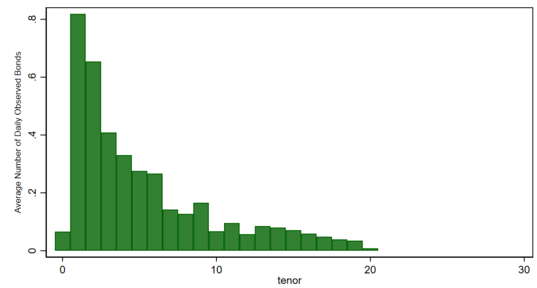
$$\phi^{Supra}_{i,j,t,t+n} \equiv y^{Supra}_{USD,j,t,t+n} + \rho_{i,t,t+n} - y^{Supra}_{i,j,t,t+n} \tag{12}$$

In practice, relying only on bond yields at a single maturity term to compute the basis as the difference in average yields to maturity could render the computation imprecise as the yield does not account for the profile in spot rates throughout the coupon payment schedule of the bond. Assuming a constant yield at every coupon payment date implicitly assumes a flat zero-coupon yield curve for the remaining maturity of the bond and abstracts from coupon re-

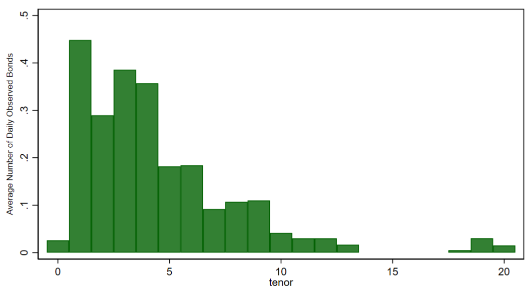
Figure 6: Summary statistics of supranational bonds in EM currencies: histogram of remaining maturity distribution (in years) of select bonds.



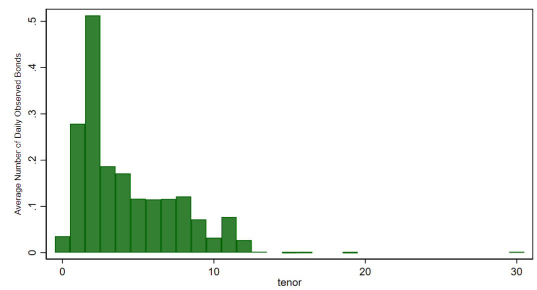
(a) TRY EIB bonds remaining maturity profile



(b) ZAR IBRD bonds remaining maturity profile



(c) BRL-IBRD bonds remaining maturity profile



(d) MXN-IBRD bonds remaining maturity profile

investment risk. Therefore, we follow Du et al. (2018b) in computing the basis with the z-spread method. That is, we calculate the spread over the entire yield curve for the remaining maturity of the bond that would be required to equalize the discounted schedule of cash flows (coupon and principal payments) with the observed market price. This method utilizes the information across the entire maturity structure of the supra bond to calculate the basis as each periodic cash flow is discounted with a different discount rate. The z-spread for the supranational bond issued by j in USD with residual maturity n is defined as a parallel shift of $s^{\$}_{j,t,t+n}$ in the dollar IRS curve and is calculated iteratively using:

$$P^{\$}_{j,t,t+n} = \sum_{\tau=1/q}^{n} \frac{c^{\$}}{\left(1 + y^{j,IRS}_{t,t+\tau} + s^{\$}_{j,t,t+n}\right)^{\tau}} + \frac{1}{\left(1 + y^{j,IRS}_{t,t+\tau} + s^{\$}_{j,t,t+n}\right)^{n}} \tag{13}$$

where q is the annual coupon payment frequency, $c^{\$}$ the dollar coupon rate and $P^{\$}_{j,t,t+n}$ the bond's market price at time t. The z-spread for the same supra issuer in currency i, with cash flows swapped into USD at the pre-determined schedule is calculated similarly as a parallel shift over dollar interest rate swap (IRS) curve by the amount $\bar{s}^{i}_{j,t,t+n}$ according to:[14]

[14]The IRS rate gives us the fixed interest rate that is swapped against the floating Libor rate over a given maturity to discount the coupon payments. We follow the literature in using the Libor dollar IRS rate as the risk-free interest rate and the associated IRS curve for the underlying term structure for the risk-free rate (see

$$P^i_{j,t,t+n} = \sum_{\tau=1/q}^{n} \frac{c^i}{\left(1 + y^{i,IRS}_{t,t+\tau} + \chi^{i,xccy}_{t,t+\tau} + \overline{s}^i_{j,t,t+n}\right)^\tau} + \frac{1}{\left(1 + y^{i,IRS}_{t,t+\tau} + \chi^{i,xccy}_{t,t+\tau} + \overline{s}^i_{j,t,t+n}\right)^n} \tag{14}$$

To obtain the IRS rates $y^{i,IRS}_{t,t+\tau}$ and the cross-currency basis swap rates from currency i to dollar $\chi^{i,xccy}_{t,t+\tau}$ at maturities $t+\tau$, we fit a Nelson-Siegel model to estimate the zero-coupon curve for both rates. Calculating the z-spread of the currency i bond over the LIBOR IRS and the cross-currency basis swap rate (xccy) yields the z-spread of the respective bond in currency i over the dollar LIBOR IRS rate of the same maturity, and hence makes the z-spreads comparable across currencies. Note that we only use the estimated zero curve to fill in for the corresponding xccy and IRS rates at the coupon payment dates, and not to impute bond prices themselves. Unlike the supra bonds themselves, the xccy and dollar IRS are much more liquid at a range of tenors and amenable to estimating a zero-coupon yield curve using daily prices. The z-spread and as a result, the supranational basis is only calculated for issuers and dates where we have actually observed bond prices on secondary markets. Moreover, to calculate the z-spread, we match pairs of supranational bonds in dollar and the corresponding emerging market currency with residual maturities within five months of each other to calculate the z-spread and basis.

Under the no arbitrage assumption, the dollar and swapped z-spreads have to be equal if markets price the supranational credit risk to be the same. The difference between the two spreads therefore corresponds to the true deviation from CIP for a given supranational bond issuer.

$$\phi_{i,j,t,t+n} = s^{\$}_{j,t,t+n} - \overline{s}^i_{j,t,t+n} \tag{15}$$

4.3.2 Extracting the currency-specific CIP deviation

For exposition, we focus on the one-year purified CIP ($n = 1$), which is the modal residual maturity for many SSA issuers in emerging markets in our sample and drop the $t+n$ subscript. As derived above, we can express each basis as:

$$\phi_{i,j,t} = s^{\$}_{j,t} - \overline{s}^i_{j,t} = \tau_{i,t} + \hat{\lambda}^{Supra}_{i,j,t} \tag{16}$$

where the second equality follows the same decomposition as in eq. (11) with $\hat{I}^{Supra}_{i,j,t} = 0$ and $\hat{\lambda}^{Supra}_{i,j,t} = \lambda^{Supra}_{i,j,t} - \lambda^{Supra}_{USD,j,t}$ denoting the relative convenience/liquidity yield for supra issuer j in local currency i vs. US dollar.

It is likely that supranational convenience yields in EM's are very small, especially relative to those in dollar and euro, as their issuance volumes and liquidity in secondary markets tend to

Du et al. (2018a)).

be low.[15] The Supra convenience yield in EMs can even be negative if liquidity in the secondary market is lower than for other (potentially risky but more liquid) local currency assets. Figure 22 in Appendix B illustrates the wide and volatile bid-ask spreads for supranational bonds in four emerging market currencies relative to the local government bond bid-ask spread of the same tenor.

To address the varying liquidity premium across time and issuers for supranational bonds, we proxy the convenience yield of the local currency supranational bond with a linear function in its bid-ask spread, which varies across issuers/currencies as well as over time for each issuer/currency. That is, we assume for supranational j :

$$\lambda_{i,j,t}^{Supra} = \lambda_{i,j}^{Supra} + \alpha_j \times BidAsk_{i,j,t} + \epsilon_{i,j,t},$$

where $\alpha_j < 0$.

The convenience yield of supranational j in currency i is on average equal to $\lambda_{i,j}^{Supra}$, depending on that issuer's presence in that currency market (i.e. issuance volume/frequency) as well as characteristic of that market and any joint characteristics of the currency market with the supranational issuer. This market-issuer fixed effect in this liquidity decomposition captures slow-moving institutional features of the EM currency market and the issuer. At high frequency, liquidity conditions also vary with fast-moving market conditions as captured by the issuer-specific sensitivity to the bid-ask spread, as well as residual idiosyncratic fluctuations in liquidity yields $\epsilon_{i,j,t}$, for example, due to idiosyncratic change in liquidity for other safe assets in that market.

With this assumption for the non-USD supranational convenience yield, and replacing the USD supra convenience yield with its definition $\lambda_{USD,j,t}^{Supra} = y_{USD,t}^{rf} - y_{USD,t}^{Supra}$, eq. (16) can thus be rewritten as follows :

$$\phi_{i,j,t}^{Supra} + y_{USD,t}^{rf} - y_{USD,j,t}^{Supra} = \tau_{i,t} + \lambda_{i,j}^{Supra} + \alpha_j BidAsk_{i,j,t} + \epsilon_{i,j,t}. \tag{17}$$

Since all variables (except for the residual and $\tau_{i,t}$) in Eq. (17) are now measurable, the "pure CIP basis" τ_{it} can be estimated by extracting market-time fixed effects in the corresponding regression equations using at least two different Supra issuers in a given market over the sample period. In other words, to identify a path for $\tau_{i,t}$, we need $j > 1$ for each currency i and period t.

We extract the "pure" CIP basis from the computed z-spread differentials using the measurement equation (17) and report the results below. The key advantage of our "pure" CIP basis is that it is conceptually free of relative credit risk premia, adjusted for differential liquidity

[15] In the US, for example, the KfW convenience premium is on average positive due to ample secondary market liquidity. It averages around 7 bps over the last 10 years, with the interquartile range at 2.5 to 11 bps.

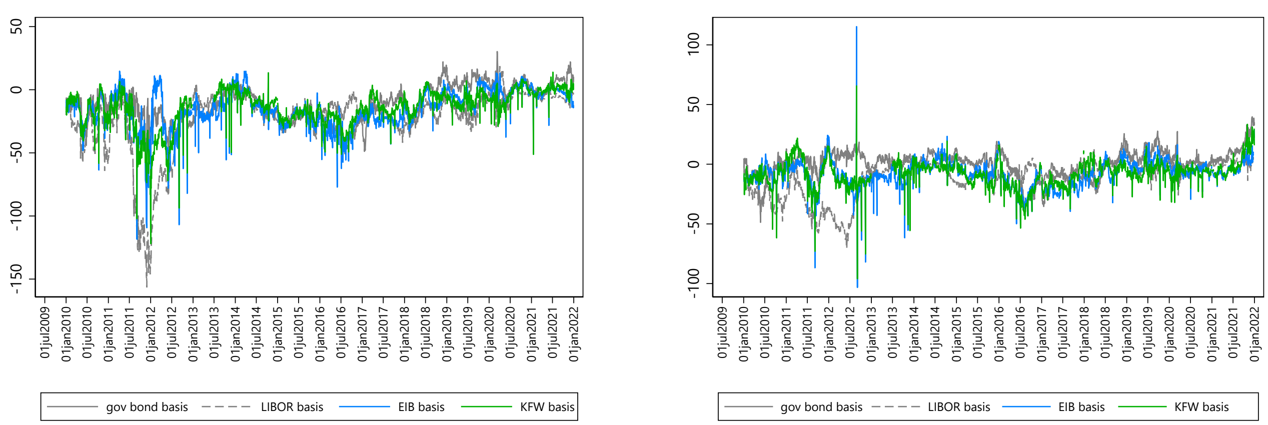
premia, and by the unique properties of the asset class, overcomes the market segmentation as well as legal, fiscal differences in treatments that plague the conventional measure. Constructing the pure CIP deviation using bonds by a given SSA issuer also overcomes the problem of not capturing the effective borrowing cost and investment return by heterogenous investors on either side of the CIP trade. Augustin et al. (2022) show how using uncollateralized interbank rates, such as LIBOR, to compute the CIP deviation may not be appropriate due to heterogeneity in counterparty risks. By constructing deviations from CIP for a single issuer across different currencies overcomes the problem of heterogeneity in credit/counterparty risk. In this case, the CIP deviation indeed reflects the violation of law of one price for a given issuer who is actually facing the observed borrowing rates in different currencies.

5 Purified CIP deviations

5.1 Purified CIP deviations in G-10 markets

Before turning to the purified CIP deviation in EM's, we look at the purified and conventional CIP basis in advanced economies. We can think of this exercise as a 'sanity check' on our approach: since interbank and sovereign credit risks should be negligible for major advanced economies that issue reserve currencies, we should expect the 'purified' CIP basis computed with supranational bonds and the 'naive' CIP basis in these G-10 currencies to coincide.

Figure 7: Purified and conventional CIP for EUR and GBP.



(a) 1y EUR Supra (EIB) and Treasury/LIBOR basis

(b) 1y GBP Supra (EIB) and Treasury/LIBOR basis

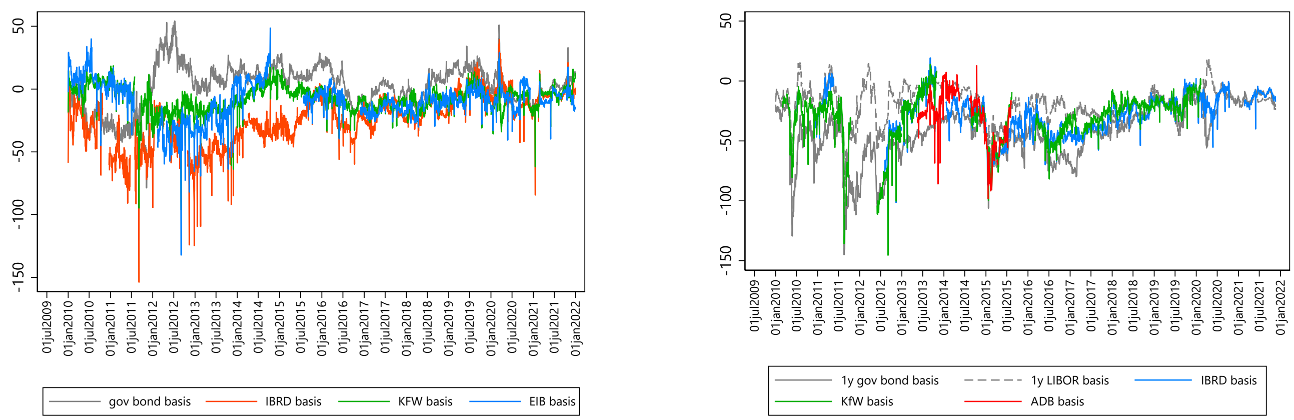
As reported in Table 3, apart from the dollar, another two G-10 currencies in which supranationals issue most often are the Euro (EUR) and the British Pound (GBP). Thus for these two currencies, we should expect that first, there is no relative credit risk priced into the supra basis (i.e. $\hat{I}_{i,j,t} = 0$) and second, that the relative liquidity or convenience premium is small (i.e. $\hat{\lambda}_{i,j,t} \approx 0$).[16] If this is true, the (purified) supranational basis should closely match the LIBOR and Treasury/government bond basis of the same tenor for the Euro and British Pound. We plot the purified CIP basis computed using the methodology above and compare it with the conventional measures of CIP basis using LIBOR and government bond yields for the Euro and British Pound in fig. 7. All series are for 1 year maturity. Treasury and LIBOR bases are constructed using the 1-year zero-coupon government bond yield or the 1-year interbank rate swapped from EUR and GBP into dollar. The purified supra basis is computed using the z-spread method and bonds issued by the EIB and KfW in EUR, GBP and dollar. As expected, we confirm that for these two G-10 currencies, both supranational CIP bases closely track the Treasury basis, and most of the time also the LIBOR one. The supra CIP deviations are, however, much more volatile than the LIBOR and Treasury bases as the supranational bonds are much less liquid than the local government bonds or LIBOR funds.

The impact of illiquidity on the supra basis becomes more evident when we look at other G-10 currencies in which supranational bonds are issued, but at lower volumes. According to Table 3, two such currencies would be the Australian dollar (AUD) and the Swiss Franc (CHF). With a much smaller volume of supranational bonds being issued and traded on the secondary market in these currencies, relative to the corresponding issuances by the same supranationals and the associated secondary market trading in dollar, we would expect the relative liquidity premium/convenience yield to be significantly negative (i.e. $\hat{\lambda}^{Supra}_{i,j,t} < 0$), although the relative credit risk should still be negligible (i.e. still $\hat{I}^{Supra}_{i,j,t} = 0$). Overall, we would expect the purified CIP basis to track the conventional bases less well in AUD and CHF compared to the extent they do so in EUR and GBP. Figure 8 shows that this is indeed the case. While still tracking the overall trends in the LIBOR and Treasury bases, the supra CIP basis displays much more volatility spikes and in such instances, tends to be lower than the Treasury basis. This is because the supra convenience yield is arguably more negative than the Treasury convenience yield due to lower liquidity of, say the IBRD/KfW/ADB bonds in CHF than the Swiss government bond in CHF. We also compute the supra basis for the Canadian dollar (CAD) and the Japanese Yen (JPY) and show how they track the conventional basis in Appendix Figure 21, with similar observations regarding the relative liquidity premia and resulting volatility.

When computing the underlying purified supra basis for currencies with relatively low secondary market liquidity in supranational bonds, it is therefore important to adjust for the differential liquidity premia to arrive at the purely frictional basis–that is, to extract τ_{it} in our decomposition of equation (17).

[16] For the EUR government bond basis, we use the 1-year yield on the German Bund.

Figure 8: Purified and conventional CIP for AUD and CHF.



