Uncovering CIP deviations in emerging markets: Distinctions, determinants, and disconnect

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Abstract

We provide a systematic empirical analysis of short-term Covered Interest Parity (CIP) deviations for a large set of emerging market (EM) currencies. EM CIP deviations tend to be wider and more volatile compared to most G10 currencies, and may move in an opposite direction compared to G10 currencies during global risk-off episodes. Motivated by theories of financial determinants of exchange rate, we show that while offshore EM CIP deviations are sensitive to changes in FX dealers' risk-bearing capacities and global risk aversion, onshore CIP deviations are largely unresponsive in segmented FX markets. Meanwhile, the sensitivity of offshore CIP deviations to global factors for currencies with segmented FX markets is stronger compared to their counterparts with integrated FX markets. After accounting for global factors, we find weak evidence of country default risk and FX intervention affecting EM CIP deviations.

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1 Introduction

More than three decades ago, Krugman and Obstfeld's (1988) bestselling international economics textbook introduced Covered Interest Parity (CIP) as the "Basic Equilibrium Condition" to understand foreign exchange (FX) markets. CIP, set out by Keynes (1923) during the floating exchange rate period after WWI, describes the intimate relationship between the premium of a currency's forward over its spot exchange rate (both rates expressed as the price of foreign currency) to its nominal interest-rate advantage over foreign currency. Absent counterparty default risk and financial frictions, CIP equates the forward premium and interest rate differential via perfect riskless arbitrage. In the case of advanced economies (AEs) and their developed FX markets, CIP appeared to hold quite closely for several decades until the Global Financial Crisis (GFC), but it seems to have broken down since the onset of the GFC, and deviations have remained since.

Emerging markets (EM), on the other hand, have received less attention in this strand of literature, even after international trading of EM currencies has reached a scale comparable to advanced economy (AE) currencies (Caballero, Maurin, Wooldridge and Xia, 2022). While much attention has been given to the understanding of EM's currency risk premia, represented by deviations from Uncovered Interest Parity (UIP), data constraints and complex market arrangements due to capital controls and FX market underdevelopment have made the analysis of CIP deviations more difficult. Our paper seeks to fill this gap. We provide a systematic discussion of the measurement of short-term CIP deviations, study the role of their macro-financial determinants, and highlight the differences between EMs and AEs. Moreover, we exploit the frequent disconnect between offshore and onshore FX markets in EMs and present a novel analysis of their different sensitivities to global macro-financial determinants.

We start by discussing the implications of CIP deviations in the context of EMs. From an international investor's perspective, a wider CIP deviation would impact their cross-border investment decisions by affecting their hedge-adjusted returns, usually obtained through forward contracts sold by global banks. From a domestic borrower's side, fluctuations of CIP deviations affect the relative cost between domestic-currency funding and synthetic funding through currency swaps. For countries with open financial accounts free from restrictions in foreign exchange trading, arbitrage implies that no distinction needs to be made between residents and non-residents when measuring CIP deviations. But this may not be the case in EMs, where offshore and onshore CIP deviations do not always closely track each other. offshore FX markets, including Non-Deliverable

Forwards (NDFs), can be disconnected from onshore FX markets affecting potentially distinct sets of market players.[1] Both in normal times and during crisis episodes, the wedges between offshore and onshore forward exchange rates are non-negligible in the case of several EMs.

Building on previous work (Cerutti, Obstfeld and Zhou, 2021), we analyze the evolution of short-term CIP deviations (a tenor of one to three months) – relevant at the "macro-financial" level – to evaluate the importance over time of key drivers of CIP deviations.[2] Focusing on short tenors helps dampen concerns related to liquidity and credit risk – more prevalent features for EMs compared to AEs. We establish a series of descriptive facts. EM CIP deviations are more volatile than those of AE currencies, with significant deviations from zero even before the global financial crisis and sharp reversals from negative to positive territories especially during economic stress periods. Cross-sectionally, the correlations of EM CIP deviations with interest rate differentials and net international investment position are negative and positive, respectively, and they have opposite signs to those in AEs.

Our two sets of empirical exercises demonstrate the important relationship between CIP deviations in EMs and global factors through two main channels. First, binding regulatory constraints for global banks affect some emerging market currencies. CIP deviations for Emerging European currencies spike on important regulatory reporting dates for European banks and Global Systemically Important Banks (G-SIBs), consistent with prior evidence for G-10 currencies that binding regulatory constraints and window-dressing activities contribute to the widening of the basis (Du, Tepper and Verdelhan, 2018; Cerutti, Obstfeld and Zhou, 2021). Second, away from reporting dates such as year-ends or quarter-ends, panel regressions using monthly averages suggest that fluctuations in global risk aversion and/or the risk-bearing capacities of important global foreign exchange dealers – measured by the aggregate capital (leverage) ratio – have a significant relationship with CIP deviations.[3] We find that while offshore EM CIP deviations are

[1] A non-deliverable FX forward (NDF) is an outright forward FX contract in which counterparties settle the difference between the contracted NDF rate and the prevailing spot rate on an agreed notional amount, generally from OTC markets in international finance centers such as Singapore, Hong Kong, London, Dubai, and New York. Unlike a deliverable forward, no physical delivery of currencies is necessitated at settlement. Only the profit and loss are exchanged. Usually settled in U.S. dollar, NDF has been the dominant hedging instrument for a number of currencies with limited offshore convertibility.

[2] We follow the convention of the literature and define the short-term CIP deviation (also known as the cross-currency "basis") as the relative difference between direct USD interest rate in the cash market and synthetic USD rate in the swap market from swapping local currency cash flow using FX forward and spot transactions.

[3] Global risk aversion is captured either with the first principal component of safe-haven currencies' spot exchange rate (Cerutti, Obstfeld and Zhou, 2021) or the broad dollar index (Avdjiev, Du, Koch and Shin, 2019).

sensitive to changes in FX dealers' risk-bearing capacities/global factors, onshore CIP deviations are largely unresponsive in segmented FX markets. At the same time, the sensitivity of offshore CIP deviations to global factors for currencies with segmented FX markets is stronger than their counterparts with integrated FX markets. Given that most major EMs are net international debtors (excluding reserves), these results are consistent with recent theories on the financial channel of exchange rate determination (Bruno and Shin, 2014, 2015; Gabaix and Maggiori, 2015; Liao and Zhang, 2020). For example, as FX dealers' leverage ratio increases, offshore CIP deviations become more positive, indicating a depreciation of the forward local currency relative to spot. This pattern in stark contrast to that of G-10 currencies and behind the large volatilities of EM CIP deviations. In EMs, FX segmentation insulates the onshore market from shocks, but it may also increase the sensitivity of offshore FX markets due to a worsening of risk-sharing.

The policy implications are ample, given EMs' market imperfections. From a macro perspective, the presence of the dollar basis (deviations from CIP with respect to the dollar interest rate) implies that one may be able to borrow or lend synthetically in domestic currency at a rate that is different from the domestic central bank rate, but dependent on monetary policies of core countries, such as the United States (Cerutti, Obstfeld and Zhou, 2021). In addition, our finding of a disconnect between onshore and offshore EM CIP deviations in their sensitivity to global factors highlights the importance of regulatory measures on FX markets. The theoretical literature on capital flow management (Korinek, 2011; Boz, Unsal, Roch, Basu and Gopinath, 2020, among others) and some recent empirical studies (Das, Gopinath and Kalemli-Özcan, 2021) show that when capital flow management measures are used in a "preemptive" manner, they could lead to a lower level of foreign currency FX debt, a lower sensitivity to global risk factors, and a reduced risk of future sudden stops and financial crises. Segmentation of the FX markets could also afford the monetary authorities wider policy space to intervene in the onshore markets in order to keep funding costs low and provide hedges to foreign-currency borrowers in the face of depreciation pressure. Going further, as prescribed by Gourinchas (2022), an EM with partial currency convertibility could supplement its interest policy rule with a target of CIP deviations. Imposing constraints on participation is not without downside, however, as segmentation amounts to levying a "tax" on hedging currency risks, which may discourage foreign participation in the local bond market if the degree of segmentation is sufficiently large (e.g., Malaysia's effective tightening of residents' participation constraint in offshore FX markets in 2016). As EM central banks increasingly tap into onshore FX markets for intervention, the disconnect also calls into question central banks' ability to alleviate adverse sentiments and capital outflow pressure in the offshore market. The limited risk-bearing capacity of global FX dealers and other arbitrageurs may in fact amplify the volatility of offshore CIP deviations and increase the hedging cost for global investors, especially when global risk perception worsens.

Our contributions to the literature are twofold. First, we extend empirical analyses of the evolution and the macro-financial determinants of short-term CIP deviations to EMs. Focusing on AEs, different authors have stressed a range of often complementary potential drivers, ranging from regulation-induced or other limits to arbitrage (Du, Tepper and Verdelhan, 2018; Cenedese, Della Corte and Wang, 2021), to changes in banks' balance sheet or risk-taking capacity connected with U.S. dollar appreciation (Avdjiev, Du, Koch and Shin, 2019; Cerutti, Obstfeld and Zhou, 2021). A few studies (Hutchison, Pasricha and Singh, 2012; Du and Schreger, 2016; Bush, 2019; Hong, Oeking, Kang and Rhee, 2020; Aggarwal, Arora and Sengupta, 2021, for example) have included several EMs in their samples, but their focus was different from ours. We provide refined measurement of CIP deviations and systematically study the offshore / onshore disconnect in CIP deviations' sensitivity to global factors.[4]

We also contribute to the onshore and offshore FX market literature. Patel and Xia (2019) and Schmittmann and Chua (2020) provide recent overviews of NDF markets in EMs.[5] While activity continued to be influenced by restrictions on currency convertibility, Patel and Xia (2019) highlight that an important driver of the surge in offshore FX NDF trading during 2016-19 was the growing appetite of global investors for EME assets. They also find that during times of global market stress, it is more likely that the offshore NDF markets will drive onshore prices. Similarly, while Schmittmann and Chua (2020) find that influences tend to run both ways after controlling for differences in time zones between markets, for the COVID-19 pandemic they find some evidence of NDFs leading onshore markets for a few Asian currencies. Jung (2021) provides evidence that macroproduential FX regulations result in a contraction of FX derivatives and consequently affect exporting activities for firms with significant hedging need. Jung and Jung (2022) discuss regulatory limits to arbitrage based on a financial intermediation model with

[4]Other work in this area include Hertrich and Nathan (2023), who study the impact of Bank of Israel intervention on USD-ILS basis, and Ben Zeev and Nathan (2023) investigate the impact of limits to arbitrage and inelastic supply for hedging services on the sensitivity of CIP deviations to hedging demand. An early related paper is Skinner and Mason (2011), who focus on a small subset of the currencies considered in this paper. Our findings highlighting that the forward FX markets are key in explaining the differences across EMs and AEs align with Kalemli-Özcan and Varela's (2021) analysis of the differences across Uncovered Interest Parity premium in EMs and AEs.

[5]We also refer the readers to an earlier summary by Lipscomb (2005), with input from market participants on the factors affecting the pricing of NDF.

margin and portfolio constraints. Our contribution to this segment of the literature is to document how different macro-financial factors can affect CIP deviations calculated using onshore and offshore FX market forwards.

The structure of the rest of the paper is as follows: the next section presents the measurement of CIP deviations, after which we evaluate the evolution of CIP deviations across times and currencies. We proceed to estimate the influence of global and country specific factors on EM CIP deviations in Section 4. We conclude and present policy implications in the last section.

2 FX market development and CIP deviation measurement

We start by introducing the concept of CIP deviations in the context of a generic EM. The pervasive financial frictions faced by international investors in gaining and hedging EM exposure warrant an extensive discussion of market openness and structural barriers, in particular in the FX forward market. Against this backdrop, we discuss issues in measuring and interpreting CIP deviations in emerging markets.

Consider an international investor with investment opportunities in an EM. For most of our empirical exercise below, we assume that the investment opportunities come in the form of short-term money-market deposits, denominated in the local currency of the emerging market economy. Let the annualized log return on the investment be denoted as $i_{t,t+n}$, where n is the tenor of the instrument. Provided that she has access, the investor could seek to use a forward FX contract to hedge her currency exposure, by selling her investment proceeds forward in exchange for the currency by which she funds the investment. We focus on CIP deviations against the U.S. dollar in this paper. Let the (log) spot exchange rate be denoted as s_t, and the (log) n-period exchange rate be denoted as $f_{t,t+n}$, both in units of local currency per USD. The hedged return on this investment is given by

$$i_{t,t+n} - (f_{t,t+n} - s_t).$$

In the ideal world in which the money-market deposit is free of default risk and the FX market is frictionless, the return on the trade must equalize the dollar funding cost $i^{\$}_{t,t+n}$, giving rise to the Covered Interest Parity (CIP) condition (1):

$$i^{\$}_{t,t+n} = i_{t,t+n} - (f_{t,t+n} - s_t). \quad (1)$$

Financial frictions and default risk eliminate riskless arbitrage opportunities, giving rise to potentially profitable CIP trades. Following the convention in the literature (see, for example, Du, Tepper and Verdelhan (2018)), a negative deviation from CIP in the form of

$$x_{t,t+n} = i^{\$}_{t,t+n} - [i_{t,t+n} - (f_{t,t+n} - s_t)] < 0 \tag{2}$$

indicates that the returns on the hedged investment in the EM money market exceeds the cost of direct dollar funding, or the return on direct dollar investment in securities of similar maturities.

Deviations from CIP can also be interpreted through the lens of an emerging market borrower. Rewrite (2) as

$$x_{t,t+n} = [i^{\$}_{t,t+n} + (f_{t,t+n} - s_t)] - i_{t,t+n}. \tag{3}$$

The borrower could either fund herself in local currency at rate $i_{t,t+n}$, or in dollar (with cost $i^{\$}_{t,t+n}$) and convert the amount raised to local currency in the spot FX market. To alleviate the concern of currency mismatch and debt revaluation upon depreciation, she could further hedge the currency risk from the dollar borrowing by entering into a contract that stipulates the buying of U.S. dollar in the forward market at exchange rate $f_{t,t+n}$ to repay the debt obligations maturing n periods later.[6] A negative $x_{t,t+n}$ indicates that this synthetic funding arrangement is cheaper than raising local-currency funding directly.

It's now well known that up until the Global Financial Crisis (GFC), the CIP condition (1) held well for the advanced economies (Du, Tepper and Verdelhan, 2018). The breakdown of the canonical Libor basis after the GFC, while significant, is small in magnitude compared to the currency risk premium measured by deviations from the Uncovered Interest Parity condition (Kalemli-Özcan and Varela, 2021). For advanced economies, as a result, the sources of interest rates and exchange rates that enter (2) is largely immaterial from a macro-financial standpoint. However, as discussed in Du and Schreger (2016, 2022), among others, and as our exercise would show, various forms of market segmentation, counterparty risk, and data availability issues would complicate the analysis of CIP deviations in emerging markets at the outset.

[6]For comparison, the ex-post unhedged amount to repay in local currency with a debt face value equal to 1 USD is given by $i^{\$}_{t,t+n} + (s_{t,t+n} - s_t)$.

Market segmentation and regulatory barriers to arbitrage Partial convertibility of currencies and capital accounts remains a central characteristic of most EMs, despite significant development over the past two decades. Many EM currencies are convertible on the current account but with limited convertibility on the capital account and considerable degrees of market segmentation. Regulation-induced limits to arbitrage come in a number of forms, including limits on onshore net open position (NOP) of forwards and swaps, prohibition of resident participation in offshore FX derivatives markets, as well as documentation requirements of underlying investment for non-resident access to onshore FX hedging instruments.[7] The levels and dynamics of CIP deviations, according to (1) and (2), are thus complicated by the gap between forward exchange rates faced by offshore non-resident investors versus onshore resident borrowers.

Default risk While counterparty risk in the FX forward market is small in short horizons, as deliverable currency forward contracts are usually collateralized, and NDF contracts are net-settled, purely risk-free investment opportunities in emerging markets are scarce. In the presence of default risk, riskless arbitrage is no longer feasible, even absent market frictions. Investors would demand additional compensation corresponding to loss due to default, on top of the covariance between the pricing kernel and the time-varying default risk.

Canonical dollar interest rates, such as Libor, provide at best an incomplete picture of short-term dollar funding costs for emerging market institutions. On the one hand, the relative underdevelopment of EM financial markets precludes the use of near-risk-free interest rates of instruments such as Overnight Index Swaps (OIS), except for very few countries. On the other hand, benchmark interest rates may describe funding costs faced by only a subset of market players (Morales and Vergara, 2017; Rime, Schrimpf and Syrstad, 2022), and they may be derived from estimates rather than from actual trades.

One could seek to adjust for the impact of default risk, by adding a proxy for the loss-upon-default compensation to (2), usually using CDS spread, denoted l_t (Du and Schreger, 2016, 2022):

$$x^{adj}_{t,t+n} = i^{\$}_{t,t+n} - [(i_{t,t+n} - l_t) - (f_{t,t+n} - s_t)]. \tag{4}$$

Usually, the data on sovereign CDS is used to make such adjustments (see Du, Im and Schreger (2018)). In the case of emerging markets currency NDF, sovereign default is traditionally seen as a minor pricing factor, if not negligible (Lipscomb, 2005). Moreover,

[7] Bank for International Settlements (2022) and Jung and Jung (2022) provide systematic documentations of regulations on FX derivatives markets in Asia-Pacific EMEs.

any adjustment using CDS spreads is subject to the issue that at short tenors relevant at the macro-financial level (e.g., three-months), CDS contracts are either not written, have unobservable prices, or are illiquid.[8] Therefore, adjustments according to (4) may introduce additional measurement errors and reduce data coverage dramatically.

More importantly, we run the risk of introducing spurious dynamics by adding l_t. It is well known that emerging market CDS spreads share a common factor that is closely related to shifts in global risk aversion (González-Rozada and Yeyati, 2008; Longstaff, Pan, Pedersen and Singleton, 2011; Gilchrist, Wei, Yue and Zakrajšek, 2022). As the CDS contracts linked to dollar-denominated debt instruments are primarily traded offshore, adjusting the basis using CDS may mechanically reduce the sensitivity of the offshore basis to global factors, while increasing that of the onshore basis. To gauge the impact of sovereign risk, we instead use the benchmark unadjusted basis, and consider country default risk as a potential determinant of the dynamics in our regression exercise.

Our approach The above discussion motivates our construction of benchmark CIP deviations, characterized by the following principals. In Appendix A, we provide a step-by-step explanation of our calculations.

- *Short tenors*: We focus on 1-month and 3-month CIP deviations. The markets for short-tenor forwards and domestic interbank lending are the most liquid, and the concern for credit risk is smaller relative to longer tenors.

- *Off- and onshore forward exchange rate*: For currencies with segmented markets for currency forward transactions (often countries with a large NDF market), we compute CIP deviations using forward exchange rates faced by both onshore and offshore market participants.[9]

- *Dollar interest rate partially reflecting EM default risk*: In advanced economies, dollar interest rate benchmark – the Libor rate – is not the marginal funding rate or investment instruments for most participants (Rime, Schrimpf and Syrstad, 2022). We make a stronger case for emerging market CIP deviations to reflect this fact. While we compute one version of CIP deviations based on the canonical Libor

[8]Major provider of CDS data, such as Markit, only report CDS spreads from the tenor of 6-month onwards.

[9]Except for the case of China (see Section 4), we make no distinction between offshore and onshore interest rates, instead using domestic interbank rates as the representative rates. Administrative filing suggests that while partial barriers to entry may exist, major international investors, such as PIMCO, actively tap into domestic money markets using interest rate swap agreements, receiving floating money market interest rates, or engage in cross-currency basis trade directly with the basis linked to domestic money market rates.

dollar rate, our preferred measure of U.S. dollar interest rate faced by emerging markets is the *A2/P2* non-financial commercial paper interest rate. This interest rate accounts for the credit risk of EM dollar borrowers with fundamentals close to the A2/P2 rating tier.[10] To the extent that EM money market interest rates also price the same underlying credit risk, the credit risk component in the CIP deviations (2) would be partially offset by the interest rate differential.[11]

We obtain spot, forward exchange rates as well as money-market interest rates from Bloomberg and Refinitiv. We include both the offshore (often non-deliverable) and the onshore forward rates (if explicitly indicated by Bloomberg or Refinitiv as so).[12] We choose benchmark short-term interbank domestic interest rates based on availability. To achieve the maximum coverage and overcome issues with sporadically missing observations, our measure for the dollar interest rate is a simple average of the U.S. commercial paper interest rate provided by the Federal Reserve (FRED ticker `RIFSPPNA2P2D90NB` for 90-day issuances) and Bloomberg (ticker `DCPD090Y` for 90-day issuances). We use continuously compounded interest rates, making sure that the deviations account for day count conventions for individual currencies, as well as maturity date differences for forward contracts priced at different points in the calendar, following Du, Tepper and Verdelhan (2018) and Cerutti, Obstfeld and Zhou (2021).[13]

From Bloomberg and Refinitiv forward exchange rates, we select representative series with the best coverage to calculate our benchmark onshore and offshore CIP deviations. For a subset of EM currencies, we observe significant wedges between offshore forwards and onshore forwards.[14] We adopt a wide definition of emerging markets to cover 20 non-G10 currencies. Our sample spans the period from 2002 to 2021, although currencies differ in the availability of data. We report the Bloomberg and Refinitiv tickers in Appendix Table A1.

[10]On Refinitiv, we search short-term credit ratings of major banks headquartered in the EMs we consider with operations in the U.S (based on the latest foreign bank structure data: https://www.federalreserve.gov/releases/iba/202203/default.htm). Most banks in emerging markets are assigned a rating of B, A3/P3 or A2/P2. Examples of the A2/P2 category include Banco de Crédito e Inversiones (Chile), Banco de Crédito del Perú (Peru), and Bangkok Bank (Thailand).

[11]Currency-specific variations in default prospects remain unaccounted for.

[12]For Refinitiv, onshore forward quotes refer to quotes submitted by domestic data providers.

[13]As we use closing quotes and intraday prices are scarce for emerging markets, we do not account for time differences in daily data releases that potentially make the hypothetical CIP trade infeasible should markets be accessible. This is less of a concern, however, given that EMs' interbank money market interest rates are usually slow-moving.

[14]We discuss the disconnect in more detail in the next two sections. The currencies are BRL, CNY, IDR, INR, MYR, PHP, THB, and TWD. Also see Figure B2 for time-series charts of CIP deviations for individual currencies.

3 Time-series and cross-sectional stylized facts

Having discussed measurement, we focus on providing a set of stylized facts on EM CIP deviations in this section, and conducting a number of descriptive analyses tracing the evolution and cross-country differences of EM CIP deviations. The method employed in this section closely resembles prior literature analyzing G10 CIP deviations (Du, Tepper and Verdelhan, 2018; Avdjiev, Du, Koch and Shin, 2019; Cerutti, Obstfeld and Zhou, 2021). The description centers on using offshore / NDF as benchmark measures, as they are the standard in the literature and by doing so it facilitates comparison with AEs.

3.1 Evolution of CIP deviations

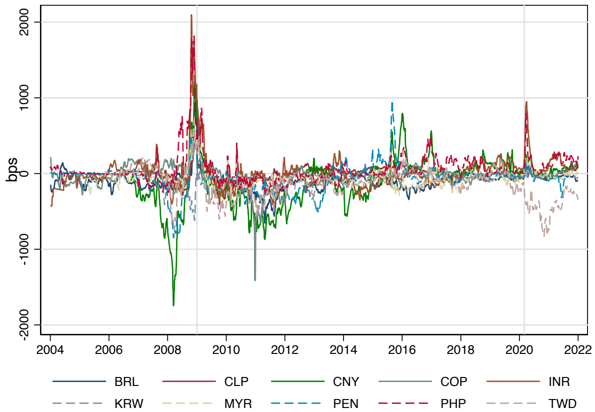
Figure 1 displays our benchmark 3-month offshore CIP deviations across EMs. We divide the EMs into two groups to facilitate the visualization: (i) countries with NDF in the first row of charts, and (ii) countries with the more traditional FX deliverable forwards in the second row of charts. The right-hand chart in each row has countries with larger CIP deviations. For comparison, Figure B1 in the Appendix plots the evolution of Libor-based G10 CIP deviations, and Table B1 reports the average levels of G10 CIP deviations.

In general, although there is substantial heterogeneity across EMs as well as over time, CIP deviations widened during the GFC, and they fluctuate after the crisis with some recognizable common peaks such as the Taper Tantrum in 2013 and the beginning of the COVID-19 crisis in January 2020. Offshore CIP deviations of EM currencies are considerably larger and more volatile than their G-10 currency counterparts. Moreover, offshore CIP deviations fluctuate from negative to positive territories during crisis periods in many EMs. For AEs, on the other hand, post-GFC CIP deviations are persistently negative for most AEs until the COVID-19 crisis. The pervasive use of capital flow management measures in EMs may explain this fact, as they affect the relative scarcity of US dollars to different investors (see Keller (2021) for an analysis of Peruvian banks).

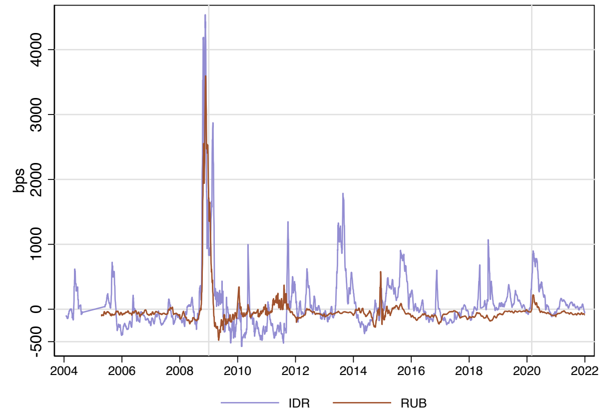
It is also visible in Figure 1 that countries with NDF have larger CIP deviation than countries with deliverable forwards. FX market segmentation could play a role, as the existence and size of offshore NDF markets is also a function of capital restrictions on foreign participation in domestic FX markets and the offshore deliverability of the domestic EM (McCauley and Shu, 2016). The growing appetite of global investors for EM assets has been one important driver in offshore FX trading in recent years, led by the robust growth in NDF trading (Patel and Xia, 2019).

Table 1, panels (a) and (b) show the differences between the offshore and onshore CIP deviations for two groups of countries in our sample. In the first group, we show 8

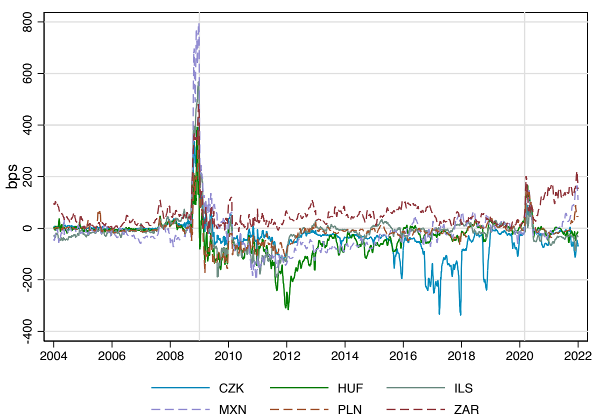
Figure 1: Benchmark offshore 3-month CIP deviations



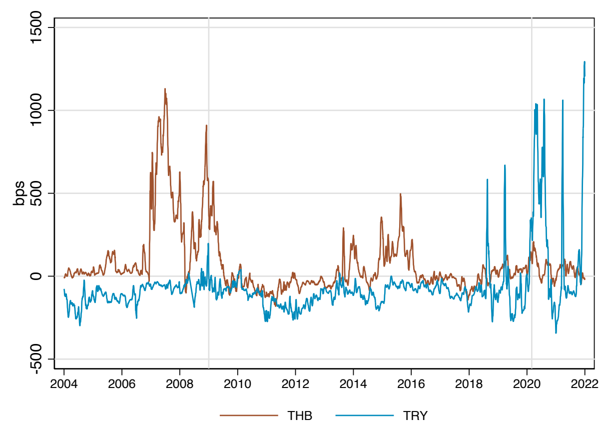
(a1) Non-deliverable forwards



(a2) Non-deliverable forwards



(b1) Deliverable forwards



(b2) Deliverable forwards

Note: Gray vertical lines correspond to Jan 2009 and Mar 2020. 10-day moving averages expressed in basis points, 2004-2021. The benchmark 3-month CIP deviations are offshore quotes or quotes on non-deliverable forwards. Sources: Bloomberg, Refinitiv, authors' calculation.

currencies in our sample with a wide difference between offshore and onshore CIP calculations. All but Thailand correspond to jurisdictions with NDF. Thailand, which does not have a NDF market due to the presence of an offshore deliverable forward market, has been imposing limitations on non-residents engagement with onshore financial institutions to manage currency risks related to the Thai Baht (e.g., requirement of providing proof of underlying for each transaction; end of the day outstanding position limit for non-residents).[15] Malaysian authorities took a different approach and they tightened restrictions in 2016 by effectively banning offshore trading of NDFs by domestic enti-

[15]Some of these limitations on non-residents were relaxed in January 2021 according to the 2022 AREAER.

ties.[16] This resulted in a fall of 48 percent in offshore trading (see Patel and Xia (2019); Schmittmann and Chua (2020) for more details).