(a) 1y AUD Supra and Treasury/LIBOR basis

(b) 1y CHF Supra and Treasury/LIBOR basis

5.2 Purified CIP deviations in emerging markets

We are able to estimate the pure CIP basis using supranational bond data for eight EM currencies, six of which offer sufficient data to examine the behavior of CIP basis over time.[17] Regarding the set of supranational issuers, we have six issuers who have issued bonds in EM currencies over the last two decades: the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the World Bank (IBRD), the International Finance Corporation (IFC), and the German development bank Kreditanstalt für Wiederaufbau (KfW). Not all issuers have been active in all markets at all times. Overall, the IBRD, KfW and EIB have been the most active issuers in EM currencies (see Table 13 in the Appendix).

Having shown that the purified CIP basis passes our sanity checks using AE currencies (even prior to purging for liquidity differentials), we move on to applying the purification methodology to EM currencies. Importantly, as supra bonds in EM currencies are much less liquid than in USD or EUR, it is crucial to adjust the supra CIP basis in EM currencies for the differential liquidity premium as shown above.

Let us look at the three EM currencies with the most liquid supranational bond trading: Brazilian Real in Figure 9, Turkish Lira in Figure 10 and South African Rand in Figure 11. These three EM currencies have absorbed a relatively high volume in supranational issuances (see Table 3 and Table 13 in the Appendix).[18] We have four to five supranational issuers' bonds

[17] Note that to have a a time-series for supra basis, we need to observe at least one transaction price in both the EM currency and the dollar on the same day, issued by the same supranational in the secondary market, both with the same adjacent residual maturity (for example 1-year maturity) to compute the corresponding z-spread at that tenor, which greatly limits the set of supra bonds that can be used.

[18] In the appendix, we show the corresponding results for the Mexican Peso, Indian Rupee, Indonesian Rupee, (offshore) Chinese Yuan, and the Russian Ruble. However, the supra CIP bases computed for these currencies

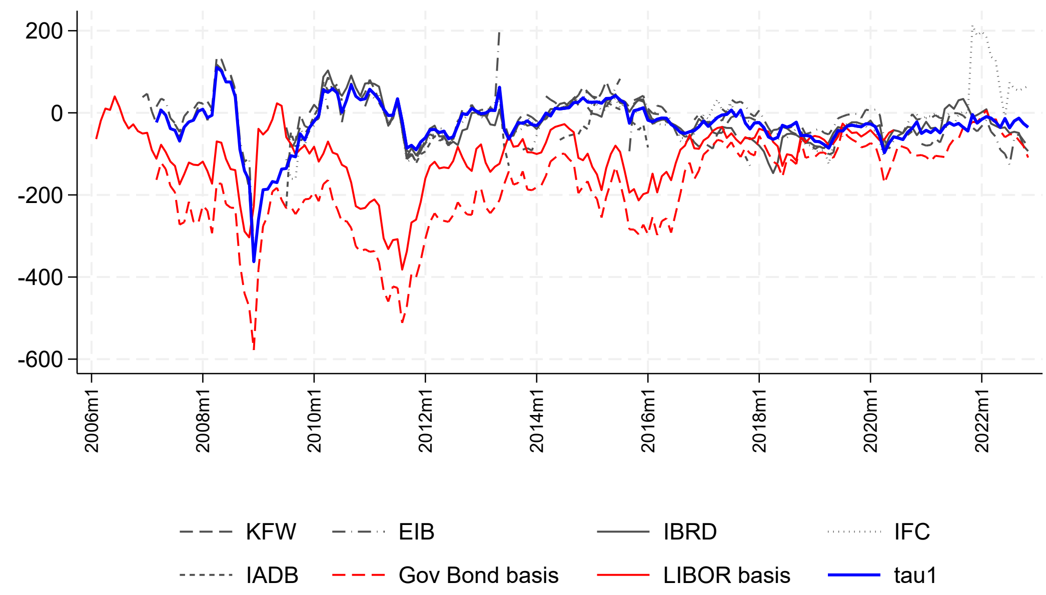


Figure 9: Brazilian Real–CIP basis derived from individual supranational bonds by issuer, extracted purified CIP basis (tau1) and conventional LIBOR and Government bond basis.

being traded on the secondary markets in these currencies since the early or mid-2000 (going back the longest for the South African Rand), allowing us to construct purified CIP deviations in Emerging Markets since before the GFC. For each currency, we plot the z-spread computed for each supranational issuer that had 1-year residual maturity bond traded during the sample period. Even before any adjustment for liquidity differential, we see that the supra z-spreads are clustered above the conventional LIBOR and government bond bases, consistent with them pricing in no relative credit risk unlike the conventional ones.

Using these daily z-spreads for each supranational bond in a given currency market, we extract the common time fixed effect following the procedure behind equation (17). To smooth over daily volatilities, we aggregate all spreads to monthly averages and use secondary market bond prices of at least two supranational issuers in a given EM currency with the same or adjacent residual maturity observed in the same month to extract the common CIP basis. At the same time, we net out the impact of differential liquidity of the dollar bond versus the local currency bond of each issuer using the bid-ask spread. The resulting purified CIP bases are plotted as blue lines in Figures 9, 10 and 11. This is to our knowledge the first computation of CIP deviations for such a long sample period across multiple major EM currencies, stretching back to the early or mid-2000 and updated to the recent post-COVID period.

Overall, three main observations can be drawn:

1. In line with the decomposition above, the higher credit risk for EM's sovereigns and banks

are much less reliable as they have much lower issuance volumes and liquidity, and for most of the sample period, have too few overlapping supra bonds traded on the secondary markets with adjacent residual maturities.

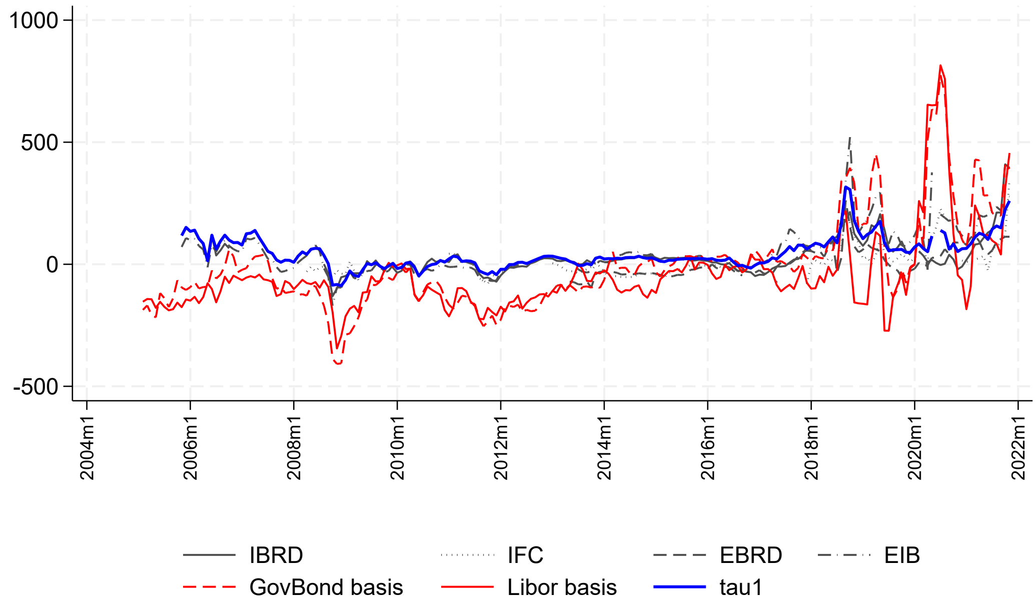


Figure 10: Turkish Lira–CIP basis derived from individual supranational bonds by issuer, extracted purified CIP basis (tau1) and conventional LIBOR and Government bond basis.

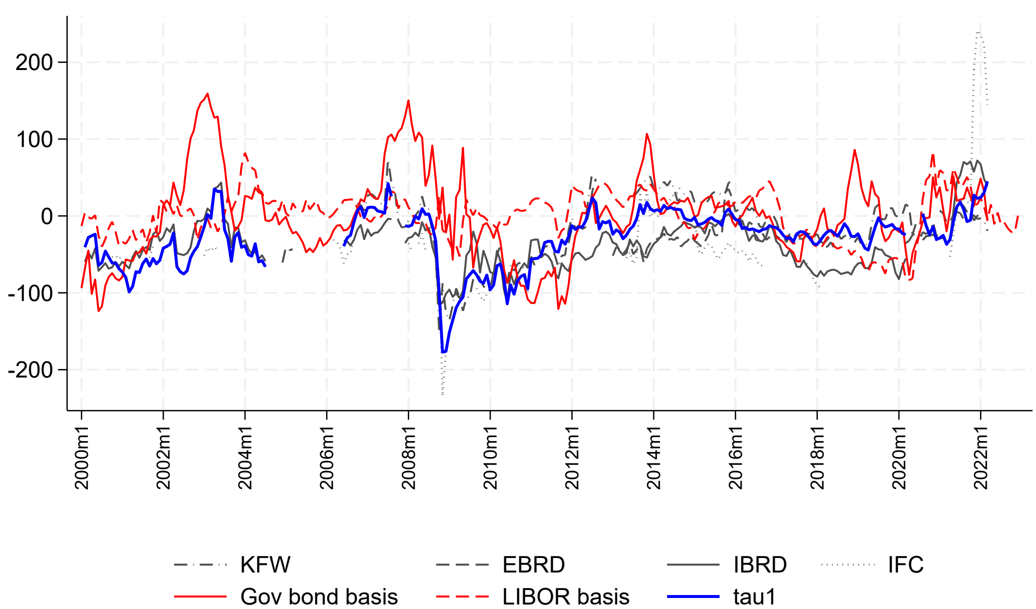


Figure 11: South African Rand–CIP basis derived from individual supranational bonds by issuer, extracted purified CIP basis (tau1) and conventional LIBOR and Government bond basis.

together with negative relative treasury premium (vis a vis the US) indeed result in the government bond and LIBOR basis being lower than the riskless supra CIP deviation (which is free of credit risk and adjusts for liquidity differentials). The discrepancy is less stark for South African Rand, though the purified series is still more stable than the conventional one. The government bond basis typically exhibits the largest swings, likely due to the higher and more volatile sovereign credit risk than banking sector credit risk priced in LIBOR, in addition to the negative relative convenience yield of EM government bonds (relative to US treasury bonds). However, we also see that LIBOR contains substantial risk-premium when comparing the LIBOR basis with the supranational one. Using the LIBOR basis (the conventional measure of CIP deviation) can therefore be especially misleading in EM's.

2. As the pure CIP basis is purged from risk-and liquidity premia, it is more stable and likely reflects slower-moving intermediation frictions. It is precisely the empirical measure of the intermediary pricing wedge in equation (8) which in turn is due to balance sheet constraints, FX market shallowness, as well as capital and liquidity regulations. As part of the balance sheet constraint, the riskless CIP basis also reflects the so-called dollar premium (see Obstfeld and Zhou (2022)) and can rise and fall with the "specialness" of the dollar, in turn reflecting the shadow cost of dollar funding of the intermediary.

3. The most striking difference compared with conventional measures of CIP basis is the change in sign: using the estimated risk-less CIP basis, the deviation becomes more positive (with the exception of the GFC), meaning that the riskless synthetic dollar yields in EM markets are lower than the cash dollar yields. Our model framework illustrated how this arbitrage opportunity exist in countries with net dollar liabilities: due to constrained balance sheet space of intermediaries, this arbitrage gain must exist for them to provide the FX forwards and swaps demanded by local USD debtors. As this CIP deviation goes in the opposite direction of the conventional CIP deviations driven by credit risk and convenience yield, it makes sense that purging for risk-premia would reveal the underlying hedging-channel of the CIP deviation.

Table 5 summarizes the average level of CIP deviations for each emerging market currency, calculated for all eight EM currencies for which we have at least some overlapping supranational bonds being traded at the same time. The first difference to note, in line with the example cases above, is that the value of the purified CIP deviation is often by orders of magnitude smaller than the conventional ones, as is the case for their relative absolute values (see Appendix Table 14). Second, in many cases, the sign is flipped, suggesting that risk and convenience yields embedded in the conventional CIP likely completely masks the degree of intermediation frictions in currency markets. The sign of the 'purified' CIP basis on the other hand, is qualitatively consistent with the prediction of our model-implied CIP equation: EM's with large net external

Table 5: Mean CIP deviations (and standard deviations) at 1-year tenor using conventional (LIBOR and Government Bond) vs. (Supranational bond) purified measures for overlapping sample periods (in bps).

Currency	LIBOR CIP basis	Gov. bond CIP basis	Purified CIP basis
BRL	-113.11	-196.80	9.39
	(72.12)	(103.14)	(39.82)
CNY	-24.43	6.02	-30.92
	(144.18)	(128.12)	(60.13)
IDR	-506.78	63.73	5.10
	(136.46)	(117.85)	(35.69)
INR	-516.31	-82.08	3.83
	(134.08)	(116.79)	(34.86)
MXN	-	-39.07	8.63
		(47.67)	(21.8)
RUB	-56.82	1.23	-39.08
	(43.05)	(57.86)	(196.62)
TRY	-21.74	-3.51	52.53
	(232.70)	(261.21)	(82.98)
ZAR	0.42	-0.94	-28.38
	(31.81)	(54.07)	(36.17)

Note: Summary statistics for each currency are taken over sample periods where data for all three measures of CIP deviations are available at 1-year tenor. Purified CIP is calculated according to the procedure described in section 4, only available for months when at least two supranational bonds with 1-year (or adjacent) residual maturity have been traded for a given currency. 1-year LIBOR interest rates are not available for MXN.

liabilities tend to have a positive purified CIP basis (Türkiye, Mexico, Brazil), while EM's which traditionally run current account surpluses and have net external assets on average have negative purified CIP basis (China, Russia). We turn to a more systematic analysis of this cross-sectional pattern in the following subsection.

5.3 Cross-sectional variation in 'purified' CIP deviations

We specialize the model by assuming $\alpha = 1$ in eq. (10). Averaging across time for a given currency i, we get the following simple expression:

$$CIP_i \approx \bar{\mu} a \left(\frac{\bar{F}_i^*}{\bar{W}_i^*} \right), \tag{18}$$

with all variables indexed with i being averages over time for country i and $\bar{\mu}$ the average shadow cost of reserves.[19] As discussed previously, the average shadow cost of reserves $\bar{\mu}$ is common across currencies and therefore cannot account for the cross-section variation in CIP. Instead, all the cross section variation must arise from differences in the average demand for hedging, relative to the intermediation capacity for that currency, $\bar{F}_i^*/\bar{W}_i^*$.

In the cross-section, countries with net dollar liabilities, like Australia, New Zealand or current account deficit EMs have a positive net demand for dollar forwards, requiring $\bar{F}_i^* > 0$. According to the above equation, these countries should have a positive basis $CIP_i > 0$. Conversely, countries with net dollar assets have a net supply of dollars forward, hence $\bar{F}_i^* < 0$, and a negative basis $CIP_i < 0$, as in Liao and Zhang (2020).

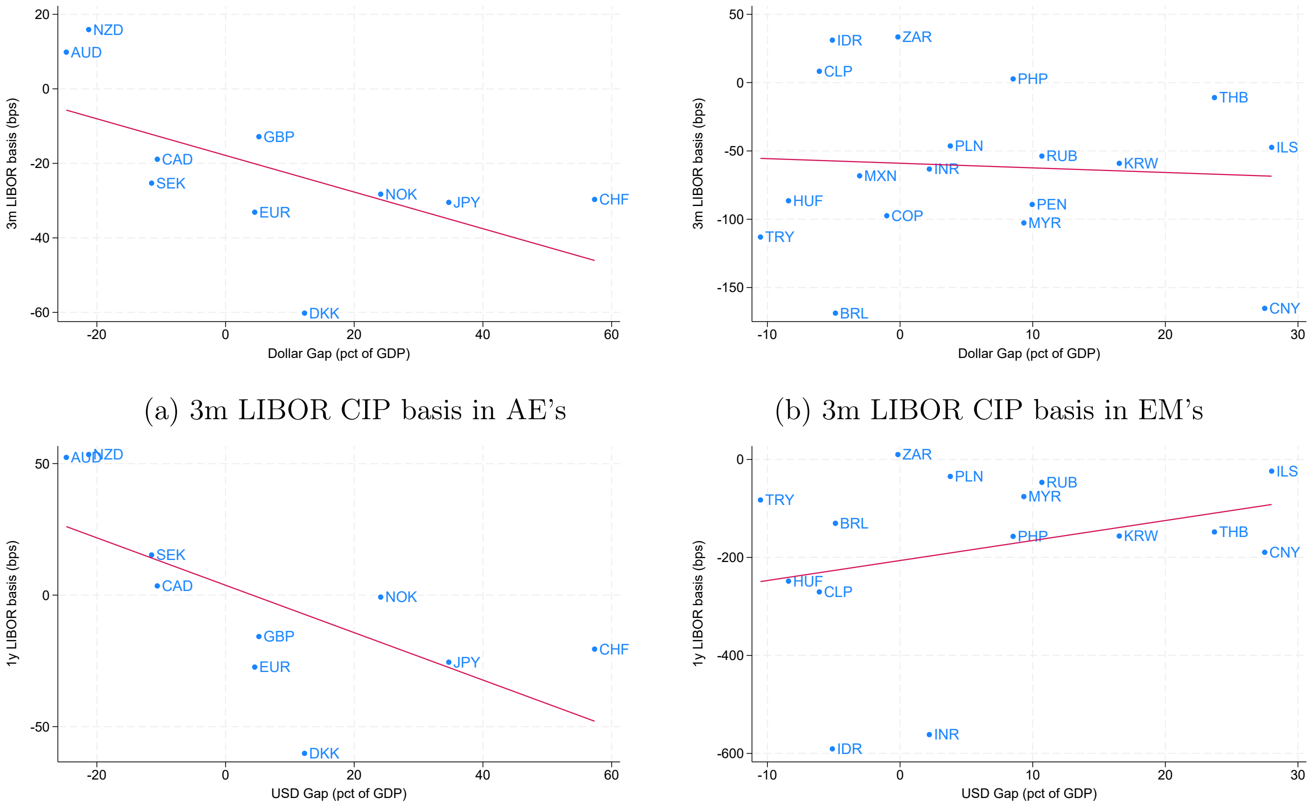
To measure the net dollar exposure and associated hedging demand $\bar{F}_i^*$ at the aggregate level, we use the dataset constructed by Benetrix et al. (2019) and updated in Allen and Juvenal (2024), which provides a decomposition of the gross external asset and liability position in each country by currency over time, including gross positions in major reserve currencies as well as the local currency. This data allows us to measure the hedging demand for dollar forwards by constructing a *dollar gap* as the difference between external dollar debt asset and external dollar debt liabilities as a share of GDP in each country.[20] A positive dollar gap would imply that residents have a net demand for spot dollar (to fund the assets) and a net supply of forward dollars (to hedge the asset exposure back to local currency), in other words, $\bar{F}_i^* < 0$. Conversely, countries with a negative dollar gap, or a net external dollar liability position, would tend to have a net demand for dollar forwards to hedge their dollar liabilities, i.e. $\bar{F}_i^* > 0$. Finally, assuming that the intermediary net worth dedicated to currency i is proportional to country i GDP ($W_i = \kappa Y_i^*$), we expect $\frac{\bar{F}_i^*}{Y_i^*} \propto USDGAP_i$.