Panel (b) instead highlights EMs for which offshore and onshore CIP deviations are similar despite the fact of the existence of NDFs in all four countries. Korea had the largest NDF market among EMs in the 2019 BIS triennial survey (close to USD 60 billion in daily average turnover). Despite a generally open capital account, Korea maintains limits on non-resident domestic currency borrowings from domestic banks and registration requirements for non-resident portfolio investors. Nonetheless, Korean residents can freely participate in the NDF market, and their arbitrage activities ensure close integration between offshore and onshore FX forward markets.

Finally, panel (c) displays the remaining 8 EMs in our sample. Their currencies are mostly convertible currencies (including through deliverable forwards), so there are no significant differences between offshore and onshore calculations. We instead present the difference between the basis computed using A2/P2 commercial paper rate or the US dollar Libor rate (IBOR) in the USD leg. CIP deviations using commercial paper rates are generally larger than IBOR calculated ones, due to the embedded credit risk in the dollar CP rate.[17]

3.2 Cross-sectional correlations with macro-financial variables

We follow existing literature (see, for example, Avdjiev, Du, Koch and Shin (2019)) to investigate cross-sectional relationships between the bases and key macro-financial variables, and we find sharp differences between EMs and AEs as shown in Figure 2. There is a strong positive correlation (about 0.72) between AEs' CIP deviations and the level of interest rates in the cross-section. Australia and New Zealand, in particular, have high-rate currencies and positive CIP deviations, indicating that direct USD dollar borrowing is more expensive than synthetic dollar interest in the FX forward market. As highlighted in the literature (see Du and Schreger (2022) for a summary), the high yield in those two countries prompts investors in low-interest AE countries to take a long position in Australian/New Zealand dollars, generating USD dollar funding and hedging demand that translate into positive CIP deviations.

There is also a strong correlation (in this case negative, about -0.6) between AE's CIP

[16] The requirement not to engage in the NDF market was already present before 2016 but it was not strictly enforced.

[17] The magnitude of *ex-ante* deviations from uncovered interest rate parity (UIP) (based on exchange rate expectations from survey data) are typically larger than CIP deviations in emerging markets. However, for most currencies, the correlations between CIP and UIP deviations are often very small (Kalemli-Özcan and Varela, 2021).

Table 1: Average CIP deviations by currency (bps)

Panel (a): Currencies with wide offshore/onshore forward differential: dollar-CP bases

	Offshore forward			Onshore forward		
	02-07 mean/sd	08-09 mean/sd	10-21 mean/sd	02-07 mean/sd	08-09 mean/sd	10-21 mean/sd
BRL	-261.18	48.65	-122.20	-313.83	-77.50	-139.28
	(542.58)	(293.88)	(102.95)	(1047.24)	(103.25)	(104.87)
CNY	-329.56	-202.18	-61.84	-154.40	-157.29	-127.51
	(211.00)	(685.55)	(269.09)	(205.45)	(418.48)	(180.77)
IDR	-85.12	546.05	83.47	-49.32	140.87	-16.92
	(205.09)	(1298.53)	(336.09)	(102.23)	(242.22)	(99.82)
INR	29.96	192.54	-3.36	-32.03	-19.92	16.58
	(135.85)	(630.61)	(160.19)	(146.55)	(250.39)	(91.04)
MYR	-55.11	66.45	-68.76	-18.31	23.27	-39.09
	(76.40)	(264.97)	(98.45)	(19.22)	(96.83)	(33.75)
PHP	33.63	345.16	48.59	5.49	37.42	17.23
	(151.27)	(548.80)	(144.27)	(22.79)	(72.88)	(22.38)
THB	153.66	245.01	14.62	12.07	60.59	-17.97
	(260.51)	(235.84)	(93.25)	(17.72)	(109.04)	(30.85)
TWD	35.32	-123.52	-167.52	-3.28	13.26	-68.80
	(88.67)	(348.94)	(177.30)	(12.58)	(109.03)	(45.09)

Panel (b): Non-deliverable currencies with comparable offshore/onshore CIP deviations

	Offshore forward (NDF) mean/sd	Onshore forward mean/sd
CLP (9/15/2017-12/31/2021)	-6.92	-8.39
	(44.31)	(60.32)
COP (11/29/2018-12/31/2021)	4.99	3.19
	(49.37)	(46.26)
KRW (8/16/2004-12/31/2021)	-52.36	-53.10
	(77.11)	(79.40)
PEN (9/30/2002-12/31/2021)	-56.18	.
	(183.28)	(.)

Note: Table 1 reports average 3-month CIP deviations by currency. The CIP deviations are defined according to Equation (1), using USD A2/P2 commercial paper rate as the dollar interest rate, so that a negative CIP deviation correspond to a lower direct dollar interest rate relative to the synthetic dollar interest rate. Panel (a) reports summary statistics for 8 currencies with substantial data coverage on both onshore and offshore forward exchange rates whose CIP deviations differ widely according to the type of forward exchange rate used. Panel (b) reports non-deliverable currencies whose offshore/onshore CIP deviations are close in levels with the data available. PEN, whose data on onshore forward exchange rate is not available, is also reported in Panel (b). Standard deviations are reported in parentheses.

deviations and their net international investment position (excluding reserves). In the case of net creditors countries (e.g., Japan and Norway, countries with high domestic savings and relatively low interest rates), they will have more negative cross-currency

Table 1: Average 3-month CIP deviations by currency and time period (bps, cont'd)

Panel (c): Currencies with data on deliverable forward, by types of dollar interest rates

	Dollar rate: A2/P2 CP			Dollar rate: IBOR		
	02-07 mean/sd	08-09 mean/sd	10-21 mean/sd	02-07 mean/sd	08-09 mean/sd	10-21 mean/sd
CZK	8.36	53.11	-57.61	-1.10	-38.28	-74.39
	(15.12)	(108.89)	(62.96)	(9.53)	(35.80)	(57.67)
HUF	1.18	4.23	-48.25	-7.74	-91.06	-67.18
	(24.93)	(136.49)	(65.48)	(22.35)	(101.53)	(61.09)
ILS	-11.03	85.36	-22.80	-20.75	-21.59	-43.11
	(21.58)	(168.66)	(43.39)	(17.88)	(70.44)	(42.78)
MXN	-10.07	141.07	-31.06	-19.47	36.76	-50.48
	(32.22)	(246.14)	(58.98)	(28.57)	(121.60)	(55.90)
PLN	4.04	5.66	-14.70	-5.39	-93.11	-35.53
	(17.80)	(115.13)	(36.18)	(13.30)	(62.40)	(33.23)
RUB	-57.70	303.41	-57.44	-62.14	132.50	-73.20
	(33.56)	(1001.67)	(90.27)	(33.17)	(814.97)	(87.78)
TRY	-168.51	-56.43	-54.94	-174.80	-136.87	-75.42
	(138.58)	(63.42)	(235.15)	(141.71)	(91.09)	(224.41)
ZAR	38.38	96.17	55.17	29.22	6.16	36.60
	(30.67)	(122.03)	(41.92)	(25.05)	(31.49)	(42.64)

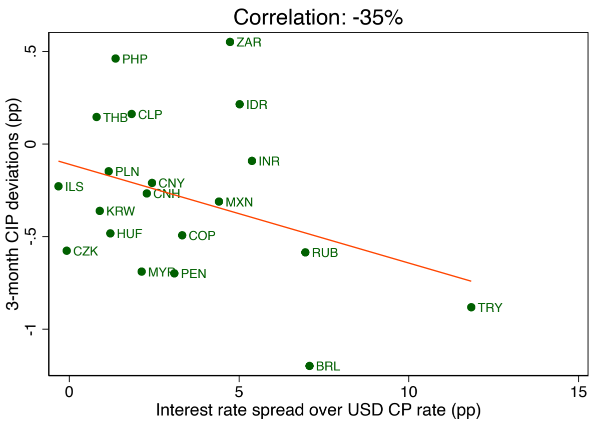
Note: Table 1 reports average 3-month CIP deviations by currency. The CIP deviations are defined according to Equation (1), so that a negative CIP deviation correspond to a lower direct dollar interest rate relative to the synthetic dollar interest rate. Panel (c) reports the summary statistics for currencies with data on offshore forward exchange rates only. The first three columns use A2/P2 commercial paper rate as the proxy for direct USD interest rate. The last three columns use dollar Libor rate. For currencies with an asterisk, we compute CIP deviations using offshore non-deliverable forward exchange rates. Other currencies have deliverable FX forwards. Standard deviations are reported in parentheses.

basis and face a higher premium to borrow and hedge US dollars in the FX forward market. This negative correlation is also consistent with Liao and Zhang's (2020) hedging demand channel that links the cross-country pattern of CIP deviations to net USD dollar asset holdings.

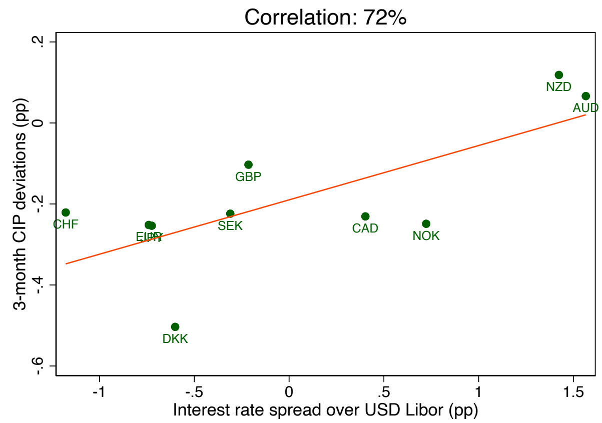
On the other hand, not only is the level of the correlations much smaller (about 0.35 and 0.30 for the level of the interest rate and the NIIP position, respectively), but also the sign in both cases is different in the case of EMs' CIP deviations. In addition to large heterogeneity across EMs due to the frequent segmentation of the offshore and the onshore FX markets, the cross-sectional relationship for EM currencies may reflect the fact that our sample of EMs includes only net debtor countries and countries with positive interest spreads over US rates, thus rendering the heterogeneity among currencies less stark than that in the G10 currency group.[18]

[18]In this set of figures, we drop TWD as an outlier. TWD's CIP deviations behave in a similar way to G10 currencies. See Figure B5 for scatterplots where we put TWD back. We also provide a version of the

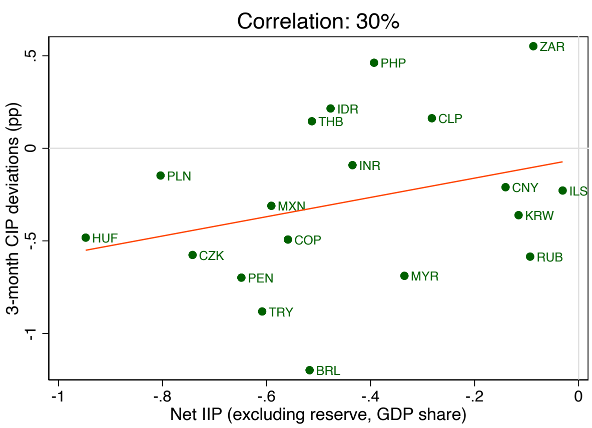
Figure 2: CIP deviations and macro correlates across countries (2010-2021)



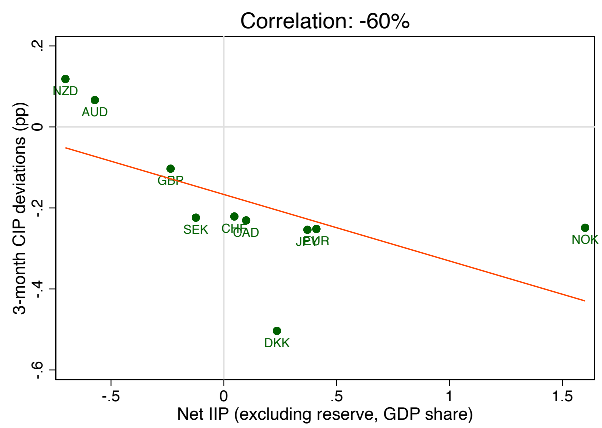
(a1) Interest rate differential: EM



(a2) Interest rate differential: AE



(b1) Net IIP (minus reserves) to GDP ratio: EM



(b1) Net IIP (minus reserves) to GDP ratio: AE

Note: Figure 2 plots time-series averages of benchmark 3-month CIP deviations against key macro-financial aggregates of emerging markets and advanced economies. The benchmark 3-month CIP deviations are offshore quotes or quotes on non-deliverable forwards. Interest rate spread for emerging market currencies is calculated by taking the difference between 3-month money market rate and 3-month US A2/P2 commercial paper rate. For advanced economies, dollar interest rate is Libor rate. Net international investment position (IIP) are annual observations from the Milesi-Ferretti and Lane (2017) dataset, updated to 2021 (link: `https://www.brookings.edu/research/the-external-wealth-of-nations-database/`). We subtract reserves from the aggregate international investment position for each country. Sample period: 2010-2021. The outlier TWD is dropped (see Appendix Figure B5) The daily CIP deviations are winsorized at 1% and 99% before being aggregated for the graphs.