In fig. 12 panel (a), we see that using the conventional 3-month LIBOR basis, the predicted cross-sectional correlation between the CIP basis and the dollar gap holds well for AE currencies (sample correlation of -0.59), similar to results in Liao and Zhang (2020). However, no such correlation can be observed for EM currencies in panel (b) when using the 'naive' LIBOR CIP basis, as has also been noted in Cerutti and Zhou (2024). A similar asymmetric pattern holds for the 1-year LIBOR CIP basis in panels (c) and (d), which again show a strong negative correlation between the average dollar gap and the CIP basis for AE currencies (sample correlation of -0.65), and if anything, a weak positive correlation for EM currencies. The same result is obtained if we use government bond-based CIP basis at different tenors (see Figure 24 in the Appendix).

Next we explore the relationship between the dollar gap and the 'purified' CIP basis. For the eight EM currencies for which we can construct the purified CIP, we compare the correlation

[19] This approximation ignores a covariance term between the shadow cost of reserves and the demand for hedging.

[20] The focus on debt instruments is motivated by the evidence that debt instruments are hedged at higher ratios than equity (see Campbell et al. (2010); Du and Huber (2024)).



(a) 3m LIBOR CIP basis in AE's

(b) 3m LIBOR CIP basis in EM's

(c) 1y LIBOR CIP basis in AE's

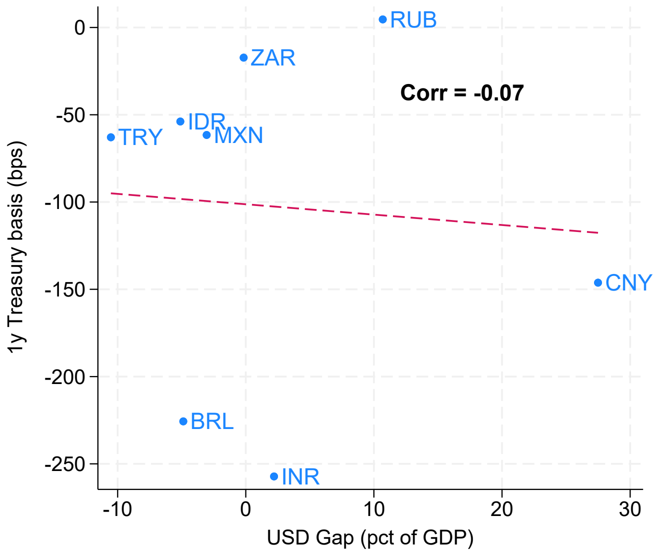
(d) 1y LIBOR CIP basis in EM's

Figure 12: Net dollar debt asset position (USD Gap) and average 3-month and 1-year LIBOR CIP basis in AE's and EM's: 2010-2017 averages by country/currency. For EUR, the GDP-weighted average of national USD gaps is taken.

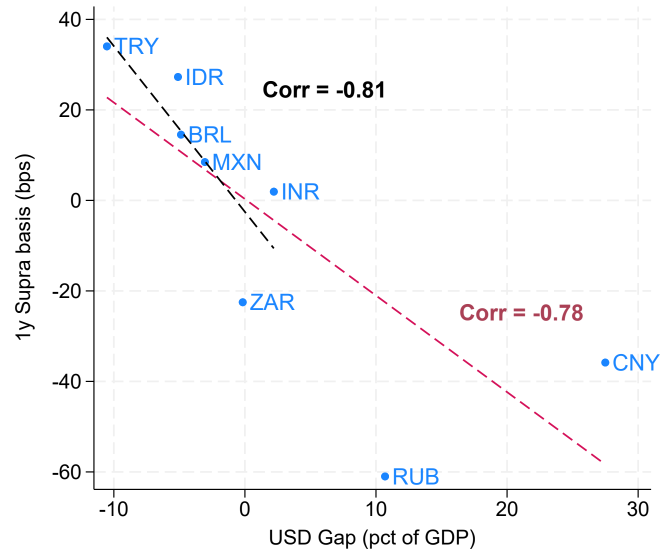
with the dollar gap over the same subsample in fig. 13. We focus on the 1-year tenor for the construction of the purified CIP basis as it is the modal tenor available (cf. fig. 6). Similar as for the sample of all EM currencies in panel (c) of Figure 12, the 1-year LIBOR basis for the eight EM subsample also does not show any cross-sectional correlation with the dollar gap in panel (a) of fig. 13. When we replace the CIP basis with the supranational one, however, a clear negative correlation emerges as predicted by the hedging demand channel.[21] Similar or even stronger results obtain when we use the second most frequent tenor of 3-years.[22] The correlations also hold, with even a steeper slope, if we exclude the outlier data points for the Russian ruble and the Chinese yuan, which exhibit the most volatile swings among the supra bases (see fig. 23 in the Appendix).

[21] The sample correlation turns from zero in panel (a) to -0.8 in panel (b) of fig. 13.

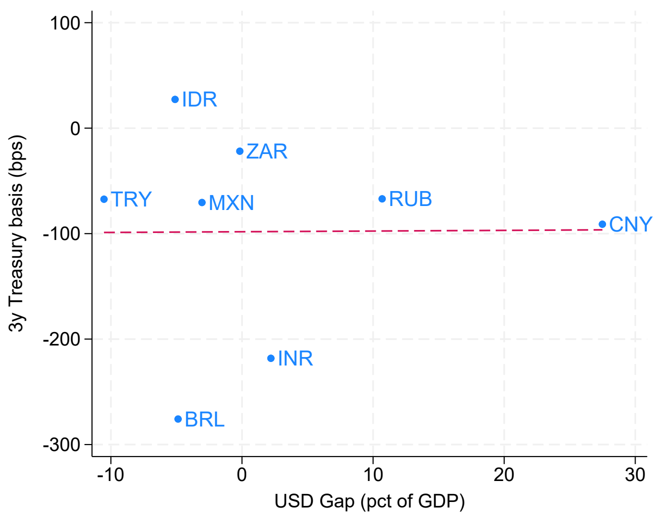
[22] The sample correlation turns from zero in panel (c) using the 3-year Treasury basis to -0.9 using the 3-year supra basis in panel (d) of fig. 13.



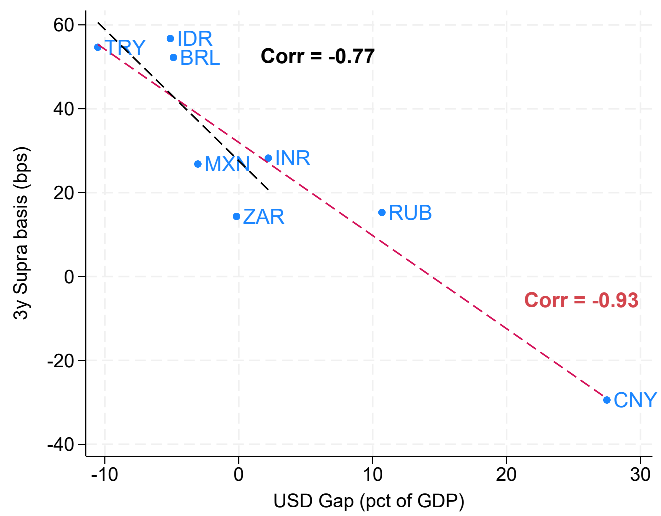
(a) 1y Treasury CIP basis in EM's



(b) 1y Supra CIP basis in EM's



(c) 3y Treasury CIP basis in EM's



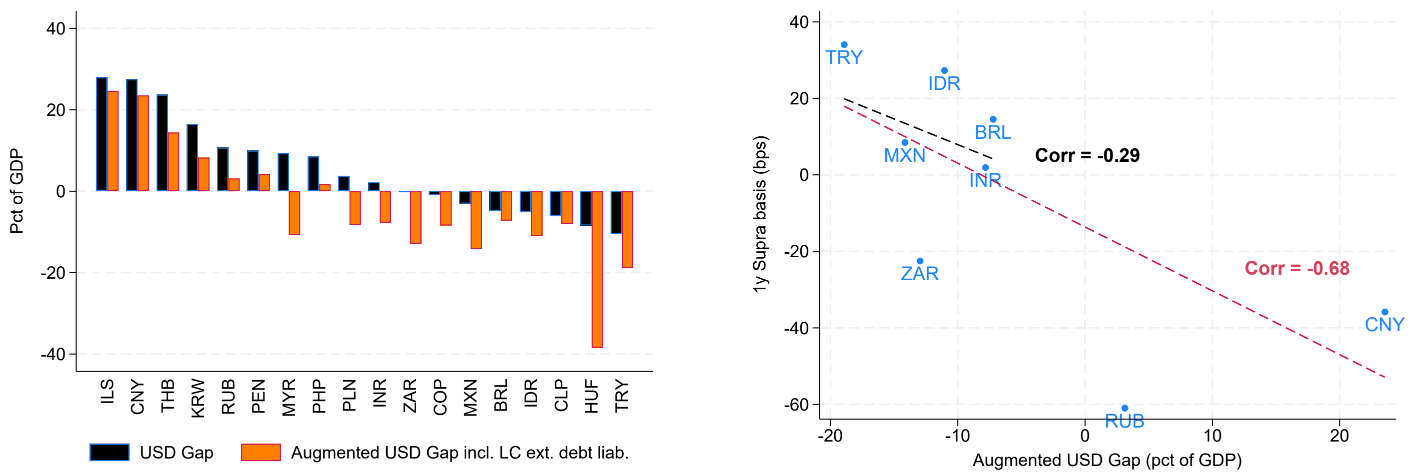
(d) 3y Supra CIP basis in EM's

Figure 13: Net dollar debt asset position (USD Gap) and average 1-year and 3-year Treasury vs. Supranational CIP basis for the subsample of EM's with supranational bonds: 2010-2017 averages by country/currency.

5.3.1 Carry Trade and foreign investors' forward demand

The dollar gap captures the demand for hedging stemming from domestic borrowers' and lenders' exposure to exchange rate risk, reflecting the currency/dollar mismatch on the aggregate domestic balance sheet. Over the past two decades, global investors, primarily dollar-funded ones, have greatly increased their footprint in emerging market local currency asset markets, generating potentially a new channel for dollar hedging demand resulting from currency mismatches on foreign investors' balance sheets. Domestic dollar borrowers and international local currency investors (who fund themselves in dollars) would both have a motive to hedge against dollar appreciation by buying dollar forwards. We can define an *augmented dollar gap* by subtracting external dollar debt *and* external local currency debt from external dollar assets, as both types of liability positions generate a demand for dollar forwards and hence make the dollar gap more negative:

$$USDGAP_t^{aug} = \frac{Ext.DebtAssets_t^{USD} - Ext.DebtLiabilities_t^{USD} - Ext.DebtLiabilities_t^{LC}}{GDP_t} \tag{19}$$



(a) Augmented measure for dollar gap

(b) 1y Supra CIP basis vs. Augmented USD Gap

Figure 14: Augmented dollar gap in the cross-section of major EM's, 2010-2017 average.

Figures 14a shows that for major EM's, the addition of foreign local currency debt holding makes the dollar gap substantially more negative, with the difference being particularly pronounced for ZAR, MXN and TRY among the EM currencies in our sample.

In the cross-section, we see the augmented dollar gap still being negatively correlated with the supra CIP basis, but the correlation is weaker compared to the domestic one (see fig. 14b). This is not entirely surprising considering that foreign investment into EM local currency is, to a significant extent, a form of carry trade that seeks exposure to the local currency, and correspondingly, generates a net demand for local currency forwards or net supply of dollar forwards (see Brunnermeier et al. (2008) and De Leo et al. (2024)). However, we also know that foreign investors' positions can be especially volatile (a phenomenon coined as "Original Sin Redux", see Bertaut et al. (2023)), and that the demand for hedging goes up in times of financial stress (Liao and Zhang (2020), Du and Huber (2024)). Taken together, we should expect the demand for dollar forwards coming from external local currency debt to be low or even negative (i.e. turning to net supply) during periods with abundant dollar liquidity while turning positive during periods of dollar scarcity. The cross sectional correlation between foreign investors' local currency assets and the CIP basis is effectively averaging across these shifting correlation patterns over time, returning only a weak correlation.

Therefore in the following, we go beyond the cross-sectional correlation and explore the time-series dimension of the CIP deviation within currencies to analyze how its fluctuation is shaped by the dollar cycle and the underlying demand for dollar funding and hedging. We use the augmented dollar gap as the baseline proxy for dollar forward demand in emerging market currency markets to account for foreign investors' demand for dollar forwards.

5.4 Time variation in the purified CIP deviations

5.4.1 CIP co-variation with the global dollar cycle

We now turn to variation of the CIP deviation over time for individual emerging market currencies. We seek to estimate the relationship between the CIP deviation, the shadow cost of dollar funding (μ_t), proxies for intermediary balance sheet capacity ($\bar{W}^*_{it}$) and the net hedging demand $\bar{F}^*_{it}$ as predicted by our model (for the case $\alpha = 1$ and $\bar{W}_{it} = \kappa Y_{it}$):

$$CIP_{it} = \frac{\mathcal{F}_{it}}{\mathcal{E}_{it}} \frac{R^*_t}{R_{it}} - 1 = \frac{a}{\kappa} \mu_t \frac{\bar{F}^*_{it}}{Y^*_{it}}, \tag{20}$$

where all variables are aggregated over all intermediaries but are currency i specific, except for the intermediary's shadow cost of dollar financing μ_t and the dollar borrowing rate R^*_t, which are time-varying global variables that apply to all currencies.

While we do not have a high-frequency measure of the net dollar forward position intermediated by global banks $\bar{F}_{it}$, we assume that the demand for dollar hedging accommodated by the intermediary is slow moving, as it is pinned down by pre-determined currency composition of external balance sheets, which in the aggregate, are relatively stable over time (see Benetrix et al. (2019)) as they are in turn pinned down by slow-moving interest rate differentials (Du and Schreger (2022), Liao and Zhang (2020)). That is, we assume that:

$$CIP_{it} \approx \frac{a}{\kappa} \mu_t \frac{\bar{F}^*_i}{Y^*_i} \tag{21}$$

This assumption is supported by evidence in the empirical literature showing that, while it is both supply and demand for dollar hedging that is relevant for the level of the CIP deviation, in the time series, it is the change in intermediary's dollar funding costs (μ_t) and capital that drive most of the CIP change over time (e.g. Dao et al. (2025), Avdjiev et al. (2019), Zeev and Nathan (2024)).

We do not have data for currency-specific hedging demand but, as corroborated by the cross-sectional analysis, can proxy for its slow-moving trend using the (negative of the) augmented dollar gap. We make this assumption explicit with the following measurement equation:

$$\frac{\bar{F}_i^*}{Y_i^*} = \rho_0 + \rho_1 \left(-USDGAP_i\right), \tag{22}$$

where the dollar gap is the augmented measure that includes external local currency debt. Demand for dollar forwards relative to the size of the economy is driven by hedging demand, and thus assumed to be proportional to the opposite position of the dollar (asset) gap exposure of domestic agents and local currency exposure of foreign investors (larger net dollar debt giving rise to more demand for dollar forwards). We therefore expect the hedging demand channel to yield $\rho_1 > 0$. At the same time, there is a component of forward demand which is independent of the dollar gap exposure in external balance sheets, reflected in the intercept term ρ_0. This constant reflects the persistent need for dollar funding arising from the need to finance imports or investments that are denominated in dollar (Gopinath and Stein (2021)).[23] Such dollar funding demand arises from a currency mismatch in trade and financial flows, even when there is no currency mismatch in aggregate balance sheets (financial stocks). The dollar funding channel therefore predicts $\rho_0 < 0$, as demand for dollar funding or swaps creates a supply of dollar forwards (through the forward leg of the swap). Plugging the hedging demand equation (22) into the CIP equation (21), we obtain

$$CIP_{it} \approx \frac{a\rho_0}{\kappa}\mu_t + \frac{a\rho_1}{\kappa}\left(-USDGAP_i\right), \tag{23}$$

which, after taking first differences, yields our baseline regression equation:

$$\Delta CIP_{it} = \alpha_i + \beta_1 \Delta dollar_t + \beta_2 \Delta dollar_t \times \left(-USDGAP_i\right) + \gamma' X_{it} + \epsilon_{it} \tag{24}$$

We follow the literature and use the log-change in the Broad Dollar Index ($dollar_t$) as a proxy for global USD funding conditions, i.e. for the shadow cost of dollar funding μ_t (see Bruno and Shin (2017), Obstfeld and Zhou (2022), Avdjiev et al. (2019)). The key coefficient of interest is β_2, which measures the impact of the interaction between the dollar funding cost and (the negative of) the country-specific dollar gap. We expect $\beta_2 > 0$ so that tighter global funding conditions make the CIP deviation more positive for countries with larger negative net dollar gaps, that is, countries with larger demand for dollars forward, such as New Zealand and Mexico. Conversely, tighter global conditions make the CIP deviation more negative for countries with larger positive net dollar gaps, that is, countries with larger supply of dollars forward, such as Japan. The dollar funding channel, on the other hand, should yield $\beta_1 < 0$.

Apart from these main variables of interest, the regression also controls for currency fixed-effect, the change in log dollar index (as a standalone variable), and other controls summarized in the vector X_{it}: the lagged level of the CIP basis to capture mean reversion, the slow-

[23] Demand for dollar funding offshore occurs in the form of demand for synthetic dollar which effectively creates a supply of dollar forwards or demand for dollar swaps (with dollar supplied in the forward leg of the swap).

moving change in the dollar-gap (note these are at annual as opposed to monthly frequency), and other variables for robustness checks discussed below. We estimate this and all other regression equations in the following using OLS fixed-effect (within) estimator, but compute Driscoll-Kraay standard errors to allow for heteroskedasticity, autocorrelation and cross-panel correlation of the residuals.[24]

In Table 6, we estimate eq. (24) using conventional CIP measures in AEs and EMs. While the coefficient estimates for the AE sample deliver the right negative sign for the change in broad dollar and positive sign for the interaction term–albeit statistically insignificant, it is not the case for the EM sample. Similar to the cross-sectional correlation, using the conventional CIP basis does not yield the theory-predicted negative sign for the change in dollar index and positive sign for the interaction between the change in dollar index and underlying dollar gap. Results even go in the opposite direction, possibly driven by a higher risk premium on the local currency government bond yield and interbank borrowing rate in countries with larger net external dollar debt (and hence pulling the CIP deviation into negative direction) when dollar funding costs increase (columns 3-4 and 7-8).

Table 6: Baseline regressions with LIBOR and Government Bond CIP basis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	3-month tenor				12-month tenor			
	AE		EM		AE		EM	
Dep.var: ΔCIP_t	LIBOR	GOV	LIBOR	GOV	LIBOR	GOV	LIBOR	GOV
CIP_{t-1}	-0.196***	-0.200***	-0.190***	-0.170***	-0.113***	-0.133***	-0.032***	-0.042***
	(0.034)	(0.040)	(0.016)	(0.019)	(0.028)	(0.025)	(0.008)	(0.013)
$\Delta dollar_t$	-1.702***	-3.593*	5.549***	8.501***	-1.111**	-2.058***	2.974***	1.847*
	(0.451)	(1.905)	(0.634)	(0.973)	(0.450)	(0.682)	(0.829)	(0.944)
$\Delta dollar_t * (-USDGAP_i)$	0.007	0.015	-0.122*	-0.220**	-0.009	0.002	-0.199**	-0.269***
	(0.015)	(0.010)	(0.071)	(0.105)	(0.011)	(0.007)	(0.083)	(0.094)
$-USDGAP_i$	-0.026	-0.067*	-0.007	0.283**	-0.013	0.023	0.130*	0.238**
	(0.028)	(0.038)	(0.068)	(0.130)	(0.017)	(0.030)	(0.073)	(0.116)
Observations	1790	1790	3147	3094	1790	1702	2627	3028
Number of currencies	10	10	18	18	10	10	15	18
Within R2	0.125	0.143	0.125	0.11	0.096	0.122	0.053	0.041

Notes: Driskoll-Kraay heteroskedasticity and autocorrelation robust standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. Table presents regression results for equation (24) at monthly frequency for G10 AE currencies and EM currencies with available data, using the LIBOR CIP and the Government bond (GOV) CIP basis at 3-month and 1-year tenor. *dollar* stands for the log Broad dollar Index. $USDGAP_i$ denotes the augmented dollar gap: dollar net external asset position plus the external debt in local currency position (in percent country i GDP) to capture hedging demand of domestic borrowers and foreign investors in local currency assets. Currency fixed effect included in all regressions. Sample period: February 2006 to December 2020.

In table 7, we instead replace the conventional CIP deviation in EM's with the supranational

[24] Due to the small number of currencies (N) and long sample period, or large (T), Driscoll-Kraay (1998) standard errors are more appropriate and conservative than clustering.

CIP deviation for the six EM currencies where we have sufficient bond price data.[25] The coefficient on the change in the broad dollar index is now negative as expected for the funding channel. Moreover, the estimated coefficient on the interaction term between dollar funding cost and the dollar gap now yields the positive coefficient implied by the model. The interaction term is larger and more precisely estimated when we use only the three most liquid markets for supranational bonds in local currency (Brazil, Türkiye and South Africa).

Finally, in columns 3-4 , we replicate the same regression using the conventional government bond CIP basis for exactly the same sample of observation as in column 1-2 to facilitate comparison. As before, the estimation does not detect any significant effect of the hedging channel of the dollar cycle as predicted by theory. The same non-result also holds when we use the Libor CIP basis (column 5-6).

Table 7: Baseline regression with Supranational CIP basis in EM's

	(1)	(2)	(3)	(4)	(5)	(6)
	ΔCIP_t measure:					
	$\Delta \tau_t$	$\Delta \tau_t$	ΔGOV_t	ΔGOV_t	$\Delta Libor_t$	$\Delta Libor_t$
CIP_{t-1}	-0.137***	-0.121***	-0.082***	-0.055***	-0.106***	-0.148***
	(0.020)	(0.021)	(0.021)	(0.020)	(0.029)	(0.043)
$\Delta dollar_t$	-3.654**	-5.806***	-2.585	-6.192***	-1.289	-2.494
	(1.825)	(1.807)	(2.717)	(1.798)	(1.418)	(1.711)
$\Delta dollar_t * -(USDGAP_i)$	0.198**	0.261***	0.096	0.136	-0.015	0.060
	(0.087)	(0.075)	(0.180)	(0.160)	(0.137)	(0.163)
$-(USDGAP_i)$	0.260*	0.223**	0.494**	0.350*	0.054	0.138
	(0.135)	(0.113)	(0.245)	(0.182)	(0.154)	(0.160)
Observations	801	493	801	493	658	487
Number of EM currencies	6	3	6	3	5	3
Within R2	0.0849	0.110	0.044	0.059	0.055	0.079

Notes: Driskoll-Kraay heteroskedasticity and autocorrelation robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Table presents regression for equation (21) using Supra CIP basis at 1-year tenor for six EM currencies with available data (column 1) and using the sub-ample with the top 3 most liquid EM supranational bond markets (column 2). Columns 3-4 and 5-6 repeat the regressions in col 1-2 using the 1-year government bond CIP basis and Libor interbank basis respectively. 1-year Libor swap rates are not available for the Mexican Peso. *dollar* stands for the log Broad dollar Index. $USDGAP_i$ denotes the augmented hedging demand proxy: dollar net external asset position plus the external debt in local currency position (in percent country i GDP) to capture hedging demand of foreign investors in local currency assets. Currency fixed effect included in all regressions.

[25] The 6 EM's with sufficient bond price data from several supranational issuers in local currency over a common time span to allow for extraction of a common time factor are: Brazil, Türkiye, Mexico, South Africa, Indonesia, India.

To give a sense of magnitude for the estimated effects, Figure 15 (a) plots the predicted change in the purified CIP basis in response to a monthly appreciation of the broad dollar by 1.3 percent (equal to its sample standard deviation) at different values of the negative dollar gap (i.e. the net hedging demand proxy). For a country with zero dollar gap where net hedging demand versus the dollar is balanced, a typical dollar appreciation is estimated to lower the CIP basis by 8 basis points, consistent with the dollar funding channel. If net hedging demand for dollar forwards is positive, with dollar liabilities and local currency external debt at 30 percent of GDP (corresponding for example to the position of Hungary), the CIP is estimated to increase by 7.5 bps instead. With $-(USDGAP)$ ranging from -41 to 67 percent of GDP in EM during the sample period and the median monthly change in purified CIP basis in the sample being 8 bps, the estimated differentials are sizable. An alternative way to illustrate the impact of the underlying dollar gap is to show the gradient of the marginal impact of the dollar gap on the CIP basis at different rates of broad dollar appreciation/depreciation, as is done in panel (b) of Figure 15. The positive interaction term estimated in column 1 of Table 7 indicate that the positive impact of a larger (negative) dollar gap, i.e. higher hedging demand for dollar forwards, is positive when the dollar is appreciating and negative when the dollar is depreciating. The magnitudes for these differentials are substantial: a 5 percent appreciation in the broad dollar predicts a 12.5 bps larger increase in the CIP basis for a 10 pct of GDP higher dollar gap, while the differential is a negative 7.3 bps when the dollar depreciates by the same amount. With the standard deviation in the dollar gap being 15 pct of GDP across all EM's and 7 pct for the EM's in our estimation sample, estimated differentials are large.

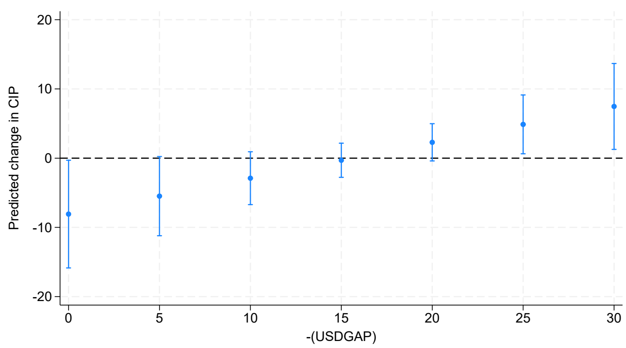
The symmetric response of the CIP basis to variations in the dollar gap across the dollar cycle explains why the correlation between the dollar gap and the purified CIP basis only holds weakly in the cross-section (see Figure 14b). The (augmented) dollar gap pulls the CIP basis in opposite directions depending on the dollar cycle, though on average still delivering a negative correlation as shown in Figure 14b. [26]

5.4.2 Measures of the global dollar cycle

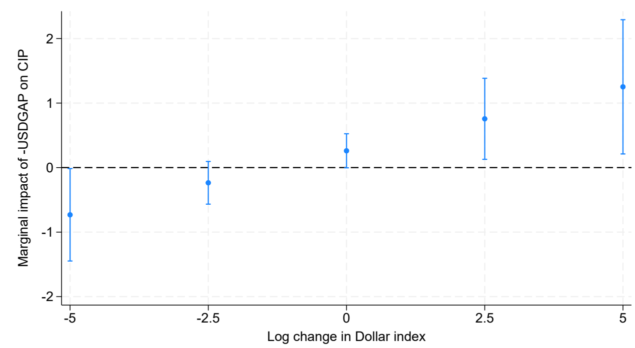
So far we have focused on the role of a currency's exposure to the underlying dollar gap in shaping the response of the purified CIP basis to a given shock to the intermediary's dollar funding cost. Following the literature, we have interpreted the log-change in the broad dollar index as a proxy for global dollar funding conditions, i.e. variations in the capacity of intermediaries to provide or absorb dollar funding (Avdjiev et al. (2019), Bruno and Shin (2015), Bruno and Shin (2017)). We now turn to different measures for the global dollar shock. Other proxies for the global dollar cycle should affect the purified CIP basis in a similar fashion. Table 8 shows regression results for equation (22) using the purified CIP basis as dependent variable,

[26] This is consistent with the predicted marginal impact of the negative dollar gap estimated to be a small but positive for the average dollar appreciation of around zero in panel (b) of Figure 15.

Figure 15: Dollar gap and CIP response to dollar appreciation.



(a) Predicted change in CIP basis (in bps) at different dollar gap positions



(b) Marginal impact of (negative) dollar gap on CIP basis (in bps) for different changes in the dollar exchange rate (in pct).

Notes: Panel (a) shows the predicted change in the purified CIP basis in response to 1.3 percent broad dollar appreciation, computed for varying degrees of hedging demand proxied with the negative dollar gap. Panel (b) shows the marginal impact of an increase in 1 ppt in the (negative) dollar gap ratio (in percent of GDP) on the predicted change in the CIP basis, evaluated at different rates of prevailing broad dollar depreciation/appreciation rates. Predicted values are based on estimates in column (1) of Table 7 with confidence intervals at 90 percent level.

but substitute the broad Dollar index with the VIX index (column 1), the global financial cycle factor from Miranda-Agrippino and Rey (2020) (column 3) and the Treasury basis from Jiang et al. (2020) (column 5) respectively.[27]

Consistent with our model prediction, an increase in global risk aversion captured by the VIX index, a retreat in the global financial cycle as captured by the global factor (itself summarizing forces that move international risk assets, capital flows and financial intermediation capacity), or an increase in synthetic Dollar borrowing rates for G-7 advanced economies as captured by a more negative Treasury basis all have a negative impact on the purified CIP basis if the Dollar gap is zero or positive. This, again, reflects the dollar funding channel. At the same time, the same increase in μ, whichever way measured, also triggers an increase in the purified CIP basis proportional to the underlying Dollar liability gap. This, in turn, is in line with the hedging demand channel. This robustness of our main results to different ways of measuring the global dollar cycle further supports the validity of the purified CIP basis.

Finally, when jointly controlling for the broad dollar index as well as any of the alternative measures of μ (columns 2, 4, 6), we find that the broad dollar reduces the explanatory power of the alternatives and remains the most statistically significant driver of the dollar cycle. We therefore continue to use the broad dollar as our baseline measure for dollar funding costs.

[27] Table 8 applies the regression to the subsample of the most liquid supranational bonds but results are robust when using the whole sample (see Appendix Table 15).

Table 8: Alternative measures of μ_t

	(1)	(2)	(3)	(4)	(5)	(6)
			Dep. Var: $\Delta\tau_t$			
τ_{t-1}	-0.106***	-0.111***	-0.115***	-0.117***	-0.109***	-0.115***
	(0.022)	(0.022)	(0.019)	(0.021)	(0.022)	(0.022)
$\Delta \log VIX_t$	-0.380***	-0.234**				
	(0.117)	(0.091)				
$\Delta \log VIX_t * (-USDGAP_i)$	0.014**	0.007				
	(0.005)	(0.005)				
$\Delta - GFCy_t$			-25.56***	-17.86***		
			(6.329)	(6.218)		
$\Delta - GFCy_t * (-USDGAP_i)$			1.016***	0.640**		
			(0.302)	(0.306)		
Δx_t^{Treas}					53.41***	35.70***
					(16.79)	(11.95)
$\Delta x_t^{Treas} * (-USDGAP_i)$					-2.284**	-1.477
					(1.105)	(1.050)
$\Delta dollar_t$		-4.629***		-3.554**		-4.656***
		(1.672)		(1.539)		(1.476)
$\Delta dollar_t * (-USDGAP_i)$		0.228***		0.175***		0.206***
		(0.070)		(0.065)		(0.065)
$(-USDGAP_i)$	0.148	0.193*	0.147	0.177*	0.146	0.203*
	(0.111)	(0.107)	(0.097)	(0.102)	(0.119)	(0.106)
Observations	548	493	548	493	495	493
Number of currencies	3	3	3	3	3	3
Within R2	0.101	0.124	0.109	0.125	0.095	0.123

Notes: Driskoll-Kraay heteroskedasticity and autocorrelation robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Table presents regression for equation (24) using Supra CIP basis at 1-year tenor as dependent variable, for three EM currencies with the most liquid supranational bond markets, and where μ is empirically measured by : the VIX index (col. 1-2), the Global Financial Cycle ($GFCy$) dynamic factor from Miranda-Agrippino and Rey (2020) (col. 3-4) and the Treasury basis (x^{Treas}) from Jiang et al. (2020) (col. 5-6). We multiply $GFCy$ by -1 so that an increase signifies tightening of financial conditions. *dollar* stands for the log Broad dollar Index. $USDGAP_i$ denotes the augmented hedging demand proxy: dollar net external asset position plus the external debt in local currency position (in percent country i GDP) to capture hedging demand of foreign investors in local currency assets. Currency fixed effect included in all regressions.

Of course, fluctuations in the dollar exchange rate can also reflect shifts in the demand for dollar safe assets (Jiang et al. (2020)). Such demand shifts in turn could also be associated with corresponding demand shifts for dollar forwards (that is, an increase in F^*_{it}) as global investors seek long exposure to the dollar and dollar assets, away from other currencies' assets. In our framework, such a demand increase for forwards should have qualitatively same impact on the CIP basis as a tightening of forward supply. Furthermore, as argued in Krishnamurthy and Lustig (2019), a global shift in demand for dollar assets would affect countries with higher external debt or higher dollar liabilities disproportionately as they are more exposed to an unwinding of carry trade positions and/or increase in hedging ratios. Therefore, the price impact on the CIP basis resulting from this demand shift could also be assumed to be proportional to the dollar gap. The regression results in Table 8 would thus be consistent with either the supply or demand driven interpretation of shifts to μ.

5.4.3 Interaction with intermediary net worth

We have so far collapsed the model-implied CIP equation into the most compact form to test for the interaction between underlying hedging demand and dollar funding cost μ_t in driving the CIP basis over time. In the following, we unpack this CIP equation to allow for another crucial variable, namely the leverage of the global intermediary, to vary simultaneously.