3.3 Period-end dynamics reflecting binding regulatory constraints

CIP deviations of G10 currencies are closely related to regulation-driven financial constraints imposed on global banks. Du, Tepper and Verdelhan (2018) suggest that spikes of CIP deviations near regulatory reporting dates can be interpreted as clear evidence on the role of regulatory constraints on currency arbitrageurs' balance sheets, as window-

scatterplots in Figure B6 using countries with integrated offshore and onshore currency markets, to be defined in Section 4. The correlations are very similar to those generated from the full sample.

dressing activities temporarily reduces the intermediation capacity of banks. Figure 3 plots the evolution of the benchmark 1-month CIP deviations at quarter ends. While the impacts are larger during the last quarter of the year, there is also movement during other quarter-ends, especially in the case of Eastern European EM currencies (CZK, HUF, PLN, RUB) with a relatively more globally-integrated FX markets. European banks subject to quarter-end reporting regulation tend to have a large role in Eastern Europe given their universal business model, which includes European broker-dealers as part of the European banking group (Cerutti, Claessens and Ratnovski, 2017).

Regulatory constraint on the liquidity of the money market becomes much more binding as we approach important report dates for regulatory calculations. As highlighted by Cerutti, Obstfeld and Zhou (2021), the capital surcharge for globally systemically important banks (G-SIBs), introduced on January 1, 2016, has a notably strong effect in driving three-month benchmark CIP deviations in the fourth quarter, when U.S. and euro area regulators evaluate G-SIB balance sheets. Our event-study methodology – which follows the one for AEs in Cerutti, Obstfeld and Zhou (2021) – gives an idea of the marginal impact of the regulations at times when the regulatory constraints are more binding. Figure 4 shows the estimated coefficients when we regress daily 3-month offshore / NDF CIP deviations on a set of dummies indicating the dates before and after the day when 3-month forward contracts begin to settle at the start of next year (these contracts are usually priced at end-September each year).[19] Before the G-SIB regulation went into place, the 3-month bases for EME European currencies, AE currencies and other deliverable EM currencies experienced little to no action during these dates. For non-Eastern European EM NDFs, estimated coefficients before year-end dates are large yet statistically insignificant (panel (c)). After 2016, however, we observe a downward jump of the AE basis by 13 basis points on average (panel (b)). In panel (a), we find that the average response of CIP deviations (23 bps) is stronger in the case of Eastern European currencies, nearly twice the amount of G10 currencies. Little to no action is observed for other EM currencies. It follows that the regulatory constraints facing global FX dealers are especially binding for emerging markets (particularly for curren-

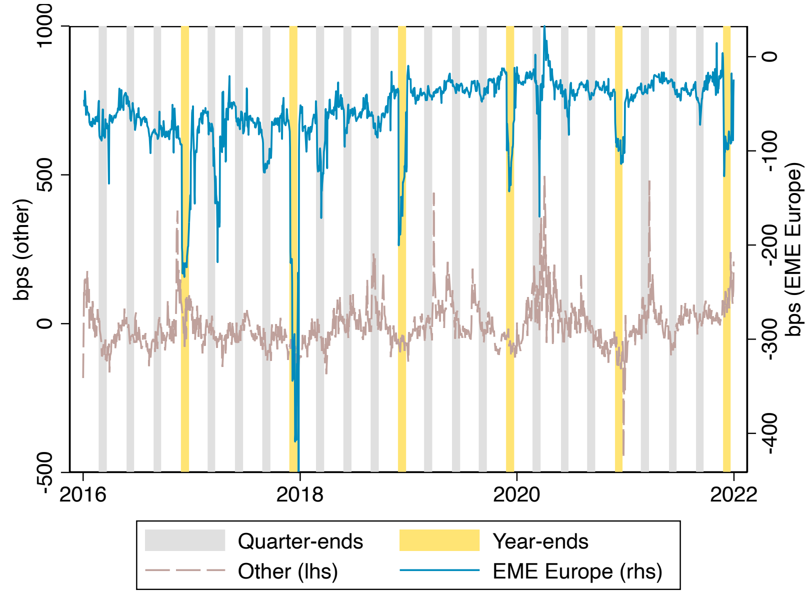
[19]The regression specification is

$$x_{i,t} = \sum_{s=-10}^{s=10} D_{i,t+s}\beta_s + \alpha_i + \varepsilon_{i,t}$$

where $x_{i,t}$ denotes daily CIP deviations, and $D_{i,t-s}$ is a dummy variable indicating whether date $t-s$ is the first day that a 3-month forward contract settles in the next calendar year. These regressions also include currency fixed effects. In Figure 4, we report 95% confidence intervals based on heteroskedasticity-robust standard errors as the number of clusters to compute clustered standard errors is very small.

cies observing large intermediation activities by European banks), with arbitrage capital retreating from EM markets by more than their AE counterparts.

Figure 3: Quarter-end dynamics for 1-month CIP deviations

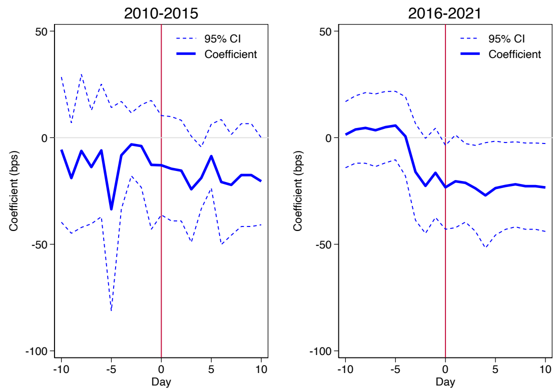


Note: Figure 3 plots average 1-month offshore / NDF CIP deviations from 2016 to 2022 for two distinct currency groups. The blue solid line (rhs) plots average basis for EME European currencies (CZK, HUF, PLN, RUB). The red dashed line (lhs) plots averages over all other EM currencies.

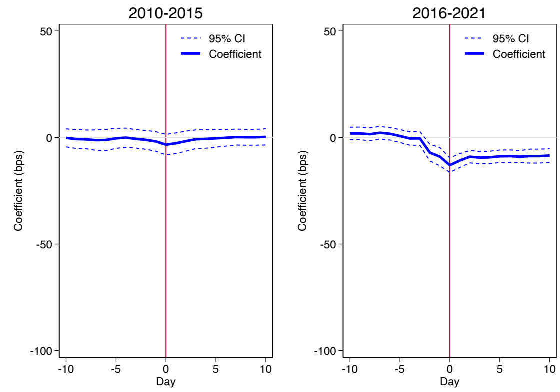
4 Global factors and CIP deviations: onshore and offshore disconnect

Away from regulatory reporting dates, as demonstrated in the literature on G10 CIP deviations (Avdjiev, Du, Koch and Shin, 2019; Augustin, Chernov, Schmid and Song, 2020; Liao and Zhang, 2020; Cerutti, Obstfeld and Zhou, 2021), the sensitivity of CIP deviations to global factors may capture variations in the risk-taking capacity of global financial intermediaries. In this section, we set out to investigate this relationship in the context of EM currencies, while making an important distinction between offshore and onshore bases. We attribute the potential heterogeneous responses to FX market segmentation and costly financial intermediation, as in Du (2019) and Liao and Zhang (2020). Through panel regressions, we find that offshore CIP deviations respond positively to a decline in the balance sheet capacity of key EM currency dealers, while onshore CIP deviations have little response, sometimes even to the opposite direction, suggesting a

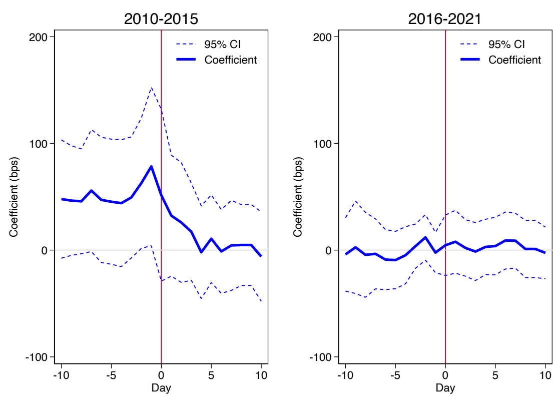
Figure 4: Year-end dynamics of 3-month basis, by groups of currencies



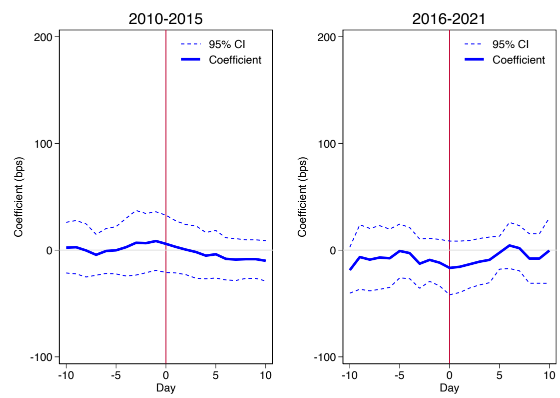
(a) EME European currencies



(b) AE currencies



(c) Other EM currencies: non-deliverable



(d) Other EM currencies: deliverable

Note: Figure 4 plots reports event-study coefficients on the panel of G10 three-month Libor bases against the U.S. dollar. The offshore/NDF CIP deviations are projected on a set of dummy variables indicating days around the start and end of the time window in which a three-month forward's settlement date is of a different year than its maturity date. Day 0 typically refers to two days before the end of September. The left-hand-side plot of each panel plots the coefficients estimated over the 2010-2015 sample, when G-SIB regulation were not in place. The right-hand-side plot reports the corresponding coefficients after regulations were enacted from 2016 to 2021. The EME European currencies we consider are CZK, HUF, RUB, PLN (Panel (a)). The advanced economy currencies (Panel (b)) are G10 currencies. Panel (c) and panel (d) look at other EM currencies (non-deliverable and deliverable, respectively). We report 95% confidence interval based on heteroskedasticity-robust standard error (due to a small number of clusters)

significant disconnect. Consistent with a limited risk-bearing capacity explanation, we further show that the response of CIP deviations to global factors is mostly driven by offshore non-deliverable forward. In a final step, echoing our discussion in Section 2, we also use our regression framework to investigate the role of a number of domestic factors, including country default risk and FX interventions, in driving CIP deviations in emerging markets.

4.1 Theoretical underpinnings and hypotheses: Basis sensitivity, costly financial intermediation, and segmented markets

Consider the costly intermediation model of Liao and Zhang (2020). In the theory, net creditors with a positive external investment position (such as institutions in non-U.S. advanced economies such as Japan) hedge their currency position from investing in dollar-denominated assets by selling dollar forward. In times of financial stress, swap dealers with a limited risk-bearing capacity require a lower price of the forward dollar to absorb the demand pressure in supplying local currency forward. This leads to the local currency being overvalued in the forward market relative to the spot market, after adjusting for interest rate differentials – a more negative CIP deviations (see (2)). The logic is similar for countries with a negative external position.

In the context of emerging market economies, typically an international net debtor when we exclude reserve accumulation, the international investor introduced in Section 2 funds herself in dollars, converts the dollar to local currency to purchases local currency assets and demands currency hedges from FX swap dealers located offshore. Consider a shock that dampens the intermediation capacity of FX swap dealers, who supply dollar forward to the investor. The shock could be due to a rise in global risk aversion or changes in global financial conditions, such as a broad appreciation of the US dollar that raises the tail risk facing global banks with FX dealer arms due to borrowers' currency mismatch (Bruno and Shin, 2014, 2015). While the spot exchange rate appreciates due to usual risk-on/risk-off reasons, the price of the dollar in the forward market may rise by even more, as FX swap dealers would require a higher spread (i.e., more expensive forward dollar) to be willing to supply liquidity to satisfy investors' hedging demand. Meanwhile, hedging demand may also respond to global risk-off shocks, as previously unhedged carry traders exploiting pure UIP deviation may decide to protect the downside and eliminate some exchange rate uncertainty by demanding dollar forward. Both forces lead to an overreaction of local currency depreciation in the forward market relative to that in the spot market. Using the notation of (2), a larger $f - s$ leads to a *positive* change in offshore CIP deviations, holding the interest rate unchanged.

With perfect arbitrage in the spot and forward market, pressures in the offshore market would transmit unabated to the onshore market, resulting in the same response of onshore CIP deviations to global risk aversion shocks. However, for a number of EM currencies, significant limits to arbitrage exist, with numerous restrictions imposed on domestic FX intermediation, as Sections 2 and 3 document. Derivative markets are especially subject to position limits and participation constraints, which effectively segment the markets for FX swaps (Jung and Jung, 2022). onshore FX dealers, usually domestic banks, are less directly affected by global risk-off shocks, thus reducing intermediation capacity by less. Agents with access to both markets, constrained by regulation, may not be able to fully arbitrage away the offshore-onshore differentials. Instead of overreacting and depreciating by a larger amount, the forward local currency in the onshore market may *underreact* relative to its response in the spot market. Per (2), the onshore basis would be less sensitive to global financial shocks. A *negative* response of the onshore basis would also be possible. Our first hypothesis to be tested empirically can be stated as follows:

Hypothesis 1. *The sensitivity of CIP deviations computed using onshore forward exchange rates to global factors is smaller than their counterparts computed using offshore forward exchange rates.*

In the data, significant wedges between onshore and offshore CIP deviations exist. For a group of eight currencies whose wedge is considerably large (BRL, CNY, IDR, INR, MYR, PHP, THB, TWD), Figure 5 plots the evolution of offshore minus onshore CIP deviations. During normal times, the spread fluctuates around zero. In times of economic stress, the spread becomes positive, driven by an over-depreciation of local currency in the offshore forward market relative to the onshore market, in line with the theory.[20] Figure 6 zooms in on two recent global risk-off episodes, the Taper Tantrum of 2013 (Panel (a)) and the onset of the COVID-19 pandemic in early 2020 (Panel (b)). In these episodes, the difference amounts to 300-400 basis points.

Guided by the theory on the financial determinants of exchange rate (Gabaix and Maggiori, 2015; Liao and Zhang, 2020, among others), we also expect that the difference in the sensitivity of *offshore* CIP deviations to global factors depends on the degree of segmentation in the forward market. International banks are often the dominant counterparties for non-deliverable FX forward through its market-making role (Lipscomb, 2005). In recent periods, they have faced increasing hedging demand from international mutual funds' investment in local-currency bond markets.[21] On the other hand, both onshore and offshore participants could share risk for currencies with an integrated forward market. This results in a steeper supply curve for hedging services for currencies

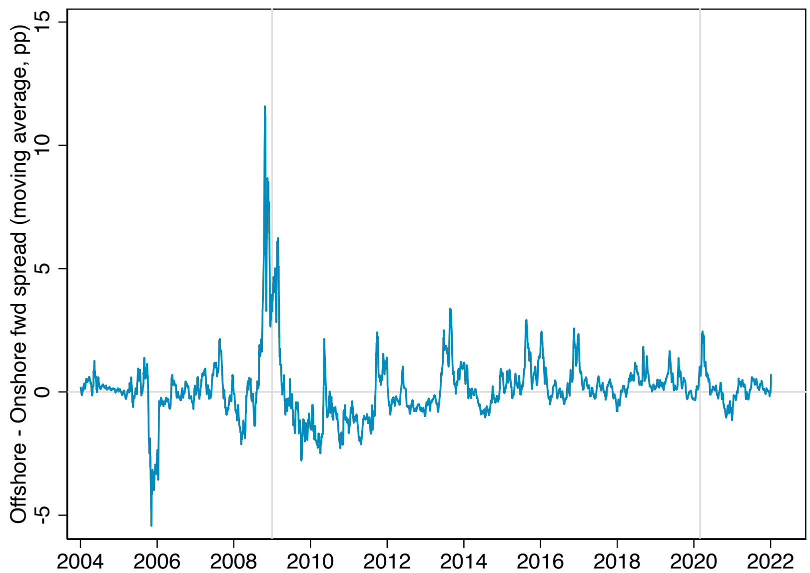
[20] Note that we use the same interest rate and spot exchange rate throughout to compute offshore and onshore CIP deviations for each currency.

[21] The increase in overall trading of emerging market currencies is largely driven by a shift in hedging demand from bank and insurance companies to international asset managers (Caballero, Maurin, Wooldridge and Xia, 2022). For capital inflows to emerging markets after countries' inclusion in international equity and bond indices, see Raddatz, Schmukler and Williams (2017). For international mutual funds' currency hedging practices, see Sialm and Zhu (2021).

with segmented markets, effectively amplifying the response of offshore CIP deviations for these currencies when global risk-aversion tightens.[22]

Hypothesis 2. *The sensitivity of offshore CIP deviations to global risk factors for currencies with segmented FX markets is stronger compared to their counterparts with integrated FX markets.*

Figure 5: Offshore-onshore CIP deviation spread (pp)



Note: Average offshore minus onshore 3-month CIP deviations for BRL, CNY, IDR, INR, MYR, PHP, THB and TWD. Gray vertical lines refer to the Great Financial Crisis and the COVID-19 crisis.

4.2 Empirical strategy

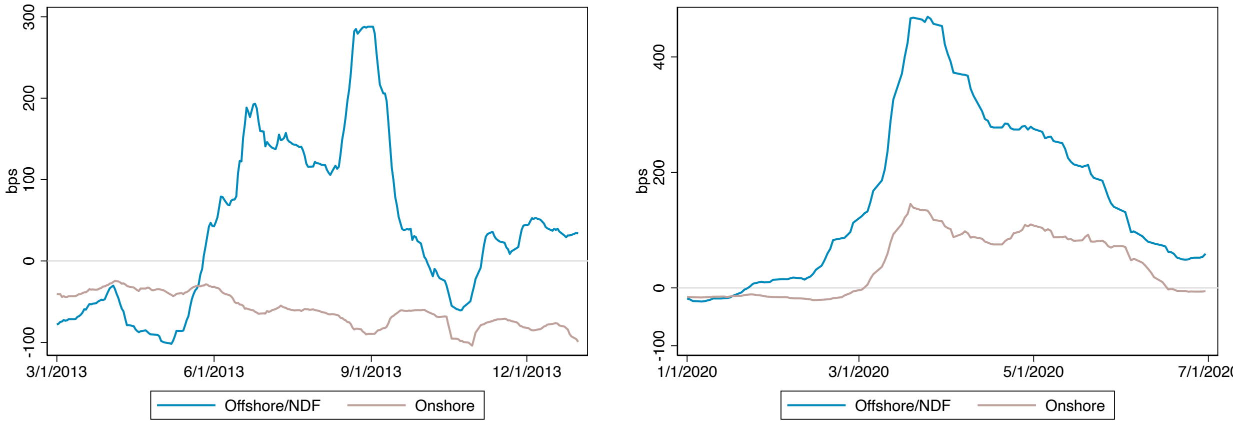
Our baseline specification to test the above hypotheses is given by the following monthly regression:

$$\Delta x_{i,t} = \alpha_i + \Delta \mathbf{F}_t \boldsymbol{\beta} + \Delta \mathbf{Z}_{i,t} \gamma + \varepsilon_{i,t} \tag{5}$$

where i denotes a currency, $\mathbf{F}_t$ is a vector of global factors, and $\mathbf{Z}_{i,t}$ captures currency-specific determinants. The currency fixed effect α_i absorbs time-invariant unobserved factors driving CIP deviations. The first-difference specification is used to filter out

[22]Krogstrup and Tille (2018) attributes the heterogeneous sensitivity of foreign currency capital flows to global risk factors to intermediaries' ex-ante currency exposure.

Figure 6: Average CIP deviations during global risk-off episodes: Currencies with segmented FX forward markets



(a) Taper Tantrum

(b) COVID-19

Note: Average offshore and onshore 3-month CIP deviations for BRL, CNY, IDR, INR, MYR, PHP, THB and TWD. Individual series are first smoothed using 10-day moving averages before taken cross-sectional averages.

potential unit roots. We also check if the sensitivity to global factors differs across currencies, by running time-series regressions currency by currency:

$$\Delta x_{i,t} = \alpha_i + \Delta \mathbf{F}_t \boldsymbol{\beta}_i + \Delta \mathbf{Z}_{i,t} \gamma_i + \varepsilon_{i,t} \tag{6}$$

We discuss the choice of variables in our baseline specification in more detail. Detailed descriptions of regressors and summary statistics are reported in Appendix Table B2. Guided by the theory of costly financial intermediation, we compute the largest emerging market currency dealer banks' leverage ratios and construct an aggregate dealer leverage factor, in the spirit of He, Kelly and Manela (2017).[23] Euromoney's annual FX survey has been reporting the market share of FX dealer banks for EM currencies since 2015. For all dealer banks appearing with top-ten market shares in at least one wave of survey, we obtain their key financial indicators from Bloomberg and compute the intermediary leverage ratio, as the inverse of capital ratio defined as

$$ICR_{j,t} = \frac{\text{Market equity}_{j,t}}{\text{Market equity}_{j,t} + \text{Book debt}_{j,t}}$$

[23] Huang, Ranaldo, Schrimpf and Somogyi (2022) study the role of constrained dealers in supplying liquidity in the FX market by considering a similar dealer leverage measure. The He, Kelly and Manela (2017) primary dealer leverage ratio measure is a powerful predictor of CIP deviations for advanced economy currencies (Augustin, Chernov, Schmid and Song, 2020; Cerutti, Obstfeld and Zhou, 2021).

where book debt is computed by subtracting total common equity from total assets. A high intermediary leverage ratio, in particular, corresponds to a low intermediary capital ratio, so that the dealer leverage is countercyclical. The bank-specific ratio is aggregated using equal weights. An increase in the dealer leverage factor captures declining risk-bearing capacities of the largest EM currency dealers. We provide the list of dealer banks in Appendix Table A2.[24]

Among other currency-specific correlates, following Cerutti, Obstfeld and Zhou (2021) and Krohn and Sushko (2022), we also use normalized bid-ask spread of FX forwards to gauge the impact of market liquidity on the basis. The forward market liquidity measure is defined as

$$10000 \times \frac{F_t^{ask} - F_t^{bid}}{F_t^{mid}}$$

where F denotes the level of the forward exchange rate, and $F_t^{mid} = (F_t^{ask} + F_t^{bid})/2$ is the mid-price. We also include 3-month nominal money market interest rate differential to account for hedging demand imbalances induced by shifts in the funding cost and relative attractiveness of investment in EM currencies versus the USD.[25]

We also consider other global factors. Avdjiev, Du, Koch and Shin (2019), among others, demonstrate the close comovement between the broad dollar index and CIP deviations for advanced economy (G10) currencies. Cerutti, Obstfeld and Zhou (2021) further show that a single principal component of nominal effective exchange rates of safe-haven currencies (USD, JPY, CHF) are powerful correlates of G10 CIP deviations. An increase in the common factor (appreciation of the safe haven currency) leads to a widening of the basis, suggesting that global risk aversion may be the underlying drivers of both the dollar and the basis. We therefore also include the safe-haven currency common factor, as well as the residuals from projecting the broad dollar onto the common factor, to understand if flight to safety aggravates the balance sheet constraints and captures additional dimensions of EM CIP deviation dynamics Appendix Figure B8 plots the evolution of the common factor and the residual. Finally, in a series of robustness

[24] The survey results can be accessed at https://www.euromoney.com/surveys/foreign-exchange-survey. The use of top-ten dealers in each survey is without loss of generality, as the offshore FX market is significantly concentrated. According to the 2022 Euromoney FX survey, the top 20 FX dealer banks of EM currencies account for nearly 90% of the total market. Appendix Figure B8 shows that our dealer leverage measure strongly comoves with He, Kelly and Manela (2017) primary dealer leverage ratio.

[25] See the discussion in Cerutti, Obstfeld and Zhou (2021). The inclusion of nominal interest rate differentials in the regressions is also justified by the fact that, if $x_{t,t+n} \neq 0$, a regression of forward premium $(f - s)$ onto the interest rate differential yields a coefficient generally not equal to 1. Subtracting from both sides of the equation leads to a mechanical relationship between the basis and the interest rate differentials.

checks we corroborate our findings by using the *broad dollar index* as our measure of intermediaries' risk-bearing capacity (Avdjiev, Du, Koch and Shin, 2019). The intuition of using this index as a proxy follows from Bruno and Shin (2014), that a broad appreciation of US dollar raises the tail risk of global intermediaries' portfolio due to currency mismatches facing local borrowers.

To prevent the dynamics of regulatory report dates from affecting our results, we conduct our regression exercise using monthly averages of financial variables. We winsorize the CIP deviations and FX liquidity measure at 1% and 99% tails to alleviate the concern for outliers. We report two-way clustered standard errors by time and currency.[26]

We end this section with a number of remarks on our empirical strategy. First, the FX dealer leverage ratio is only modestly correlated with shifts in global uncertainty proxied by VIX (with a correlation coefficient of 0.45 from 2010 to 2021). Other global factors, such as safe-haven currencies' principal component, are distinct from the usual measures of global uncertainty.[27] Second, Figure B8 demonstrates that our FX dealer leverage ratio does not spike during quarter-ends or year-ends, even if European global banks are included in our calculations (see Table A2). Fluctuations of the leverage ratio do not reflect the strength of regulatory constraints, but instead captures the overall soundness of the FX dealer sector, consistent with the intermediary asset pricing framework of He and Krishnamurthy (2013); He, Kelly and Manela (2017), and the risk-taking channel of exchange rate determination (Bruno and Shin, 2014, 2015).

4.3 Regression results

4.3.1 Evidence from panel regressions

Table 2 reports our key findings. Panel (a) focuses on our baseline measure of intermediary leverage as the global factor. Across sample periods and onshore / offshore basis, a rise in the U.S. interest rate relative to the EM country leads to an increase in the basis. The forward-market bid-ask spread is associated with positive coefficients throughout the specifications. Interpreted through the lens of costly financial intermediation, these positive coefficients capture the effect of financial tightening – a relative increase in the U.S. interest rate enlarges the opportunity costs of swap dealers to engage in intermediation activities, while an increase in the bid-ask spread reflects these players' reluctance to supply liquidity. For our key explanatory variable – FX dealer leverage ratio, columns

[26] In Table B6, we report results from the same specifications but generated using CIP deviations constructed with 3-month USD Libor rate.

[27] Our safe-haven common factor is only marginally correlated with VIX, with a correlation coefficient of 0.1.

(1) and (2) indicate a strong correlation between a tightening intermediary leverage constraint and a more positive offshore CIP deviations. A one percentage point increase in the leverage ratio corresponds to a 1.1 basis points increase in the offshore basis for the entire sample, and 0.9 basis points for the post-crisis sample.[28]

The sign of the correlation between CIP deviations and FX dealer leverage is consistent with the limited risk-bearing capacity theory we outlined. To understand this, we first compare our results with G-10 currencies. An important distinction is that while EMs are in general net debtors, most AEs are net creditors in their international investment positions. For G-10 currencies, a tightening of FX dealer and/or primary dealer leverage is associated with a *negative* response of CIP deviations (see Avdjiev, Du, Koch and Shin (2019); Cerutti, Obstfeld and Zhou (2021) and Appendix Table B4). During risk-off episodes, offshore CIP deviations tend to jump "up" for emerging market currencies, but spike "down" for advanced economy currencies. This stark difference is responsible for at least part of the larger volatility of EM CIP deviations than AE CIP deviations.

For further verification of our hypotheses, we focus on the post-2010 sample to take advantage of better data availability for all currencies. The effect of a reduced risk-bearing capacity of global intermediaries displays a strong pattern of disconnect between onshore and offshore bases. In line with our hypothesis 1, for currencies with significant segmented markets, columns (5) and (6) show that a one percentage point increase in the leverage ratio corresponds to a 1.35 basis point increase in the offshore basis, but only a 0.38 basis point (and a statistically insignificant) increase in the onshore basis. Table 2 also shows that the sensitivity of the bases to interest rate differentials and FX market liquidity also exhibits some degrees of disconnect.