Recall that eq. (20) specifies the basis to be a function of the intermediary wealth that is dedicated to trading currency i, $\bar{W}^*_{it} = \sum_j W^*_{ijt}$ where the summation is over intermediaries j. We now define η_t as the intermediaries' leverage, i.e. the ratio of their debt to net worth:

$$\eta_t = \frac{D^*_{ijt} + D_{ijt}/\mathcal{E}_{it}}{W^*_{ijt}}$$

where, D^*_{ijt} and D_{ijt} denote, respectively, the dollar and local currency liabilities of the currency i desk of intermediary j. For simplicity, this leverage ratio is assumed identical across currency desks and intermediaries. If we assume further that the debt of each intermediary-currency desk is proportional to output, $D^*_{ijt} + D_{ijt}/\mathcal{E}_{it} = \kappa_{ij} Y_{it}$, then we can substitute into eq. (20) and express the basis as:

$$CIP_{it} = \frac{\mathrm{a}}{\kappa_i} \mu_t \eta_t \frac{\bar{F}^*_{it}}{Y_{it}}, \tag{25}$$

where $\kappa_i = \sum_j \kappa_{ij}$ is a constant. eq. (25) implies that the basis widens when leverage η_t increases.

Substituting eq. (22), we obtain:

$$CIP_{it} = \frac{\mathrm{a}\rho_0}{\kappa_i} \mu_t \eta_t + \frac{\mathrm{a}\rho_1}{\kappa_i} \mu_t \eta_t \left(-USDGAP_i\right)$$

In this expanded form, the CIP basis varies not only with the marginal dollar funding cost μ_t but also with the intermediary wealth whose time variation is captured by η_t. Lower global intermediary wealth (or higher leverage capital ratio) reduces the net worth available to intermediate CIP trade in each currency market i proportionally, tightens the binding liquidity constraint and therefore widens the absolute value of the CIP basis the dealer bank requires to supply any given net forward position. The impact of an increase in dollar funding cost is thus magnified by any concurrent reduction in intermediary wealth, with the combined impact of these global variables scaled by the proxy for hedging demand (i.e. the negative dollar gap).

Taking first differences gives us the following estimating equation for the change in the CIP basis:

$$\begin{aligned}\Delta CIP_{it} \;=\;& \alpha_i + \beta_1 \Delta dollar_t + \beta_2 \Delta dollar_t \times (-USDGAP_i) \\ & + \beta_3 \Delta \eta_t + \beta_4 \Delta \eta_t \times (-USDGAP_i) \\ & + \beta_5 \Delta dollar_t \Delta \eta_t + \beta_6 \Delta dollar_t \Delta \eta_t \times (-USDGAP_i) \\ & + \gamma' X_{it} + \varepsilon_{it} \end{aligned} \tag{26}$$

where we again proxy for the intermediary's forward to GDP position to the (negative) of the dollar gap. We measure the intermediary's leverage-capital ratio using the market capital ratio of primary dealer counterparties of the New York Federal Reserve from He et al. (2017).[28] These are globally active dealer banks who are the marginal price setters in many asset markets, especially FX derivatives markets involving the dollar. Consistent with our prediction, this global variable has been shown to act like the common pricing kernel for a broad cross-section of assets, including FX. An increase the the dollar and leverage-capital ratio both tighten the dollar funding condition and thus we expect $\beta_1, \beta_3, \beta_5 < 0$ in line with the dollar funding channel and $\beta_2, \beta_4, \beta_6 > 0$ for the dollar hedging channel.

Table 9 reports the estimation results for the expanded CIP equation (26). By itself, the intermediary leverage-capital ratio has a strongly negative effect on the purified CIP basis as predicted by the dollar funding channel, with the impact offset by higher dollar liability gap as predicted by the hedging channel (column 1). The full specification in column 2 that controls for both the broad dollar index, the intermediary leverage-capital ratio as well as their interaction with each other and with the dollar liability gap delivers statistically significant estimates for the standalone, double and triple interaction coefficients, with all estimated signs conforming with out predictions above. Compared to the previous regressions with only the broad dollar index, introducing the intermediary leverage-capital ratio reduces somewhat the impact of the broad dollar, suggesting some extent of collinearity: times of broad dollar appreciation are also times when intermediary leverage ratio rises (or its capital is impaired).

The results in Table 9, column 2 also show that the intermediary net worth amplifies the impact of the broad dollar (or other variable capturing the marginal cost of dollar funding) on the CIP basis through both the funding and hedging channels. Consistent with the model, the mutual amplification is proportional to the underlying dollar gap. Currencies of countries with large net dollar asset positions experience a widening *negative* CIP basis when the global intermediary's capital ratio is low and the dollar is strong, while the same global forces would

[28] Following He et al. (2017), the leverage-capital ratio is computed as $\sum_j BookDebt_i / \sum_j MarketEquity_j$ over all primary dealer holding companies j which serve as counterparties to the New York Fed for its open market operations.

Table 9: The role of intermediary net worth

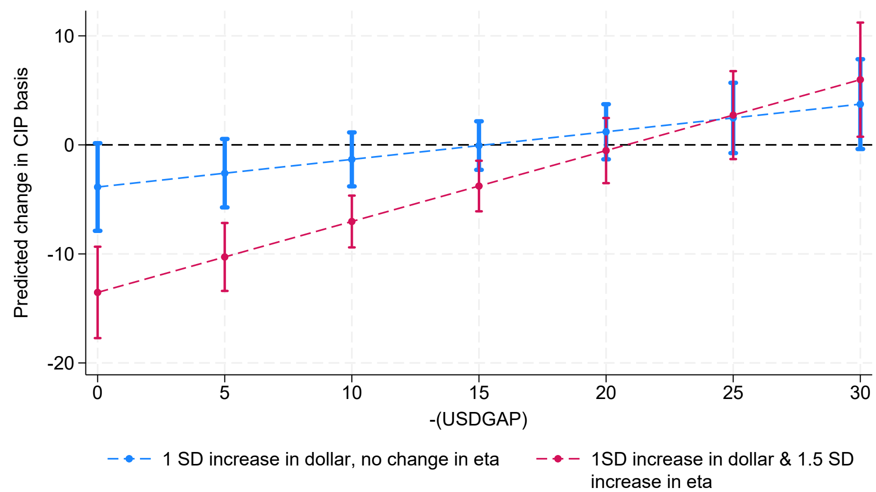
	(1)	(2)	(3)	(4)
		Dep. Var Δy_t:		
	$\Delta\tau_t$	$\Delta\tau_t$	ΔGOV_t	$\Delta LIBOR_t$
y_{t-1}	-0.114***	-0.131***	-0.0707***	-0.112**
	(0.019)	(0.021)	(0.026)	(0.053)
$\Delta\eta_t$	-4.018***	-2.092***	-2.769	-2.529
	(1.283)	(0.675)	(1.803)	(2.014)
$\Delta\eta_t \times (-USDGAP_i)$	0.172**	0.114*	-0.081	0.028
	(0.068)	(0.059)	(0.140)	(0.143)
$\Delta dollar_t$		-2.480***	-5.535**	-2.237
		(0.908)	(2.779)	(2.719)
$\Delta dollar_t \times (-USDGAP_i)$		0.107**	0.379	0.293
		(0.053)	(0.249)	(0.248)
$\Delta dollar_t \Delta\eta_t$		-1.383***	-0.0157	0.194
		(0.194)	(0.362)	(0.377)
$\Delta dollar_t \Delta\eta_t \times (-USDGAP_i)$		0.036*	-0.106***	-0.116**
		(0.019)	(0.040)	(0.0506)
$(-USDGAP_i)$	0.132	0.109	0.513**	0.279
	(0.114)	(0.098)	(0.246)	(0.222)
Observations	548	493	493	487
Number of currencies	3	3	3	3
Within R2	0.097	0.154	0.088	0.082

Notes: Driskoll-Kraay heteroskedasticity and autocorrelation robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Table presents regression for equation (26) using Supra CIP basis at 1-year tenor as dependent variable (column 1-2), the government bond CIP basis (column 3) and the Libor-based CIP basis (column 4). Sample is restricted for three EM currencies with the most liquid supranational bond markets (BRL, TRY, ZAR). *dollar* stands for the log Broad dollar Index and η_t for the global intermediary leverage-capital ratio. $USDGAP_i$ denotes the augmented hedging demand proxy: dollar net external asset position plus the external debt in local currency position (in percent of country i GDP) to capture hedging demand of foreign investors in local currency assets. Currency fixed effect included in all regressions.

make the CIP basis more *positive* in countries with large net dollar liability positions. For countries with moderate net dollar exposure, the net impact could therefore be close to zero as the hedging and funding channels offset each other.

To give a sense of the economic magnitudes of our estimates, Figure 16 illustrates the interaction between the broad dollar exchange rate and the intermediary capital ratio by plotting the CIP basis response to a given dollar appreciation with and without a tightening of intermediary leverage. As before, a broad dollar appreciation lowers the CIP basis for low dollar

Figure 16: CIP response to dollar appreciation and intermediary net worth.



Notes: Using estimates reported in column 2 of Table 9, blue line plots the predicted change in the purified CIP basis (in basis points) in response to a 1 standard deviation appreciation of the broad dollar (of 1.35 percent month on month) with unchanged intermediary leverage-capital ratio, evaluated at different levels of the dollar gap. Red line plots the predicted change in CIP basis subject to the same broad dollar appreciation but with the intermediary leverage-capital ratio increase by 1.5 standard deviations. All predicted changes are shown with 90 percent confidence bands.

liability gap countries and increases it for high dollar gap ones, but the gradient is steeper and the negative impact on the CIP (through the funding channel) much more pronounced when the dollar appreciation is accompanied by a tightening of the intermediary balance sheet capacity (that is, with a higher leverage-capital ratio). For a 1.5 standard deviation increase in the leverage-capital ratio as illustrated, the negative impact of the same dollar appreciation on the CIP basis is 3-4 times larger than with unchanged intermediary net worth. The differential becomes smaller and turns positive with larger dollar liability gaps as the hedging channel starts to dominate.

In contrast to estimates using the purified CIP basis, repeating the same regressions using the conventional measures of CIP deviation as dependent variables (i.e. those based on government bond yields and LIBOR interest rates) do not yield the predicted effects (columns 3-4 in Table 9). While some of the coefficients show the right sign, overall they are not statistically significant. Notably, the triple interaction term between the broad dollar, intermediary leverage-capital ratio and the dollar gap has the opposite sign to what the model predicts. As before, we interpret this opposite result as possibly reflecting higher credit risk driving the conventional CIP basis, a risk that is more pronounced in countries with larger dollar liabilities in times of tighter financial conditions.

6 Conclusion

We construct a novel measure of deviation from CIP in major Emerging Markets using supranational bonds, which allow us to compute a "purified" CIP basis adjusted for relative credit risk and convenience yields. We are able to document the evolution of the deviation from pure CIP for major Emerging Markets since before the GFC. We show that the deviation from CIP in EM's, unlike in AE's, has not widened post GFC. If anything, CIP deviations in AE have become more similar to those in EM's, when the latter are computed properly.

The "purified" CIP basis conforms with model-implied prediction for cross-sectional and within-currency correlation with fundamental forces driving supply and demand for USD forwards/swaps. In the *cross-section* of currencies, the purified CIP basis reveals that the long-term demand for dollar forwards arising from hedging is a strong predictor for the average level of CIP deviation across EM currencies. In the *time-series* for individual EM currencies, shocks and policies that impact the supply of dollar funding, global intermediary's balance sheet capacity, and demand for dollar assets all interact with underlying country-specific dollar hedging needs in shaping the deviation from CIP across emerging market currencies.

Going forward, the purified CIP basis offers a valuable metric to gauge the potential impact of various policies affecting emerging market currencies, such as spot and forward FX intervention, capital controls, and macro-prudential policies, which future research should explore. The purified CIP basis also allows for an empirical analysis of how central bank swap lines between the Federal Reserve and emerging market central banks (as in the case of Brazil and Mexico) can lower dollar funding and hedging costs and promote local currency investment as documented for advanced economies by Bahaj and Reis (2022). In fact, the benefits of dollar swap lines in emerging markets could be larger as their FX markets are more shallow, while funding and hedging needs stemming from local dollar borrowing and foreign local currency investments are large and growing.

Beyond understanding the determinants of hedging costs for domestic borrowers and foreign investors in emerging markets, the 'purified basis' also provides a measure of the strength of financial and aggregate demand externalities faced by Emerging Market economies. As deviations from CIP introduce a wedge between the domestic borrowing costs under the control of central banks and the synthetic local currency borrowing rate through dollar financing, the results of our paper can shed light on the transmission of monetary policy in emerging markets. Policy makers can strengthen the monetary transmission mechanism by targeting this wedge in addition to the level of domestic policy rates as proposed in Gourinchas (2022).

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Appendix A Data Appendix

Table 10: Variables and data sources

Variable	Data source	Description
Spot exchange rate	Bloomberg	Daily spot exchange rate
Forward exchange rate	Bloomberg	Daily forward point (3 month/ 6 month)
Interbank rate	Bloomberg	Daily interbank rate (3 month/ 6 month)
Cross-currency basis swap (XCCY)	Bloomberg	Daily cross-currency basis swap rate (1y, 2y, 3y, 5y, 7y, 10y)
Interest rate swap (IRS)	Bloomberg	Daily vanilla interest rate swap rate (1y, 2y, 3y, 5y, 7y, 10y)
Non-deliverable swap (NDS)	Bloomberg	Daily non-deliverable swap (1y, 2y, 3y, 5y, 7y, 10y): In replacement of XCCY and IRS for BRL, INR, CNY, IDR, KRW, PHP, COP, PEN, RUB
Government bond yields	Bloomberg	Daily government bond yields (1y, 2y, 3y, 5y, 7y, 10y)
SSA bonds	Bloomberg	Daily bond prices (bid, ask) and bond yields
Dollar Gap	Benetrix et al. (2019), Allen and Juvenal (2024)	External Dollar debt assets net of external Dollar debt liabilities, in percent of GDP, annual averages.
Augmented Dollar Gap (baseline)	Benetrix et al. (2019), Allen and Juvenal (2024)	External Dollar debt assets plus external local currency debt liabilities, net of external Dollar debt liabilities, in percent of GDP, annual averages.
Broad U.S. Dollar Index	Federal Reserve Board	Nominal trade-weighted Dollar exchange rate
Treasury basis	Bloomberg	computed as in Krishnamurthy and Lustig (2019), using zero-coupon 12-months government bond yields, forward and spot exchange rates
Primary dealer leverage ratio	He et al. (2017)	Reciprocal of primary dealers' capital ratio (market net worth in pct of book debt and market net worth)

Bloomberg Tickers and Description

Currency	Type	Ticker	Name
AUD	Spot	AUD	USDAUD Spot Exchange Rate - Price of 1 USD in AUD
AUD	Forward	AUD3M, AUD6M, AUD12M	Australian Dollar Forward Points (3M, 6M, 12M)
AUD	Interbank Index	BBSW3M, BBSW6M, BBSW1Y	ASX Australian Bank Bill Short Term Rates Mid (3M, 6M, 12M)
AUD	Basis Swap (vs US LIBOR)	ADBS1 - ADBS10	AUD-USD Basis Swap (90D Bank Bill vs 3M Libor) (1Y - 10Y)
AUD	Basis Swap (vs SOFR)	ADBSQQ1 - ADBSQQ10	AUD-USD Basis Swap (BBSW vs SOFR) (1Y - 10Y)
AUD	Interest Rate Swap (3M)	ADSWAP1Q - ADSWAP10Q	AUD Quarterly (vs. 3M Bank Bills) (1Y - 10Y)
AUD	Interest Rate Swap (6M)	ADSWAP1 - ADSWAP10	AUD Semi Annual (vs. 6M Bank Bills) (1Y - 10Y)
AUD	Government bond index	C1273M, C1276M, C1271Y - C12710Y	BFV AUD AUSTRALIA SOVEREIGN (3M, 6M, 1Y - 10Y)
CAD	Spot	CAD	USDCAD Spot Exchange Rate - Price of 1 USD in CAD
CAD	Forward	CAD3M, CAD6M, CAD12M	Canadian Dollar Forward Points(3M, 6M, 12M)