To verify hypothesis 2, we compare columns (3) and (5). Column (3) suggests that for currencies with an integrated FX market, a one percentage point increase in the leverage ratio corresponds to 0.61 basis point increase in the offshore basis, statistically significant at the 5% level. In relative terms, the effect is more than 50 percent smaller than that for the segmented currency group. Column (4) reports estimates for offshore CIP deviations, excluding currencies with a large non-deliverable forward market (CLP, COP, PEN). The level and statistical significance of the coefficients are comparable to those in column (3).

Panel (b) of Table 2 reports panel regressions adding safe-haven common factor and residuals.[29] Although the leverage ratio and the common factor is closely correlated (with a correlation of 0.4 in their monthly differences), the inclusion of an additional

[28] In untabulated robustness exercise, we find that the significant correlation between dealer leverage and CIP deviations is not sensitive to excluding the sample after 2020 marked by the COVID-19 disruption.

[29] The coefficient for the common factor and the residuals does not have a straightforward interpretation, as principal components are invariant to a scaling factor.

Table 2: EM CIP deviations and global factors

Panel (a): Baseline panel regressions

VARIABLES	(1) 02-21 Δ offshore	(2) 10-21 Δ offshore	(3) Group I: integrated 10-21 Δ offshore	(4) Group I: no NDF 10-21 Δ offshore	(5) Group II: segmented 10-21 Δ offshore	(6) Group II: segmented 10-21 Δ onshore
$\Delta(r^{US} - r)$	0.231*	0.164**	0.098	0.093	0.350***	0.212**
	(0.122)	(0.072)	(0.081)	(0.088)	(0.095)	(0.078)
Δ log dealer leverage	1.076***	0.912***	0.610**	0.630**	1.348**	0.379
	(0.344)	(0.261)	(0.218)	(0.254)	(0.428)	(0.292)
Δ fwd bid-ask	0.872*	0.828**	0.442	0.451	1.631*	0.185
	(0.438)	(0.321)	(0.267)	(0.325)	(0.779)	(0.285)
Observations	4,128	2,706	1,637	1,110	1,069	1,087
R-squared	0.069	0.042	0.036	0.043	0.061	0.057
Country FE	✓	✓	✓	✓	✓	✓

Panel (b): Add safe haven dollar factor

VARIABLES	(1) 02-21 Δ offshore	(2) 10-21 Δ offshore	(3) Group I: integrated 10-21 Δ offshore	(4) Group I: no NDF 10-21 Δ offshore	(5) Group II: segmented 10-21 Δ offshore	(6) Group II: segmented 10-21 Δ onshore
$\Delta(r^{US} - r)$	0.211*	0.156**	0.096	0.093	0.317***	0.210**
	(0.113)	(0.065)	(0.080)	(0.088)	(0.050)	(0.076)
Δ log dealer leverage	0.654**	0.599**	0.491*	0.547*	0.734*	0.341
	(0.290)	(0.235)	(0.241)	(0.272)	(0.360)	(0.268)
Δ fwd bid-ask	0.786*	0.698**	0.392	0.390	1.368*	0.177
	(0.421)	(0.276)	(0.243)	(0.292)	(0.628)	(0.278)
safe haven common factor	71.086**	40.409*	17.656	12.608	78.277*	4.363
	(28.614)	(20.225)	(17.769)	(19.050)	(35.639)	(20.453)
safe haven residual	8.291***	10.710***	3.614	2.757	21.325**	1.398
	(2.819)	(3.257)	(2.599)	(2.645)	(6.199)	(2.366)
Observations	4,128	2,706	1,637	1,110	1,069	1,087
R-squared	0.093	0.070	0.044	0.048	0.121	0.059
Country FE	✓	✓	✓	✓	✓	✓

Note: Monthly regressions of first differences. The dependent variable is changes in the 3-month CIP deviations (offshore/NDF for columns (1)-(4) in both panels, and onshore for column (5)), based on USD A2/P2 commercial paper interest rate. The independent variables include changes in the (nominal) USD A2/P2 commercial paper rate–local nominal money market rate differential, log of aggregate EM currency FX dealer leverage ratio, and forward bid-ask spread normalized by mid price of forward exchange rate. In Panel (b), the safe haven common factor is the first principal component of nominal effective exchange rate of safe-haven currencies (USD, CHF, JPY), and the residual refers to estimated error term after projecting the dollar nominal effective exchange rate onto the common factor, following Cerutti, Obstfeld and Zhou (2021). Columns (1) and (2) report regression results for all currencies from 2002 to 2021 (column (1)) and from 2010 to 2021 (column (2)). In columns (3) to (6), we focus on the 2010-2021 subperiod, and divide the sample into two groups. Group I include currencies with little FX forward market segmentation across border, as well as non-deliverable currencies with a small offshore-onshore forward spread based on available data (CLP, COP, KRW, PEN, who are further dropped in column (4)). Group II refers to currencies with substantial FX forward market segmentation (BRL, CNY, IDR, INR, MYR, PHP, THB). The CIP deviations and forward market liquidity measure are winsorized at 1% and 99%. Two-way clustered standard errors by currency and time are reported. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

proxy for global risk aversion does not qualitatively affect the estimated relationship between leverage and the bases (as shown in columns (1) and (2)), as well as the disconnect between offshore and onshore bases. It should be noted, however, that the estimated coefficients shrink in size after adding the common factor and residuals. This reflects the fact that part of the correlation between leverage ratio and CIP deviations may be driven by the interaction between flight to safety and intermediaries' balance sheet constraint. Column (5) and (6) suggests that although the safe-haven factor and residuals are highly significant and positive in the case of offshore basis, onshore basis has statistically insignificant responses to both the appreciation of the safe-haven currencies and to shifts in the component orthogonal to the common factor capturing flight to safety. Finally, comparing columns (3), (4) and (5), it is clear that as in the case of FX dealer leverage, currencies with a segmented FX forward market have more sensitive CIP deviations to safe-haven currency movements compared to their integrated counterparts.

4.3.2 Currency-specific time-series regressions

Figure 7 corroborates the evidence on onshore / offshore disconnect, using time-series regressions (6) on individual currencies in the subgroup considered in column (5) and (6) of Table 2. Consistent with the results from panel regressions, offshore bases respond positively to both a tightening of leverage and an appreciation of the common component of safe-haven currencies. On the other hand, onshore basis are typically associated with zero-to-negative coefficients.

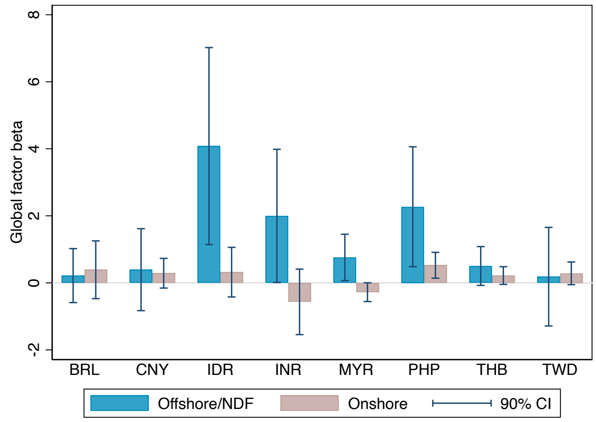
In Panel (c) of Figure 7, we report results from an exercise where we focus on the Chinese Renminbi. One advantage of studying the RMB is that we have data on both the onshore and offshore interest rates (Shibor and Hibor, respectively), with the offshore CNH market serving as an important hub for RMB trading internationally since 2014.[30] We are thus able to calculate CIP deviations for RMB in four different ways using onshore and offshore interest rates, and run horse-race time-series regressions to gauge the heterogeneous sensitivity to changes in intermediary leverage ratio. Consistent with our previous findings, since 2014, CIP deviations constructed with onshore CNY forward exchange rate and Shibor interest rate are the least sensitive, while the basis calculated using NDF and Hibor has the largest β. Our baseline measure, where the basis is measured using CNY NDF and Shibor, displays an intermediate level (albeit statistically insignificant) of sensitivity.

4.4 CIP deviations and country-specific correlates

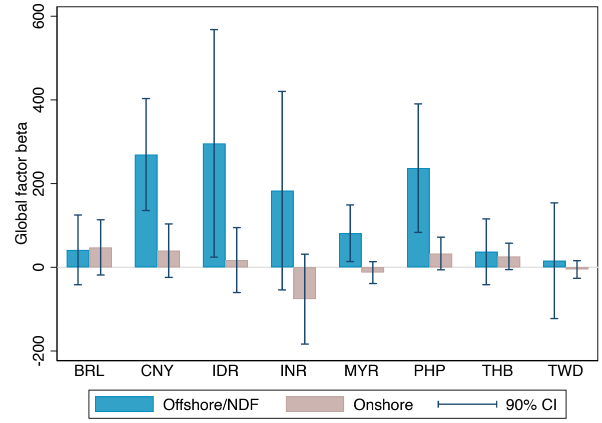
Country-specific factors could affect the dynamics of CIP deviations as well as our estimate of the global factors' importance. Although the issue of counterparty default in

[30] For details on the offshore-onshore Renminbi market and important differences of CNH from CNY, see Funke, Shu, Cheng and Eraslan (2015); Cheung, Grimm and Westermann (2021).

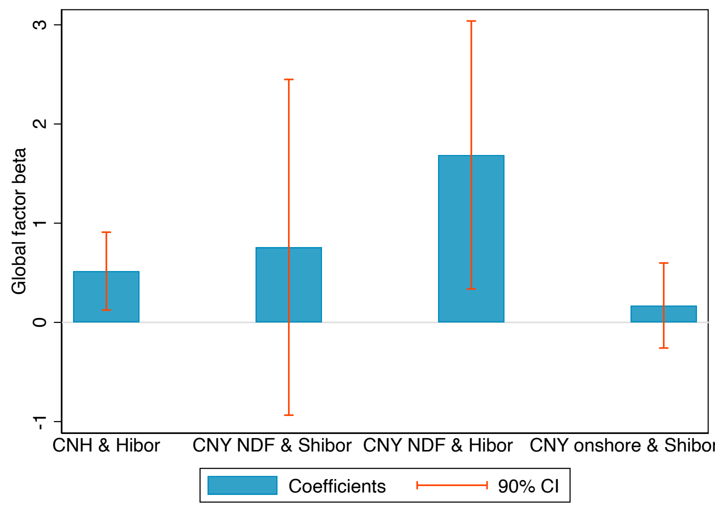
Figure 7: Global factor-β for currencies with forward-market segmentation



(a) Log FX dealer leverage (10–21)



(b) Safe-haven currency factor (10–21)



(c) RMB: Different definitions of CIP deviations, β to intermediary leverage (14–21)

Note: Time-series β of monthly change of onshore (red) and offshore/NDF (blue) 3-month CIP deviations on monthly change in log of aggregate EM currency FX dealer leverage ratio (Panel (a)) or safe-haven currency common factor (Panel (b), constructed following Cerutti, Obstfeld and Zhou (2021)), in a regression that also controls for interest rate differential and forward bid-ask spread. Error bands correspond to 90% confidence interval with Newey-West standard errors with 12 lags. In Panel (c), we focus on the Chinese RMB and investigate four versions of CIP deviations and their associated sensitivity to the dealer leverage factor. "CNH & Hibor" refers to the CIP deviations constructed using spot and forward offshore deliverable CNH exchange rate and offshore RMB interest rate (Hibor). "CNY NDF & Shibor" corresponds to our baseline measure for RMB, constructed using CNY NDF exchange rate and onshore interest rate (Shibor). "CNY NDF & Hibor" uses CNY NDF exchange rate and offshore Hibor interest rate. "CNY onshore & Shibor" uses onshore exchange rates and interest rate only. For comparison across four versions of CIP deviations, we further restrict the sample to 2014–2021. The CIP deviations are winsorized at 1% and 99%.

short-term CIP deviations is unlikely to be of significant concern, as we discuss in Section 2, sovereign default risk tends to co-move with currency risk and a surge in country risk could spill over to the currency market, both onshore and offshore. The absence of comovement between onshore CIP deviations and global factors may also reflect the role of EM central banks intervening in FX spot and forward markets or accumulating FX reserves to stabilize the spot exchange rate.

While the intuitive linkage between country-specific factors and CIP deviations may be clear, the signs of these correlations are unclear. To the extent that a rise in sovereign risk induces a flight to safety from EM by international investors and affects the forward premium through the unwinding of currency hedges, and FX interventions could have an impact on both the forward and the spot market, the relative movement between forward and spot exchange rate and thus the direction of deviations from CIP could be ambiguous. We thus take an agnostic approach and focus on whether the correlations are statistically significant, without taking a stand on the interpretation. For sovereign risk, we obtain 5-year USD sovereign credit default swap spread from Markit. As mentioned in Section 2, CDS spreads of EM sovereigns exhibit strong co-movement under the influence of a global factor. We extract the first principal component of the spread from the countries for which we have data, and include the residuals in our regressions. For the sizes of FX intervention, we use the monthly broad measure (as percentages of GDP) provided by Adler, Mano, Chang and Shao (2021), recording the accumulation of FX reserves as positive and the selling of foreign-currency reserves as a negative intervention. As FX intervention could arise endogenously as a response to market conditions, we include the measure lagged by a month into our regressions.

Table 3, Panel (a) reports the regression results on the role of sovereign default risk.[31] Consistent with the observation of Lipscomb (2005), we find weak evidence indicating that sovereign risk is a significant correlate of short-term CIP deviations. While, the 5-year CDS spread (residualized by the first principal component, as prescribed by Longstaff, Pan, Pedersen and Singleton (2011)) is significant at the 5% level for offshore CIP deviations after 2010, the statistical significance does not survive when we move to specific currency groups.[32]

In Panel (b), we also find relatively weak evidence supporting the linkage between CIP deviations and (lagged) FX intervention. For most sample cuts, the coefficient estimates are mostly positive. Intervention in the FX market by selling foreign currencies is associated with a more negative, yet insignificant CIP deviation. We observe more interesting correlations for the group of currencies with segmented forward markets. Consistent with the intuition that FX intervention is primarily carried out in onshore markets, a one percentage point increase in the size of foreign-currency asset purchase

[31] For robustness, we also produce a table with the same specification, but using CIP deviations constructed with 3-month USD Libor rate. See panel (b) of Table B6.

[32] In untabulated results, we find little association between CIP deviations and rating downgrades to sovereign bond by international rating agencies.

(as a fraction of GDP) is associated with a 3.6 basis point decline in onshore CIP deviations, potentially explained by the expectation of future reversal of intervention target (such as an exchange rate floor). For the same set of currencies, on the other hand, the correlation of offshore CIP deviations with FX intervention has the opposite sign (albeit insignificant at 10% level), suggesting potential barriers to policy transmission.

While we do not find systematic evidence in favor of a significant role of FX intervention, CIP deviations do widen during country-specific episodes of temporary currency pegs (see Amador, Bianchi, Bocola and Perri (2019) for a theoretical discussion). In Figure B7 of the Appendix, we show that the Czech National Bank, by accumulating FX reserves to maintain an exchange rate floor of the Czech Republic Kruna against the Euro from late 2013 to early 2017, induces a substantial widening of short-term CIP deviations. This is likely due to expectations of future de-peg, as forward Kruna is consistently more expensive than spot Kruna, inducing a negative forward premium.

4.5 Additional analyses and robustness

We examine the robustness of our findings in a number of ways and report the results in Appendix B:

- *Broad dollar index as the proxy for intermediary risk-bearing capacity:* Recent literature on the financial channel of exchange rate emphasizes the role of the broad dollar index as a proxy for the shadow price of bank leverage, in a similar spirit to our FX dealer leverage measure. Additionally, a strong dollar could increase the tail risk of global banks' credit portfolio, as borrowers may face currency mismatch and are thus exposed to exchange rate fluctuations (Bruno and Shin, 2014, 2015). Avdjiev, Du, Koch and Shin (2019) document a strong inverse relationship between broad dollar strength and G10 CIP deviations. We extend their analysis to emerging market economies while still distinguishing between offshore and onshore bases. Table B3 repeats our baseline panel regression (5), replacing the global factors with log changes in the broad dollar index. Figure B4 reports the counterpart from time-series regressions. The regression results are consistent with our two hypotheses, that offshore sensitivity to broad dollar appreciation is larger than that of onshore bases, and currencies with market segmentation demonstrate a stronger sensitivity compared to those with integrated currency markets.

- *Alternative tenor, currency group, interest rate benchmark:* We report in Table B5 that our results are robust to analyzing CIP deviations in a shorter horizon such as

Table 3: CIP deviations and EM-specific correlates

Panel (a): Country default risk: Residualized CDS spread

VARIABLES	(1) 02-21 Δ offshore	(2) 10-21 Δ offshore	(3) Group I: integrated 10-21 Δ offshore	(4) Group I: no NDF 10-21 Δ offshore	(5) Group II: segmented 10-21 Δ offshore	(6) Group II: segmented 10-21 Δ onshore
$\Delta(r^{US} - r)$	0.223*	0.186***	0.141	0.146	0.327***	0.192*
	(0.122)	(0.063)	(0.086)	(0.096)	(0.075)	(0.082)
Δ log dealer leverage	0.632*	0.593**	0.501*	0.525*	0.795	0.363
	(0.308)	(0.245)	(0.242)	(0.274)	(0.489)	(0.243)
Δ fwd bid-ask	0.844*	0.587**	0.291	0.290	1.272	0.196
	(0.439)	(0.254)	(0.180)	(0.209)	(0.659)	(0.266)
safe haven common factor	69.404**	37.994*	13.996	5.057	91.786*	14.722
	(29.286)	(20.012)	(16.956)	(17.507)	(41.191)	(17.821)
safe haven residual	7.551**	9.772***	3.730	2.875	21.955**	2.413
	(2.754)	(3.313)	(2.535)	(2.519)	(7.607)	(2.521)
Δ 5y residualized cds spread	0.179	0.482**	0.471	0.515	0.608	-0.065
	(0.113)	(0.221)	(0.299)	(0.351)	(0.589)	(0.159)
Observations	3,660	2,439	1,637	1,110	802	809
R-squared	0.098	0.076	0.064	0.082	0.132	0.077
Country FE	✓	✓	✓	✓	✓	✓

Panel (b): Lagged FX intervention

VARIABLES	(1) 02-21 Δ offshore	(2) 10-21 Δ offshore	(3) Group I: integrated 10-21 Δ offshore	(4) Group I: no NDF 10-21 Δ offshore	(5) Group II: segmented 10-21 Δ offshore	(6) Group II: segmented 10-21 Δ onshore
$\Delta(r^{US} - r)$	0.211*	0.155**	0.096	0.092	0.305***	0.215**
	(0.114)	(0.065)	(0.080)	(0.088)	(0.055)	(0.073)
Δ log dealer leverage	0.652**	0.588**	0.485*	0.534*	0.729*	0.344
	(0.289)	(0.234)	(0.241)	(0.271)	(0.367)	(0.263)
Δ fwd bid-ask	0.785*	0.704**	0.395	0.390	1.375*	0.181
	(0.421)	(0.278)	(0.247)	(0.295)	(0.627)	(0.273)
safe haven common factor	71.282**	42.667*	18.795	14.870	80.605*	3.251
	(28.437)	(20.396)	(17.955)	(19.520)	(35.897)	(20.386)
safe haven residual	8.300***	10.945***	3.688	2.937	22.145**	1.082
	(2.846)	(3.336)	(2.613)	(2.713)	(6.568)	(2.349)
FXI	0.173	3.426	1.224	1.870	9.758	-3.642*
	(1.226)	(2.070)	(1.476)	(1.892)	(6.046)	(1.547)
Observations	4,126	2,706	1,637	1,110	1,069	1,087
R-squared	0.093	0.071	0.044	0.049	0.126	0.063
Country FE	✓	✓	✓	✓	✓	✓

Note: Monthly regressions of first differences. The dependent variable is changes in the 3-month CIP deviations (offshore/NDF for columns (1)-(4) in both panels, and onshore for column (5)). In Panel (a), 5-year residualized CDS spread refers to the projection error estimated from regressing 5-year dollar-denominated CDS spread of each EM country (source: Markit) onto the first principal component of all CDS spreads in our sample. In Panel (b), "FXI" is to the size of foreign exchange intervention compiled by Adler, Mano, Chang and Shao (2021). A positive FXI corresponds to intervention by accumulating FX reserves, and vice versa. The FXI variable is lagged by one month. The CIP deviations are winsorized at 1% and 99%. In Panel (a), TWD is dropped for lack of data on sovereign CDS spread. Two-way clustered standard errors by currency and time are reported. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

a tenor of 1-month. Table B7 reports results from re-running the baseline panel regressions, restricting to only the Emerging European currencies analyzed in Section 3. While the estimation becomes much more imprecise, the coefficients are quantitatively similar to our baseline estimates. Section 3 shows that in response to year-end window-dressing activities, CIP deviations for these European currencies become more negative, while CIP deviations go up in response to a tightening of risk appetite. This exercise provides suggestive evidence that regulatory constraints and limited risk-bearing capacity potentially comprise two distinct channels driving CIP deviations.

Table B6 reports results obtained using IBOR-based CIP deviations as the dependent variable. For the group of currencies with integrated markets, one interesting finding is that the estimated coefficients on FX dealer leverage shrink in size and become statistically indistinguishable from zero.

Given this result, one potential concern is that the correlation between CIP deviations and intermediary leverage may not be attributed to dynamics in the FX market, but may reflect other potential channels, such as shifts in the credit risk premia. Table B8, Panel (a) shows evidence that suggests otherwise, that offshore forward premia (as measured by $f_{t,t+n} - s_t$) are also sensitive to dealer leverage factors, driven mostly by those with a segmented currency market, consistent with our baseline findings. Regressions using the broad dollar index as the proxy for the risk-bearing capacities of global intermediaries (Panel (c)) corroborates the point.

5 Discussion and policy implications

With the development of onshore FX markets and foreign participation in domestic financial systems, understanding the dynamics of short-term CIP deviations in emerging markets has increasingly important implications for macro stabilization policies. Interpreted through the lens of Equation (3), a negative CIP deviation reflects the cost advantage, on a hedged basis, of dollar-denominated funding relative to local-currency borrowing. Our systematic analysis of short-term EM CIP deviations reveals that there is an incentive to take advantage of the negative bases for most currencies in our sample. Yet during periods of heightened global risk sentiments and reduced intermediation capacities of global banks, a spike in the basis, poses significant challenges for EM borrowers to roll over liabilities, and for international currency investors to continuously hedge the currency risk.

Gourinchas (2022), in his Mundell-Fleming lecture, proposes that central banks could engage in "basis control" – targeting the level of short-term CIP deviations in an environment with foreign-currency funding frictions. In normal times, the authority would steer the basis higher to prevent private agents from overborrowing cheap foreign funding. During domestic recessions, on the other hand, CIP deviations would be kept low in order to bolster the borrowing capacity and stimulate output. Our analysis suggests that there would be ample room to engage in some type of basis control in the case of EMs.[33]

One of our main findings suggests that this would be especially the case of EMs with segmented FX markets, because unlike offshore EM CIP deviations, onshore CIP deviations are largely unresponsive to changes in FX dealers' risk-bearing capacities/global factors. Different instruments could be implemented across the financial cycle. Preemptive capital flow management and macroprudential policies, including constraints on participation in FX forward markets, could reduce the onshore market's sensitivity to movements in risk sentiments and thus dampen the pressure on the external finance premia (Das, Gopinath and Kalemli-Özcan, 2021). Meanwhile, segmentation on the forward markets provides central banks with wider policy space to lean against the wind – counteract depreciation pressure by intervening in the *forward* market to provide downside protection to domestic dollar borrowers. By entering into forward contracts with domestic borrowers that commit to buy U.S. dollar forward at a high price, the central bank effectively serves as an insurance provider and sets a ceiling on CIP deviations by offering cheaper currency hedges. The non-deliverable nature of the forward market in many EMs makes it likely that such operations would be cost-effective and would pose little threat to the stability of foreign exchange reserves.[34]

While a segmented FX market could dampen the transmission of global risk-off shocks to onshore markets across the financial cycle, our finding that the sensitivity of offshore CIP deviations to global factors for currencies in integrated FX markets is more than 50 percent smaller compared to their counterparts with segmented FX markets highlights a subtle tradeoff that policymakers need to navigate when imposing such constraints, especially during periods of financial stress. It is well understood that imposing an implicit tax on currency hedges discourages foreign participation in local-currency markets. Moreover, in markets where key providers of hedging services, such as global banks, face greater difficulty sharing risks with onshore market participants,

[33] For the pervasive impact of a strong dollar on emerging markets, see Obstfeld and Zhou (2022).

[34] Such interventions are in similar spirit to the dollar swap line operations conducted by central banks in the advanced economies. To see why the cost of intervening in the NDF market would likely be small, note that ex ante, the cost of intervention is the gap between the forward rate and the expected exchange rate at settlement. The central bank incurs ex-post loss if the realized depreciation is such that the prevailing spot exchange rate at settlement is higher than the agreed-upon forward exchange rate, and receives a transfer otherwise. To the extent that the intervention efforts of the central bank may stabilize exchange rate expectations, such operations could be profitable both ex ante and ex post. Sandri (2020) provides evidence on the profitability of Central Bank of Brazil's FX swap operations.

tightening risk-absorbing capacities of global financial intermediaries could amplify the sensitivity of offshore CIP deviations to global factors. What's more, market segmentation precludes onshore intervention measures from fully stabilizing the expectations of offshore investors. The resulting surge in hedging costs may lead to destabilizing capital outflows. For example, as shown by Schmittmann and Chua (2020), a sharply increasing NDF hedging costs can lead international investors to liquidate local currency bond holdings during crises.[35] For a small set of EM firms able to access offshore bond markets for financing or carry trade purposes (Bruno and Shin, 2017), they are nonetheless exposed to large swings in the offshore FX market. The offshore/onshore forward spread, as a sign of the risk-shifting capacity of global financial intermediaries, should receive more attention by policymakers in countries with segmented FX markets and non-resident investors in domestic markets.

In practice, EM central banks have adopted different strategies to regulate onshore FX markets. Concerned by the spillover effect of offshore NDF markets, Malaysia has been maintaining a strictly prohibition on domestic banks' offshore NDF positions since 2016, while India, citing the tradeoff outlined above, has allowed onshore banks to participate in the NDF market since 2020.[36] Meanwhile, intervention activities in the FX forward market have picked up. Gonzalez, Khametshin, Peydró and Polo (2019) show that Brazil's intervention in the domestic NDF market during and after the Taper Tantrum successfully mitigated the currency risk faced by Brazilian banks and dampened the negative real effect. Similar efforts have been observed for a number of Asian currencies in the recent dollar appreciation cycle.[37] Evaluating the macroeconomic impact and welfare benefits of capital flow management measures and FX intervention in the currency forward markets should be high in policymakers' agenda for future research.

[35] This point has received attention from policymakers in Asia-Pacific EMs. See Bank for International Settlements (2022).

[36] See Schmittmann and Chua (2020) for more information on Asian countries' policy approaches to NDF market integration, and Reserve Bank of India (2019, 2020) for arguments in favor of opening up the onshore market.

[37] Also see Domanski, Kohlscheen and Moreno (2016) for a general discussion, and Jermann, Wei and Yue (2022) for China's intervention in the offshore CNH market.

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Appendix

A Data appendix: Constructing EM CIP deviations

In this data appendix, we provide a step-by-step guide to compute short-term CIP deviations.

1. Download all necessary data from Bloomberg / Refinitiv. Table A1 contains the tickers for the forward, spot exchange rates and interest rates used in the paper.

   (a) One also needs to download contract settlement dates from Bloomberg to take into account potential differences in the actual maturity of the contract. For instance, a three-month contract may settle in 29 days instead of 30 days. This can be done by applying the `BDP` function in the Excel API to the tickers corresponding to the forward contract, with field `DAYS_TO_MTY`. One would need to override the default date setting by supplying the date when the contract is priced. In our calculations, we assume that onshore and offshore contract priced at the same date has the same days until maturity, and use the offshore contract as the benchmark.