CAD	Interbank Index	CDOR03, CDOR06, CDOR12	Canada Bankers Acceptances (3M, 6M, 12M)
CAD	Basis Swap (vs US LIBOR)	CDBS1 - CDBS10	CAD-USD Basis Swap 3M vs 3M (1Y - 10Y)
CAD	Basis Swap (vs SOFR)	CDXOQQ1 - CDXOQQ10	CAD USD Basis Swap CORRA VS SOFR (1Y - 10Y)
CAD	Interest Rate Swap (3M)	CDSW1 - CDSW10	CAD Semi Annual (vs 3M CDOR) (1Y - 10Y)
CAD	Government bond index	C1013M, C1016M, C1011Y - C10110Y	BFV CAD CANADA SOVEREIGN (3M, 6M, 1Y - 10Y)
CHF	Spot	CHF	USDCHF Spot Exchange Rate - Price of 1 USD in CHF
CHF	Forward	CHF3M, CHF6M, CHF12M	Swiss Franc Forward Points (3M, 6M, 12M)
CHF	Interbank Index	SF0003M, SF0006M, SF0001Y	ICE LIBOR CHF (3M, 6M, 12M)
CHF	Basis Swap (vs US LIBOR)	SFBS1 - SFBS10	CHF-USD Basis Swap (3M vs 3M IBOR) (1Y - 10Y)
CHF	Basis Swap (vs SOFR)	SFXOQQ1 - SFXOQQ10	CHF USD Basis Swap SARON vs SOFRRATE (1Y - 10Y)
CHF	Interest Rate Swap (3M)	SFSW1V3 - SFSW10V3	CHF Annual (vs. 3M LIBOR) (1Y - 10Y)
CHF	Interest Rate Swap (6M)	SFSW1 - SFSW10	CHF Annual (vs. 6M LIBOR) (1Y - 10Y)
CHF	Government bond index	C2563M, C2566M, C2561Y - C25610Y	BFV CHF SWITZERLAND SOVEREIGN (3M, 6M, 1Y - 10Y)
DKK	Spot	DKK	USDDKK Spot Exchange Rate - Price of 1 USD in DKK
DKK	Forward	DKK3M, DKK6M, DKK12M	Danish krone Forward Points (3M, 6M, 12M)
DKK	Interbank Index	CIBO03M, CIBO06M, CIBO01Y	COPENHAGEN INTERBANK OFFERED RATES (3M, 6M, 12M)
DKK	Basis Swap (vs US LIBOR)	DKBS1 - DKBS10	DKK-USD Basis Swap 3M vs 3M (1Y - 10Y)
DKK	Interest Rate Swap (3M)	DKSW1V3 - DKSW10V3	DKK Annual (vs. 3M CIBOR) (1Y - 10Y)
DKK	Interest Rate Swap (6M)	DKSW1 - DKSW10	DKK Annual (vs. 6M CIBOR) (1Y - 10Y)
DKK	Government bond index	C2673M, C2676M, C2671Y - C26710Y	BFV DKK DANISH SOVEREIGN (3M, 6M, 1Y - 10Y)
EUR	Spot	EUR	USDEUR Spot Exchange Rate - Price of 1 USD in EUR
EUR	Forward	EUR3M, EUR6M, EUR12M	Euro Forward Points (3M, 6M, 12M)
EUR	Interbank Index	EUR003M, EUR006M, EUR001Y	Euribor ACT/360 (3M, 6M, 12M)
EUR	Basis Swap (vs US LIBOR)	EUBS1 - EUBS10	EUR-USD Basis Swap (3M Euribor vs 3M Libor) (1Y - 10Y)
EUR	Basis Swap (vs SOFR)	EUXOQQ1 - EUXOQQ10	EUR USD Basis Swap ESTRON vs SOFRRATE (1Y - 10Y)
EUR	Interest Rate Swap (3M)	EUSW1V3 - EUSW10V3	EUR Annual (vs. 3M EURIBOR) (1Y - 10Y)
EUR	Interest Rate Swap (6M)	EUSA1 - EUSA10	EUR Annual (vs. 6M EURIBOR) (1Y - 10Y)
EUR	Government bond index	C9103M, C9106M, C9101Y - C91010Y	BFV EUR GERMANY SOVEREIGN (3M, 6M, 1Y - 10Y)
GBP	Spot	GBP	USDGBP Spot Exchange Rate - Price of 1 USD in GBP
GBP	Forward	GBP3M, GBP6M, GBP12M	BRITISH POUND Forward Points (3M, 6M, 12M)
GBP	Interbank Index	BP0003M, BP0006M, BP0001Y	ICE LIBOR GBP (3M, 6M, 12M)
GBP	Basis Swap (vs US LIBOR)	BPBS1 - BPBS10	GBP-USD Basis Swap 3M vs 3M (1Y - 10Y)
GBP	Basis Swap (vs SOFR)	BPXOQQ1 - BPXOQQ10	GBP USD Basis Swap SONIA vs SOFRRATE (1Y - 10Y)
GBP	Interest Rate Swap (3M)	BPSW1V3 - BPSW10V3	GBP Quarterly (vs. 3M LIBOR) (1Y - 10Y)
GBP	Interest Rate Swap (6M)	BPSW1 - BPSW10	GBP Semi Annual (vs. 6M LIBOR) (1Y - 10Y)
GBP	Government bond index	C1103M, C1106M, C1101Y - C11010Y	BFV GBP UK GILTS (3M, 6M, 1Y - 10Y)
JPY	Spot	JPY	USDJPY Spot Exchange Rate - Price of 1 USD in JPY
JPY	Forward	JPY3M, JPY6M, JPY12M	JAPANESE YEN Forward Points (3M, 6M, 12M)
JPY	Interbank Index	JY0003M, JY0006M, JY0001Y	ICE LIBOR JPY (3M, 6M, 12M)
JPY	Basis Swap (vs US LIBOR)	JYBS1 - JYBS10	JPY-USD Basis Swaps(3M vs 3M IBOR) (1Y - 10Y)
JPY	Basis Swap (vs SOFR)	JYBSS12M, JYBSS2 - JYBSS10	JPY USD Basis Swap TONA vs SOFRRATE (1Y - 10Y)
JPY	Interest Rate Swap (6M)	JYSW1 - JYSW10	JPY Semi Annual (vs. 6M LIBOR) (1Y - 10Y)
JPY	TBS	JYBC1 - JYBC10	JPY Basis Swap (3M VS 6M IBOR) (1Y - 10Y)
JPY	Government bond index	C1053M, C1056M, C1051Y - C10510Y	BFV JPY JAPAN SOVEREIGN (3M, 6M, 1Y - 10Y)
NOK	Spot	NOK	USDNOK Spot Exchange Rate - Price of 1 USD in NOK
NOK	Forward	NOK3M, NOK6M, NOK12M	NORWEGIAN KRONE Forward Points (3M, 6M, 12M)
NOK	Interbank Index	NIBOR3M, NIBOR6M, NIBOR1Y	OSLO BORS NORWAY INTERBANK OFFERED RATE FIXING (3M, 6M, 12M)
NOK	Basis Swap (vs US LIBOR)	NKBS1 - NKBS10	NOK-USD Basis Swap (3M VS 3M IBOR) (1Y - 10Y)
NOK	Interest Rate Swap (6M)	NKSW1 - NKSW10	NOK Annual (vs. 6M NIBOR) (1Y - 10Y)
NOK	TBS	NKBFVC1 - NKBFVC10	NOK Swap Spread (6M VS 3M NIBOR) (1Y - 10Y)
NOK	Government bond index	C2663M, C2666M, C2661Y - C26610Y	BFV NOK NORWAY SOVEREIGN (3M, 6M, 1Y - 10Y)
NZD	Spot	NZD	USDNZD Spot Exchange Rate - Price of 1 USD in NZD
NZD	Forward	NZD3M, NZD6M, NZD12M	NEW ZEALAND DOLLAR Forward Points (3M, 6M, 12M)
NZD	Interbank Index	NDBB3M, NDBB6M, NDBB1Y	New Zealand Dollar Bank Bills (3M, 6M, 12M)
NZD	Basis Swap (vs US LIBOR)	NDBS1 - NDBS10	NZD-USD Basis Swap (3M vs 3M IBOR) (1Y - 10Y)
NZD	Interest Rate Swap (3M)	NDSWAP1 - NDSWAP10	NZD Semi Annual (vs. 3M Bank Bills) (1Y - 10Y)
NZD	Government bond index	C2503M, C2506M, C2501Y - C25010Y	BFV NZD NEW ZEALAND GOVERNMENT (3M, 6M, 1Y - 10Y)
SEK	Spot	SEK	USDSEK Spot Exchange Rate - Price of 1 USD in SEK
SEK	Forward	SEK3M, SEK6M, SEK12M	SWEDISH KRONA Forward Points (3M, 6M, 12M)
SEK	Interbank Index	STIB3M, STIB6M, STIB1Y	STOCKHOLM INTERBANK OFFERED RATES (3M, 6M, 12M)
SEK	Basis Swap (vs US LIBOR)	SKBS1 - SKBS10	SEK-USD BASIS SWAP (3M VS 3M LIBOR) (1Y - 10Y)

SEK	Interest Rate Swap (3M)	SKSW1 - SKSW10	SEK Annual (vs. 3M STIBOR) (1Y - 10Y)
SEK	Government bond index	C2593M, C2596M, C2591Y - C25910Y	SWEDISH GOVERNMENT (3M, 6M, 1Y - 10Y)
USD	Interbank Index	US0003M, US0006M, US0001Y	ICE LIBOR USD (3M, 6M, 12M)
USD	Interest Rate Swap (3M)	USSW1 - USSW10	USD Semi Anl 30/360(vs3MLIBOR) (1Y - 10Y)
USD	TBS	USBA1 - USBA10	USD Basis Swap 1Mv3M (1Y - 10Y)
USD	TBS	USBC1 - USBC10	USD Basis Swap 3Mv6M (1Y - 10Y)
USD	Government bond index	C0823M, C0826M, C0821Y - C08210Y	BFV USD US Treasury Bonds/Notes (3M, 6M, 1Y - 10Y)
BRL	Spot	BRL	USDBRL Spot Exchange Rate - Price of 1 USD in BRL
BRL	Forward	BCN3M, BCN6M, BCN12M	BRAZILIAN REAL Non-Deliverable Forward Points (3M, 6M, 12M)
BRL	Interbank Index	PREDI90 - PREDI180 - PREDI360	PRExDI SWAP AVG (3M, 6M, 12M)
BRL	NDS	BCNI12M, BCNI2 - BCNI10	BRL ND CCS 1 YR (1Y - 10Y)
BRL	Government bond index	I39303M, I39306M, I39301Y - I393010Y	BRL BRAZIL GOVT BENCHMARK (3M, 6M, 1Y - 10Y)
CLP	Spot	CLP	USDCLP Spot Exchange Rate - Price of 1 USD in CLP
CLP	Forward	CHN3M, CHN6M, CHN12M	Chilean Peso Non-Deliverable Forward Points (3M, 6M, 12M)
CLP	Interbank Index	CHSWPC - CHSWPF - CHSWP1	CLP FIXED VS. CAMARA SWAP (3M, 6M, 12M)
CLP	Basis Swap (vs US LIBOR)	CHUSBS1 - CHUSBS10	CLP-USD BASIS SWAP CAM VS. 6M (1Y - 10Y)
CLP	Interest Rate Swap	CHSWP1 - CHSWP10	CLP FIXED VS. CAMARA (1Y - 10Y)
CLP	Government bond index	BV3MCLPG, BV6MCLPG, BV01CLPG - BV10CLPG	CLP Bonos Tesoreria Pesos NY 4PM BVAL Curve (3M, 6M, 1Y - 10Y)
CLP	Government bond index	C9903M, C9906M, C9901Y - C99010Y	CLP CHILE SOVEREIGN (POST 2016) (3M, 6M, 1Y - 10Y)
CNY	Spot	CNY	USDCNY Spot Exchange Rate - Price of 1 USD in CNY
CNY	Forward	CCN3M, CCN6M, CCN12M	CHINESE RENMINBI Non-Deliverable Forward Points (3M, 6M, 12M)
CNY	Interbank Index	SHIF3M, SHIF6M, SHIF1Y	CFETS SHIBOR FIXING (3M, 6M, 12M)
CNY	NDS	CCSWN1 - CCSWN10	CNY NDS Semi Annual (vs. 6M LIBOR) (1Y - 10Y)
CNY	Government bond index	C0203M, C0206M, C0201Y - C02010Y	CNY CHINA SOVEREIGN (3M, 6M, 1Y - 10Y)
COP	Spot	COP	USDCOP Spot Exchange Rate - Price of 1 USD in COP
COP	Forward	CLN3M, CLN6M, CLN12M	COLOMBIAN PESO Non-Deliverable Forward Points (3M, 6M, 12M)
COP	Interbank Index	COOVIBR3 - COOVIBR6 - COOVIBRY	Colombia IBR Nominal Rate (3M, 6M, 12M)
COP	NDS	CLSWU1 - CLSWU10	COP-USD NDS Semi-annual(vs. 6M LIBOR) (1Y - 10Y)
COP	Government bond index	C4773M, C4776M, C4771Y - C47710Y	BFV COP COLOMBIA SOVEREIGN (3M, 6M, 1Y - 10Y)
HUF	Spot	HUF	USDHUF Spot Exchange Rate - Price of 1 USD in HUF
HUF	Forward	HUF3M, HUF6M, HUF12M	Hungarian Forint Forward Points (3M, 6M, 12M)
			NATIONAL BANK OF HUNGARY BUDAPEST
HUF	Interbank Index	BUBOR03M, BUBOR06M, BUBOR01Y	INTERBANK OFFERED RATES INDEX (3M, 6M, 12M)
HUF	Basis Swap (vs US LIBOR)	HFEBS1 - HFEBS10	HUF-EUR Basis Swap 3M vs 3M (1Y - 10Y)
HUF	Interest Rate Swap (6M)	HFSW1 - HFSW10	HUF Annual (vs. BUBOR06M Index) (1Y - 10Y)
HUF	Government bond index	C1143M, C1146M, C1141Y - C11410Y	BFV HUF HUNGARY SOVEREIGN (3M, 6M, 1Y - 10Y)
IDR	Spot	IDR	USDIDR Spot Exchange Rate - Price of 1 USD in IDR
IDR	Forward	IHN3M, IHN6M, IHN12M	Indonesian Rupiah Non-Deliverable Forward Points (3M, 6M, 12M)
IDR	Interbank Index	JIIN3M, JIIN6M, JIIN1Y	BANK INDONESIA JAKARTA INTERBANK OFFERING RATE (3M, 6M, 12M)
IDR	NDS	IHSWN1 - IHSWN10	IDR NDS Semi-annual (vs. 6M LIBOR) (1Y - 10Y)
IDR	Government bond index	C1323M, C1326M, C1321Y - C13210Y	INDONESIA GOVERNMENT (3M, 6M, 1Y - 10Y)
ILS	Spot	ILS	USDILS Spot Exchange Rate - Price of 1 USD in ILS
ILS	Forward	ILS3M, ILS6M, ILS12M	Israeli Shekel Forward Points (3M, 6M, 12M)
ILS	Interbank Index	TELBOR03, TELBOR06, TELBOR12	BANK OF ISRAEL TEL AVIV INTERBANK OFFERED (3M, 6M, 12M)
ILS	Basis Swap (vs US LIBOR)	ISBS1 - ISBS10	ILS-USD Basis Swap 3M vs 3M (1Y - 10Y)
ILS	Interest Rate Swap (3M)	ISSW1 - ISSW10	ILS Annual (vs. 3M TELBOR) (1Y - 10Y)
ILS	Government bond index	I32503M, I32506M, I32501Y - I325010Y	ILS ISRAEL SOVEREIGN (3M, 6M, 1Y - 10Y)
INR	Spot	INR	USDINR Spot Exchange Rate - Price of 1 USD in INR
INR	Forward	IRN3M, IRN6M, IRN12M	INDIAN RUPEE Non-Deliverable Forward Points (3M, 6M, 12M)
INR	Interbank Index	MIFORIM3, MIFORIM6, MIFORM12	MIFOR Mumbai Interbank Forward Offer Rates (3M, 6M, 12M)
INR	NDS	IRSWN1 - IRSWN10	INR-USD NDS Semi-annual(vs. 6M LIBOR) (1Y - 10Y)
INR	Government bond index	F12303M, F12306M, F12301Y - F123010Y	INDIA SOVEREIGN BENCHMARK (3M, 6M, 1Y - 10Y)
KRW	Spot	KRW	USDKRW Spot Exchange Rate - Price of 1 USD in KRW
KRW	Forward	KRW3M, KRW6M, KRW12M	SOUTH KOREAN WON Non-Deliverable Forward Points (3M, 6M, 12M)
KRW	Interbank Index	KWCDC, KRBO6M, KRBO12M	South Korean Won Certificate of Deposit Rates (3M, 6M, 12M)
KRW	NDS	KWSWN1 - KWSWN10	KRW NDS Semi Annual (vs. 6M LIBOR) (1Y - 10Y)
KRW	Government bond index	C2323M, C2326M, C2321Y - C23210Y	BFV KRW KOREA TREASURY (3M, 6M, 1Y - 10Y)
MXN	Spot	MXN	USDMXN Spot Exchange Rate - Price of 1 USD in MXN

MXN	Forward	MXN3M, MXN6M, MXN12M	Mexican Peso Forward Points (3M, 6M, 12M)
MXN	Interbank Index	MXIB91DT, MXIB182D	MEXICO INTERBANK TIIE (91D, 182D)
MXN	Basis Swap (vs US LIBOR)	MPBS1A, MPBS2B, MPBS3C, MPBS5E, MPBS7G, MPBS10J	MXN-USD Basis Swap (28D VS 1M IBOR) (13M, 26M, 39M, 65M, 91M, 130M)
MXN	BS - SOFR	MPBSM1A, MPBSM2B, MPBSM3C, MPBSM5E, MPBSM7G, MPBSM10J	MXN-USD Basis Swap (28DTIIE VS SOFR) 364Day
MXN	Interest Rate Swap (1M)	MPSW1A - MPSW10K	MXN Monthly (vs. 28D TIIE) (1Y - 10Y)
MXN	Government bond index	C4763M, C4766M, C4761Y - C47610Y	BFV MXN MEXICO SOVEREIGN (3M, 6M, 1Y - 10Y)
MYR	Spot	MYR	USDMYR Spot Exchange Rate - Price of 1 USD in MYR
MYR	Forward	MRN3M, MRN6M, MRN12M	Malaysian Ringgit Non-Deliverable Forward Points (3M, 6M, 12M)
MYR	Interbank Index	KLIB3M, KLIB6M, KLIB1Y	Bank Negara Malaysia Klibor Interbank Offered Rate Fixing (3M, 6M, 12M)
MYR	Basis Swap (vs US LIBOR)	MRBS1 - MRBS10	MYR-USD Basis Swap (3M VS 3M IBOR) (1Y - 10Y)
MYR	Interest Rate Swap (3M)	MRSWNI1 - MRSWNI10	MYR NDIRS Quarterly (vs 3M KLIBOR) (1Y - 10Y)
MYR	Government bond index	C1283M, C1286M, C1281Y - C12810Y	BFV MYR MALAYSIA GOVERNMENT (3M, 6M, 1Y - 10Y)
PEN	Spot	PEN	USDPEN Spot Exchange Rate - Price of 1 USD in PEN
PEN	Forward	PSN3M, PSN6M, PSN12M	PERUVIAN SOL Non-Deliverable Forward Points (3M, 6M, 12M)
PEN	Interbank Index	PRBOPRB3, PRBOPRB6, PRBOPRB1	Asbanc Peru Nominal Rate (3M, 6M, 12M)
PEN	NDS	PSSWN1 - PSSWN10	PEN-USD NDS Semi-annual(vs. 6M LIBOR) (1Y - 10Y)
PEN	Government bond index	C9953M, C9956M, C9951Y - C99510Y	PEN PERU SOVEREIGN (3M, 6M, 1Y - 10Y)
PHP	Spot	PHP	USDPHP Spot Exchange Rate - Price of 1 USD in PHP
PHP	Forward	PPO3M, PPO6M, PPO12M	United States Dollar / Philippine Peso Onshore Forward Points (3M, 6M, 12M)
PHP	Interbank Index	PREF3M, PREF6M, PREF1Y	Philippines Interbank Reference Rate PHIREF at 1130am (3M, 6M, 12M)
PHP	NDS	PPSWN1 - PPSWN10	PHP NDS Semi Annual (vs. 6M LIBOR) (1Y - 10Y)
PHP	Government bond index	PDSR3MO, PDSR6MO, PDSR1YR - PDSR10YR	PDEX PDST-R1 Fixing (3M, 6M, 1Y - 10Y)
PLN	Spot	PLN	USDPLN Spot Exchange Rate - Price of 1 USD in PLN
PLN	Forward	PLN3M, PLN6M, PLN12M	Polish Zloty Forward Points (3M, 6M, 12M)
PLN	Interbank Index	WIBR3M, WIBR6M, WIBR1Y	GPW BENCHMARK WIBOR PLN (3M, 6M, 12M)
PLN	Basis Swap (vs US LIBOR)	PZBSEC1 - PZBSEC10	PLN-EUR Basis Swap (3M vs 3M IBOR) (1Y - 10Y)
PLN	Interest Rate Swap (3M)	PZSW1 - PZSW10	PLN Annual (vs. 3M WIBOR) (1Y - 10Y)
PLN	Government bond index	C1193M, C1196M, C1191Y - C11910Y	BFV PLN Poland Sovereign (3M, 6M, 1Y - 10Y)
RUB	Spot	RUB	USDRUB Spot Exchange Rate - Price of 1 USD in RUB
RUB	Forward	RUB3M, RUB6M, RUB12M	Russian Ruble Forward Points (3M, 6M, 12M)
RUB	Interbank Index	MOSKP3, MOSKP6	NFEA MosPrime Rate (3M, 6M, 12M)
RUB	NDS	RRUSSW1 - RRUSSW10	RUB-USD Annual (vs. 3M LIBOR) (1Y - 10Y)
RUB	Government bond index	C4963M, C4966M, C4961Y - C49610Y	RUB RUSSIA SOVEREIGN (3M, 6M, 1Y - 10Y)
THB	Spot	THB	USDTHB Spot Exchange Rate - Price of 1 USD in THB
THB	Forward	THB3M, THB6M, THB12M	Thai Baht Forward Points (3M, 6M, 12M)
THB	Interbank Index	BOFX3M, BOFX6M, BOFX1Y	BANK OF THAILAND BIBOR FIXINGS (3M, 6M, 12M)
THB	Basis Swap (vs US LIBOR)	TBBS1 - TBBS10	THB-USD Basis Swap (6M SIB VS 6M IBOR) (1Y - 10Y)
THB	Interest Rate Swap (6M)	TBSWNI1 - TBSWNI10	THB NDIRS Semi-Annual (vs 6M THFX) (1Y - 10Y)
THB	Government bond index	C1223M, C1226M, C1221Y - C12210Y	BFV THB THAILAND SOVEREIGN (3M, 6M, 1Y - 10Y)
TRY	Spot	TRY	USDTRY Spot Exchange Rate - Price of 1 USD in TRY
TRY	Forward	TRY3M, TRY6M, TRY12M	Turkish Lira Forward Points (3M, 6M, 12M)
TRY	Interbank Index	TRLIB3M, TRLIB6M, TRLIB1Y	BANK ASSOCIATION OF TURKEY TRLIBOR ASK RATES (3M, 6M, 12M)
TRY	CCS	TYUSSW1 - TYUSSW10	TRY-USD Annual (vs. 3M LIBOR) (1Y - 10Y)
TRY	Government bond index	C9653M, C9656M, C9651Y - C96510Y	BFV TRY TURKEY SOVEREIGN (3M, 6M, 1Y - 10Y)
ZAR	Spot	ZAR	USDZAR Spot Exchange Rate - Price of 1 USD in ZAR
ZAR	Forward	ZAR3M, ZAR6M, ZAR12M	South African Rand Forward Points (3M, 6M, 12M)
ZAR	Interbank Index	JIBA3M, JIBA6M, JIBA1Y	SAFE SOUTH AFRICA JOHANNESBURG INTERBANK AGREED RATE (3M, 6M, 12M)
ZAR	Basis Swap (vs US LIBOR)	SABS1 - SABS10	ZAR-USD Basis Swap 3M vs 3M (1Y - 10Y)
ZAR	Basis Swap (vs SOFR)	SAJSQQ1 - SAJSQQ10	ZAR USD Basis Swap JIBAR vs SOFRRATE (1Y - 10Y)
ZAR	Interest Rate Swap (3M)	SASW1 - SASW10	ZAR Quarterly (vs. 3M JIBAR) (1Y - 10Y)
ZAR	Government bond index	C2623M, C2626M, C2621Y - C26210Y	BFV ZAR SOUTH AFRICA SOVEREIGN (3M, 6M, 1Y - 10Y)

t Note: Bloomberg tickers for FX Spot, FX Forward, Basis Swap, IRS, NDS, CCS are with suffix CURNCY and abbreviated here.
t Bloomberg tickers for interbank rate and Government bond rate are with suffix INDEX and abbreviated here.

Appendix B Additional Tables and Figures

Table 12: Summary statistics for conventional CIP deviations and components: Jan 2008 - June 2023

	Libor basis	$y_{\$}^{LIBOR} - y_i^{LIBOR}$	Gov. bond basis	$y_{\$}^{GOV} - y_i^{GOV}$	ρ
	(1)	(2)	(3)	(4)	(5)
			Panel A: Advanced Economies		
3-month CIP deviation					
Mean	-19.8	-10.7	-19.4	-10.5	-8.9
Median	-17.1	5.8	-13.7	1.2	-22.7
Std. Dev.	26.7	156.4	35.2	159.8	164.4
Obs.	1,860	1,860	1,860	1,860	1,860
12-month CIP deviation					
Mean	-12.1	19.4	-17.7	11	-28.8
Median	-12.4	21.8	-12.5	12.2	-34
Std. Dev.	36.9	141.4	29.3	149.5	155.2
Obs.	1,209	1,209	1,209	1,209	1,209
			Panel B: Emerging Markets		
3-month CIP deviation					
Mean	-30.1	-377.1	-30.9	-379.3	348.3
Median	-35.2	-346.6	-42.8	-335.2	300.8
Std. Dev.	217.8	339.8	223	335.9	413.8
Obs.	3,133	3,133	3,133	3,133	3,133
12-month CIP deviation					
Mean	-153.8	-361.3	-98	-397.3	299.3
Median	-79.9	-300.8	-61.8	-334.2	215.1
Std. Dev.	228.6	344.2	209.8	349	392.7
Obs.	2,493	2,493	2,493	2,493	2,493

Notes: Summary statistics for monthly LIBOR and Government bond based CIP deviations at 3-month and 12-month maturities, corresponding interest rate/yield differentials and the dollar forward premium $\rho = f - s$ (log difference in forward and spot exchange rates). Monthly values are aggregated daily averages. All units are in basis points annualized. Sample period is post-GFC for all currencies. Overall 10 AE currencies and 16 EM currencies are included, but with different sample periods depending on data availability. Source: Bloomberg.

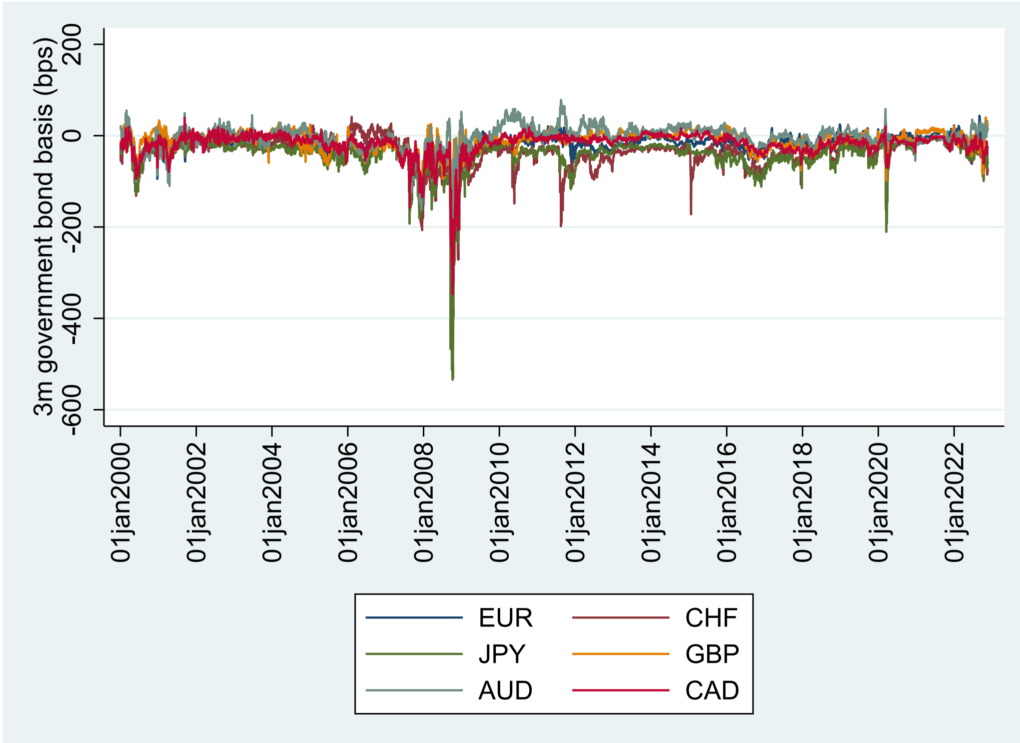
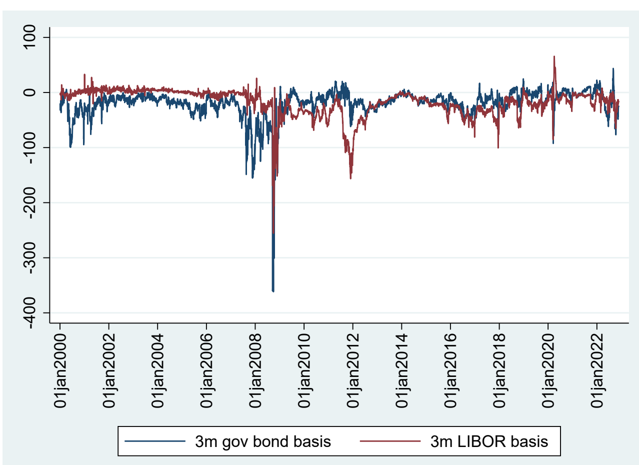
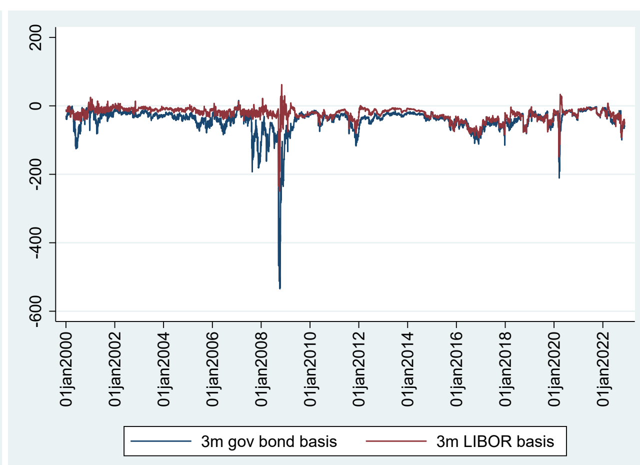


Figure 17: Government bond-based CIP deviation in AEs.

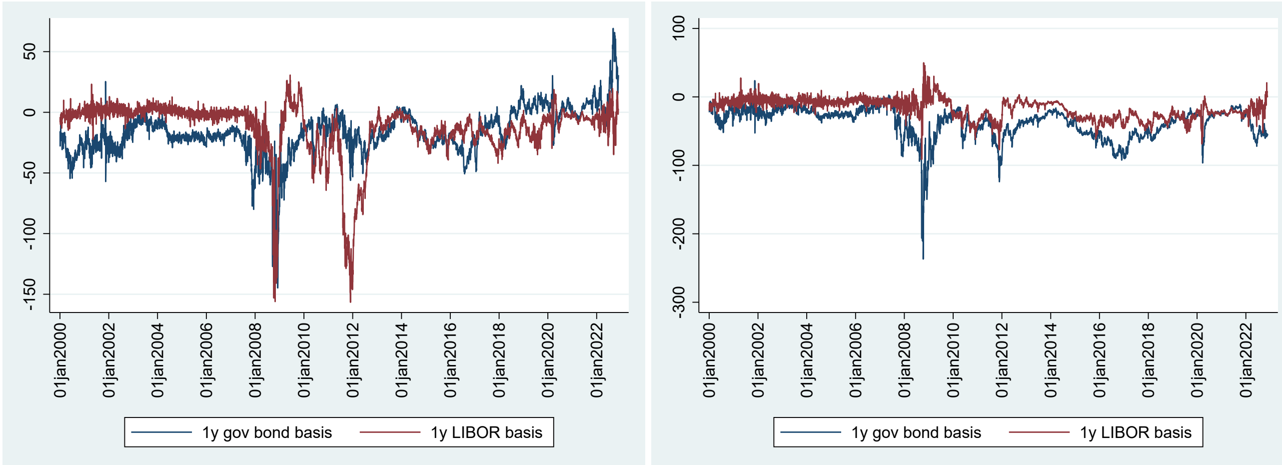


(a) EUR.



(b) JPY.

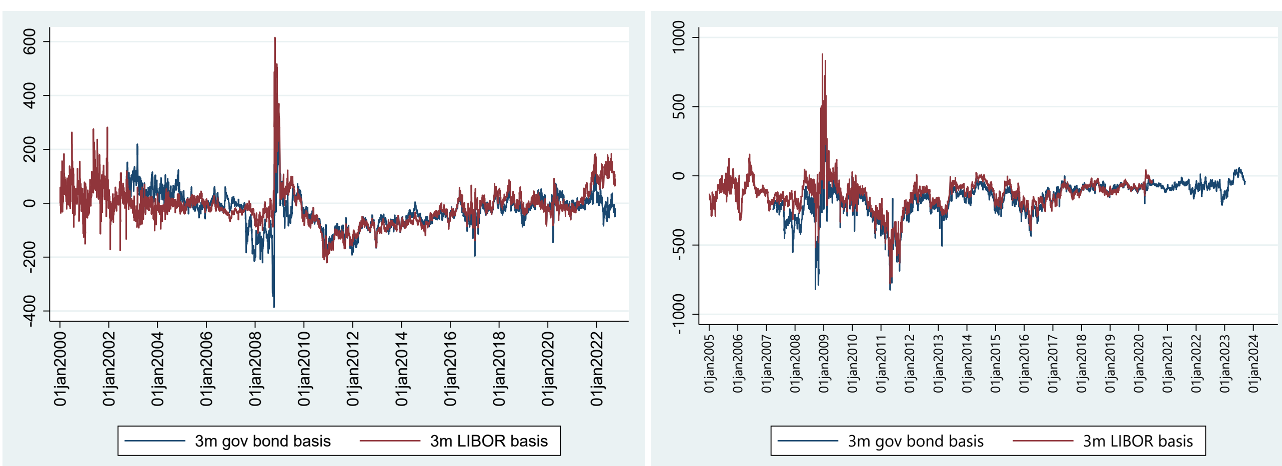
Figure 18: 3-months LIBOR and Treasury-based CIP bases in for EUR and JPY



(a) EUR.

(b) JPY.

Figure 19: 1-year LIBOR and Treasury-based CIP bases in for EUR and JPY



(a) MXN

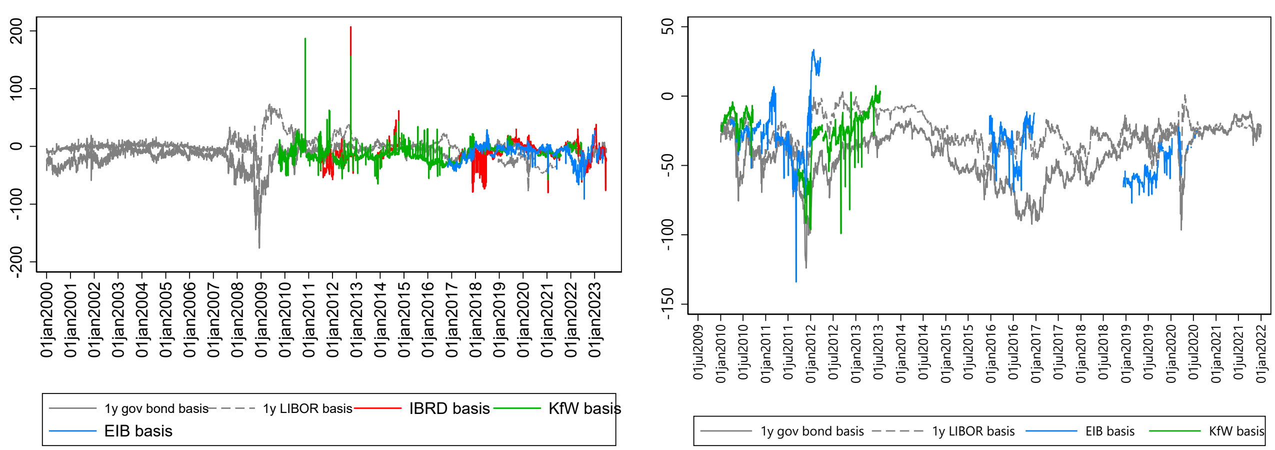
(b) BRL

Figure 20: 3-month LIBOR and Treasury-based CIP bases in for MXN and BRL

Table 13: Number of bonds per SSA by currencies

	IBRD	KFW	EIB	IFC	EBRD	ADB	IADB	AFDB
AE's								
USD	1223	721	526	515	236	344	278	139
AUD	265	75	57	56	27	116	47	40
CAD	31	29	30	7	2	13	10	4
CHF	5	21	76	2	2	7	4	3
EUR	181	646	315	33	112	35	7	28
GBP	84	91	117	21	29	31	23	9
JPY	23	287	29	68	9	13	7	13
NZD	118	41	21	38	8	33	16	18
EM's								
BRL	197	54	61	127	109	61	55	68
CNY	41	85	9	81	13	39	.	10
HKD	46	92	16	45	13	101	7	17
HUF	10	8	28	4	10	3	2	.
IDR	39	10	18	1	59	2	57	56
INR	227	1	9	20	62	8	40	45
MXN	102	13	19	64	47	31	28	26
PLN	37	10	36	1	21	9	.	.
RUB	58	5	17	51	43	13	3	15
TRY	96	50	66	142	147	160	24	73
TWD	.	.	37	.	.	20	.	.
ZAR	313	79	75	95	107	148	20	85

Notes: number of bonds with observed secondary market prices observed from January 2000 to September 2023. Source: Bloomberg. Not all bonds can be used to compute the CIP basis due to data requirements explained in the text.



(a) CAD (b) JPY

Figure 21: 1-year Supra and Treasury/LIBOR basis for CAD and JPY

Table 14: Means (and standard deviations) of the absolute value of CIP basis at 1-year tenor using conventional (LIBOR and Government Bond) vs. (Supranational bond) purified measures for overlapping sample periods (in bps).

Currency	|Libor CIP|	|Bond CIP|	|Purified CIP|
BRL	113.11	196.80	32.22
	(72.12)	(103.14)	(25.07)
CNY	105.72	104.11	43.98
	(100.43)	(74.08)	(51.25)
IDR	506.78	99.39	28.37
	(136.46)	(89.50)	(22.07)
INR	516.31	115.99	27.16
	(134.08)	(82.86)	(22.04)
MXN	-	49.55	17.25
		(36.58)	(15.83)
RUB	61.22	40.26	154.93
	(36.47)	(41.39)	(126.40)
TRY	137.60	168.86	61.69
	(188.66)	(198.96)	(76.39)
ZAR	25.53	40.90	33.67
	(18.92)	(35.28)	(31.28)

Notes: Summary statistics for each currency are taken over sample periods where data for all three measures of CIP deviations are available at 1-year tenor. Purified CIP is calculated according to the procedure described in section 4, only available for months when at least two supranational bonds with 1-year (or adjacent) residual maturity have been traded for a given currency. 1-year LIBOR interest rates are not available for MXN.

Table 15: Alternative measures of μ_t

	(1)	(2)	(3)	(4)	(5)	(6)
			Dep. Var: $\Delta\tau_t$			
τ_{t-1}	-0.128***	-0.133***	-0.131***	-0.134***	-0.128***	-0.132***
	(0.0197)	(0.0209)	(0.0183)	(0.0202)	(0.0210)	(0.0215)
$\Delta \log VIX_t$	-0.173	-0.0755				
	(0.113)	(0.0976)				
$\Delta \log VIX_t * (-USDGAP_i)$	0.00595	0.000525				
	(0.00587)	(0.00579)				
$\Delta - GFCy_t$			-19.28***	-15.45**		
			(7.354)	(6.983)		
$\Delta - GFCy_t * (-USDGAP_i)$			0.853**	0.599		
			(0.384)	(0.394)		
Δx_t^{Treas}					44.26***	34.67***
					(15.80)	(12.86)
$\Delta x_t^{Treas} * (-USDGAP_i)$					-2.121**	-1.618
					(1.037)	(1.018)
$\Delta dollar_t$		-3.245*		-1.759		-2.759*
		(1.720)		(1.459)		(1.515)
$\Delta dollar_t * (-USDGAP_i)$		0.195**		0.119		0.150**
		(0.0822)		(0.0750)		(0.0741)
$(-USDGAP_i)$	0.210*	0.250*	0.203*	0.219*	0.203	0.243*
	(0.124)	(0.131)	(0.110)	(0.121)	(0.131)	(0.127)
Observations	856	801	856	801	803	801
Number of currencies	6	6	6	6	6	6
Within R2	0.0786	0.0891	0.0918	0.0970	0.0852	0.0950

Notes: Driskoll-Kraay heteroskedasticity and autocorrelation robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Table presents regression for equation (22) using Supra CIP basis at 1-year tenor as dependent variable, for all six EM currencies with available supranational bond prices over time, and where μ is empirically measured by : the VIX index (col. 1-2), the Global Financial Cycle ($GFCy$) dynamic factor from Miranda-Agrippino and Rey (2020) (col. 3-4) and the Treasury basis (x^{Treas}) from Jiang et al. (2020) (col. 5-6). We multiply $GFCy$ by -1 so that an increase signifies tightening of financial conditions. *dollar* stands for the log Broad dollar Index. $USDGAP_i$ denotes the augmented hedging demand proxy: dollar net external asset position plus the external debt in local currency position (in percent country i GDP) to capture hedging demand of foreign investors in local currency assets. Currency fixed effect included in all regressions.

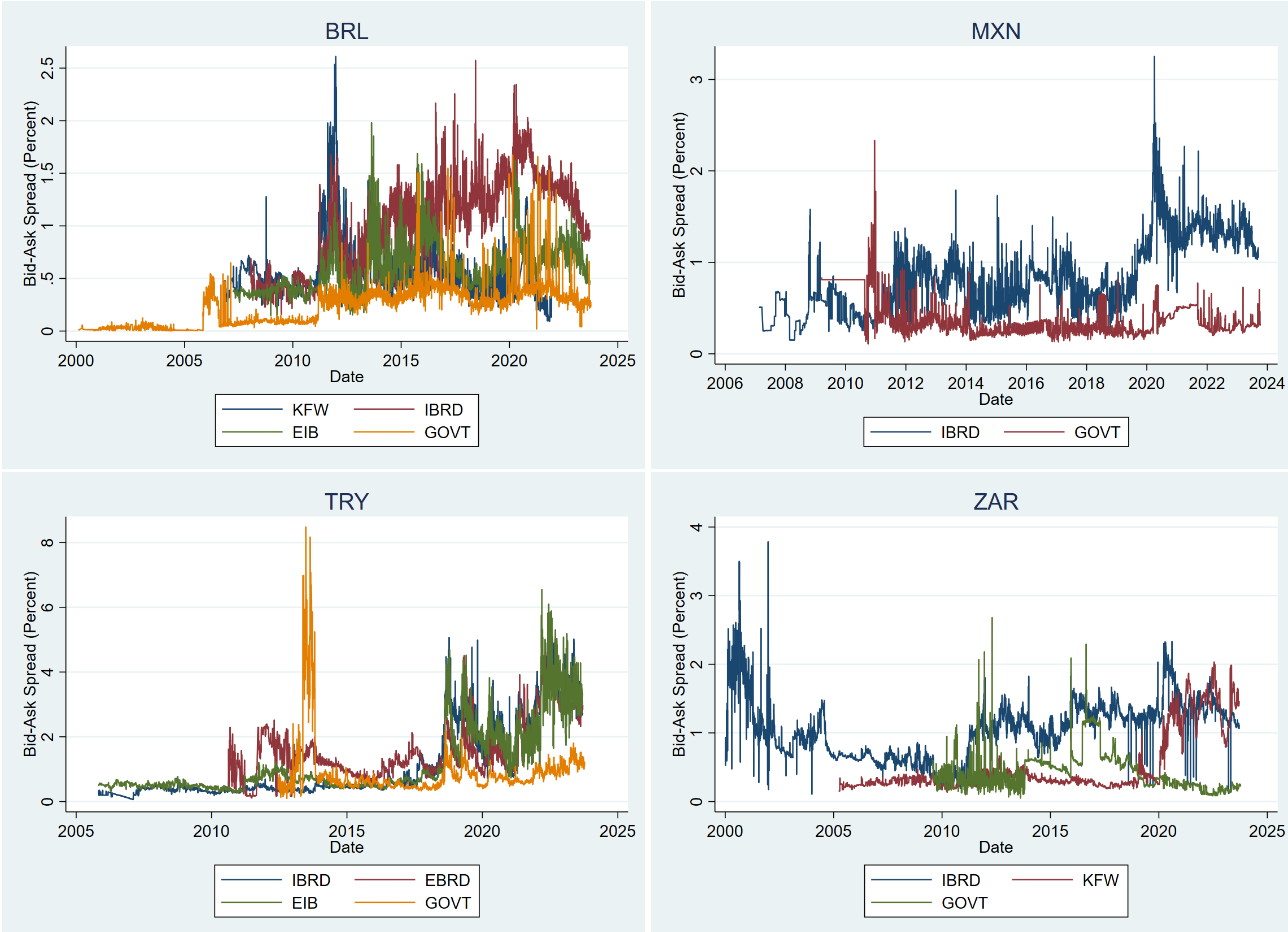
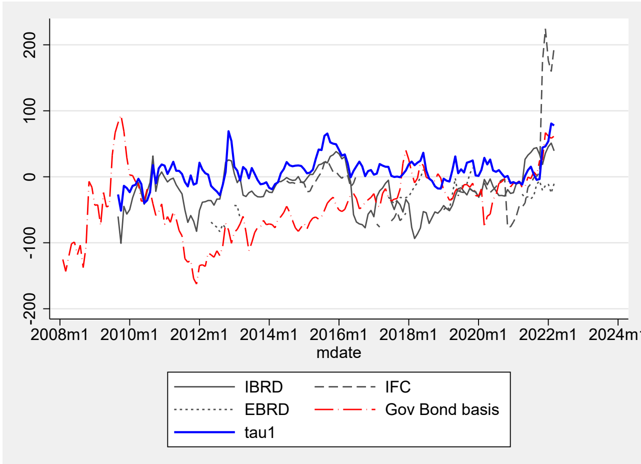
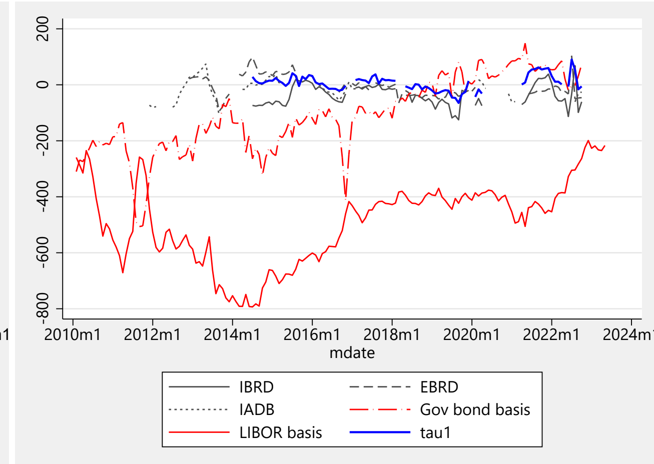


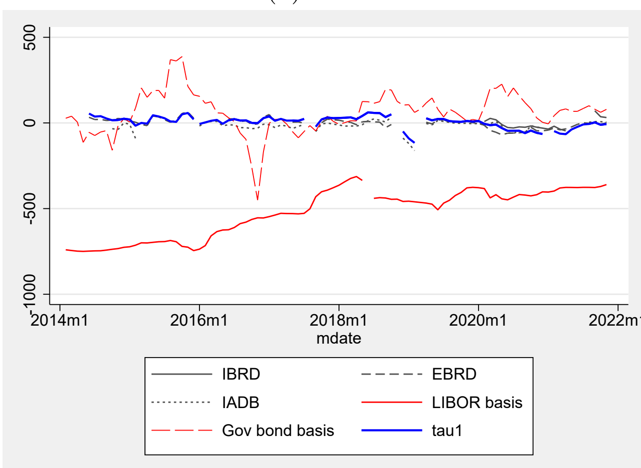
Figure 22: Daily Bid-Ask spreads for supranational and government bonds in major EM's (1-year tenor).



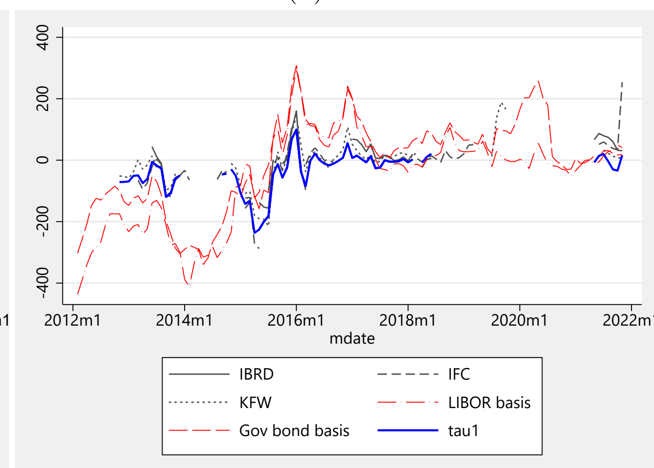
(a) MXN



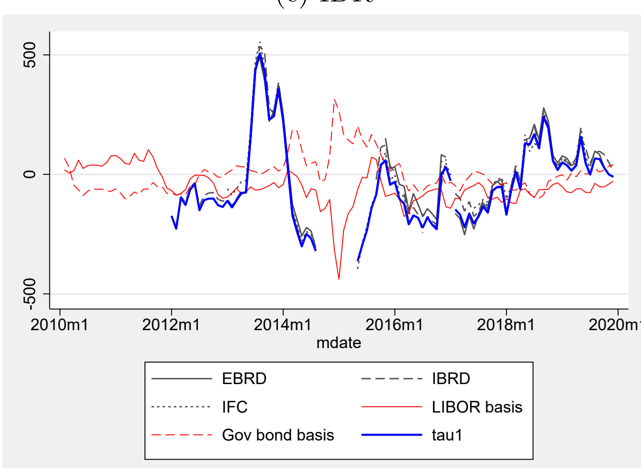
(b) INR



(c) IDR

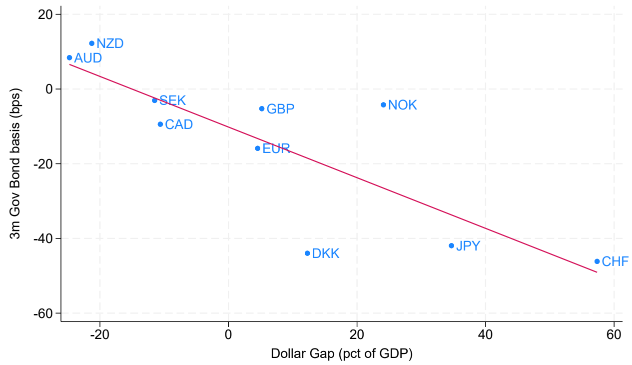


(d) CNY

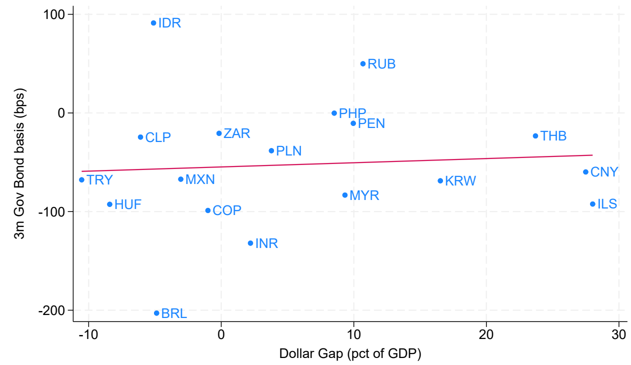


(e) RUB

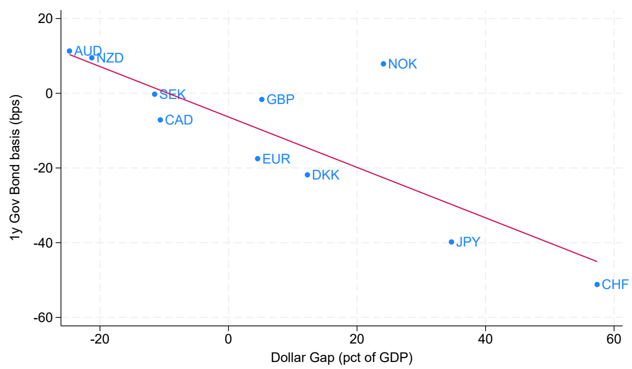
Figure 23: Purified versus conventional CIP deviations (1-year tenor).



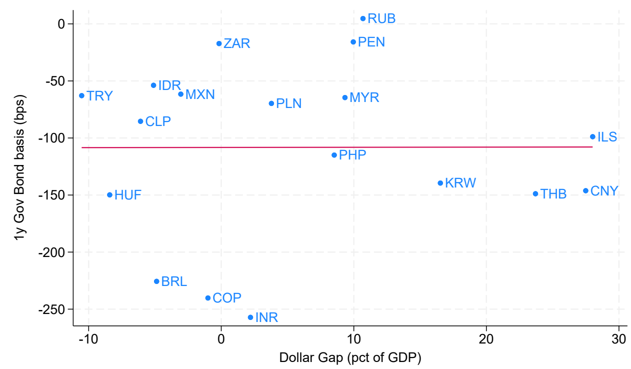
(a) 3m Treasury CIP basis in AE's



(b) 3m Treasury CIP basis in EM's



(c) 1y Treasury CIP basis in AE's



(d) 1y Treasury CIP basis in EM's

Figure 24: Net Dollar debt asset position (USD Gap) and average 3-month and 1-year Treasury (Government Bond) CIP basis in AE's and EM's: 2010-2017 averages by country/currency. For EUR, the GDP-weighted average of national USD gaps is taken.