   (b) The forward exchange rates downloaded from Bloomberg/Refinitiv are, in fact, *forward points* to be added onto the spot exchange rates to arrive at the outright forward rates. For advanced economy currencies (except Japanese Yen), forward points are usually quoted with a scale factor of 10,000, so that the outright forward exchange rate is given by $F_t = S_t + FP_t/10000$, where FP_t is forward point. Across emerging market currencies, however, market conventions differ. One needs to make sure to apply the correct scaling factor to each currency to arrive at the correct forward exchange rates. Similarly, interest rate day count convention also differs across currencies.

2. With the data in hand, we are in a position to compute CIP deviations. Without loss of generality, we focus on offshore forward rate-based 3-month basis for a particular currency i. We break the task down in several steps:

   (a) Compute outright forward rate using forward points: $F_{t,t+3m} = S_t + \frac{FP_{t,t+3m}}{\text{scaling factor}}$.

   (b) Given an interest rate series $y_{t,t+3m}$ (or the dollar equivalent) downloaded from Bloomberg / Refinitiv and expressed in percentage points, continuously compound interest rates.

$$i_{t,t+3m} = 100 \times \frac{360}{\text{days}} \times \log(1 + \frac{y_{t,t+3m}}{100} \times \frac{\text{days}}{360})$$

where days is the days to maturity for a forward contract. 360 may be replaced with 365/252 depending on the day count convention associated with a particular interest rate.

(c) Similarly, back out forward premium $\rho_{t,t+3m}$, expressed in percentage points:

$$\rho_{t,t+3m} = 100 * \frac{360}{\text{days}} \times \log\left(\frac{F_{t,t+3m}}{S_t}\right)$$

(d) Combine. Compute CIP deviations (in basis points) from

$$x_{t,t+3m} = 100 * (i^{\$}_{t,t+3m} - (i_{t,t+3m} - \rho_{t,t+3m})).$$

Table A1: Data sources and tickers – 3-month CIP deviations

				Domestic interest rate	
Country/Region	**Currency**	**offshore / NDF**	**onshore**	Definition	Ticker
Brazil	BRL	BCN3M Curncy	BCO3M Curncy	DI-PRE	PREDI90 Index *BRDPR3M* (after June 2020)
Chile	CLP	CHN3M Curncy	CHO3M Curncy	CAMARA OIS	CHSWPC Curncy
China	CNY	CCN3M Curncy	CCO3M Curncy	Interbank	SHIF3M Index
Colombia	COP	CLN3M Curncy	CLP3M Curncy	DTF	DTF RATE Index
Czech Republic	CZK	CZK3M Curncy		Interbank	PRIB03M Index
Hungary	HUF	HUF3M Curncy		Interbank	BUBOR03M Index
Indonesia	IDR	IHN3M Curncy	IHO3M Curncy	Interbank	JIIN3M Index
Israel	ILS	ILS3M Curncy		Interbank	TELBOR03 Index
India	INR	IRN3M Curncy	IRO3M Curncy	OIS	*INROS3M*
South Korea	KRW	*KRW3M=*	KWO3M Curncy	Interbank	KRBO3M Index
Mexico	MXN	MXN3M Curncy		Interbank (TIIE)	*MXTIIE3M=RR*
Malaysia	MYR	MRN3M Curncy	*MYR3M=MY*	Interbank	KLIB3M Index
Peru	PEN	PSN3M Curncy		Interbank	PRBOPRB3 Index
Philippines	PHP	PPN3M Curncy *PHP3MNDF=* (after 11/4/2016)	PPO3M Curncy	Interbank	PREF3MO Index
Poland	PLN	PLN3M Curncy		Interbank	WIBR3M Index
Russia	RUB	RUB3M Curncy		Interbank	MOSKP3 Index
Thailand	THB	THB3M Curncy	TBO3M Curncy	Interbank	BOFX3M Index
Turkey	TRY	TRY3M Curncy		Interbank	TRLIB3M Index
Taiwan	TWD	NTN3M Curncy	NTO3M Curncy	Interbank	TAIBOR3M Index
South Africa	ZAR	ZAR3M Curncy		Interbank	JIBA3M Index

Note: Tickers in italicized fonts are from Datastream/Refinitiv.

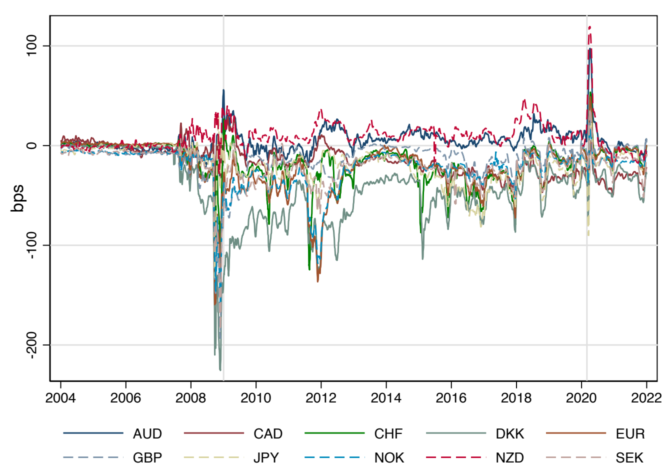
Table A2: Data sources and tickers – FX dealer leverage

Name	Bloomberg ticker
BNP Paribas	BNP FP Equity
Barclays	BARC LN Equity
Bank of America	BAC US Equity
Citigroup	C US Equity
Credit Suisse	CSGN SW Equity
Deutsche Bank	DBK GR Equity
Goldman Sachs	GS US Equity
HSBC	HSBA LN Equity
JP Morgan	JPM US Equity
Morgan Stanley	MS US Equity
Societe Generale	GLE FP Equity
Standard Chartered	STAN LN Equity
State Street	STT US Equity
UBS	UBSG SW Equity

Note: The list of FX dealer banks used to compute aggregate EM currency FX dealer leverage ratio. These banks are selected from the Euromoney FX survey as the largest market participants (excluding non-banks) in dealing EM currencies since 2015.

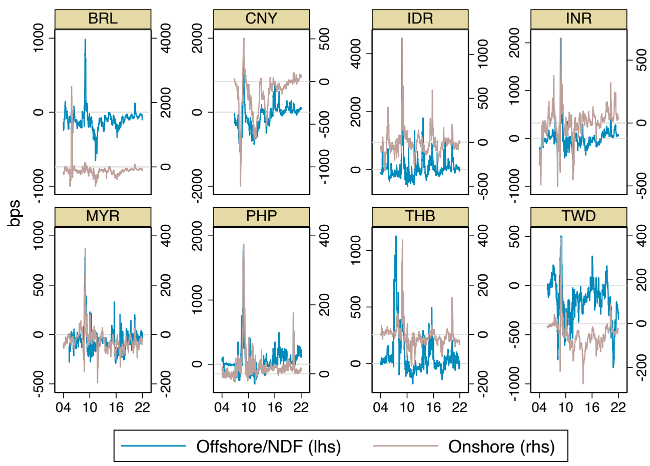
B Additional figures and tables

Figure B1: Evolution of CIP deviations: G-10 currencies



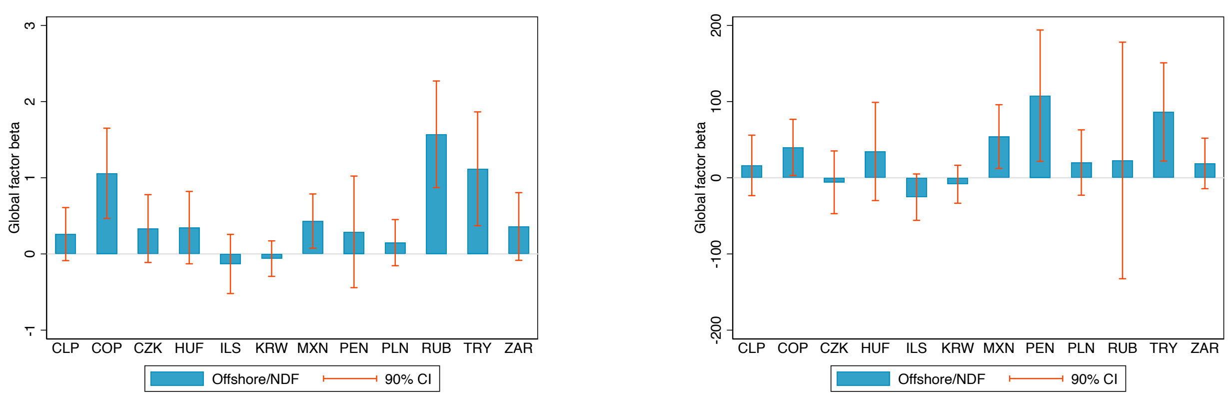
Note: Gray vertical lines correspond to Jan 2009 and Mar 2020. 10-day moving averages expressed in basis points, 2004-2021. Sources: Bloomberg, Refinitiv, authors' calculation.

Figure B2: Currencies with segmented FX forward markets: onshore / offshore 3-month CIP deviations (2004-2021)



Note: Daily onshore (red) and offshore (blue) 3-month CIP deviations for BRL, CNY, IDR, INR, MYR, PHP, THB and TWD. Gray horizontal lines refer to levels of zero.

Figure B3: Global factor-β (2010-2021) for 3-month offshore CIP deviations of other EM currencies

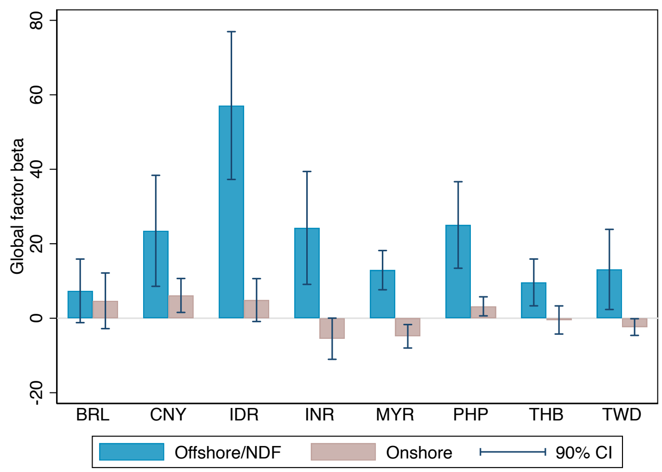


(a) Log FX dealer leverage

(b) Safe-haven currency common factor

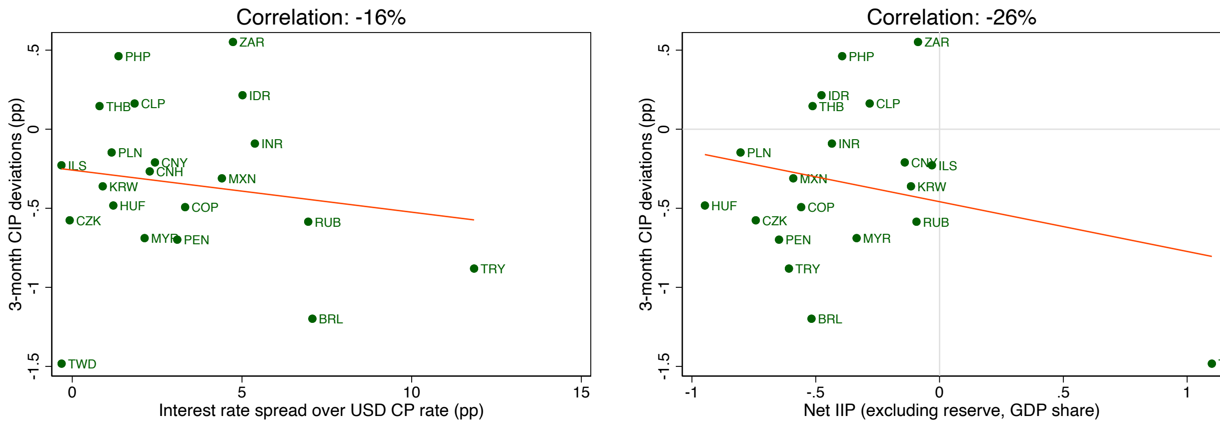
Note: Time-series β of monthly change of offshore/NDF 3-month CIP deviations on monthly changes in log FX dealer leverage ratio (Panel (a)) or safe-haven currency common factor (Panel (b), constructed following Cerutti, Obstfeld and Zhou (2021)), in a regression that also controls for interest rate differential and forward bid-ask spread. Error bands correspond to 90% confidence interval with Newey-West standard errors with 12 lags. The CIP deviations are winsorized at 1% and 99%.

Figure B4: Broad dollar-β (2010-2021) for 3-month offshore CIP deviations: Currencies with segmented markets



Note: Time-series β of monthly change of onshore (red) and offshore/NDF (blue) 3-month CIP deviations on monthly change in log of broad dollar index (see Avdjiev, Du, Koch and Shin (2019)), in a regression that also controls for interest rate differential and forward bid-ask spread. Error bands correspond to 90% confidence interval with Newey-West standard errors with 12 lags. Error bands correspond to 90% confidence interval with Newey-West standard errors with 12 lags. The CIP deviations are winsorized at 1% and 99%.

Figure B5: CIP deviations and macro correlates across countries (2010-2021), with TWD

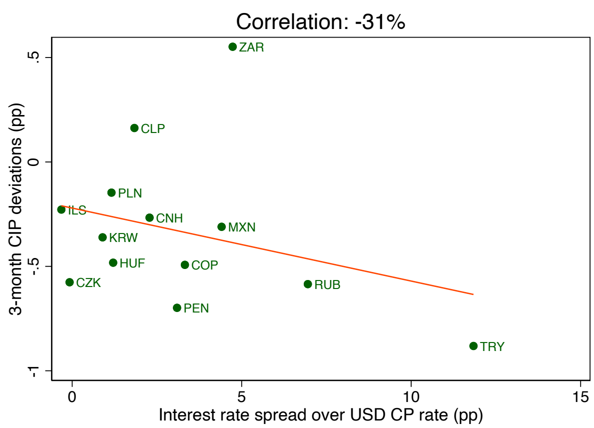


(a) Interest rate differential: EM

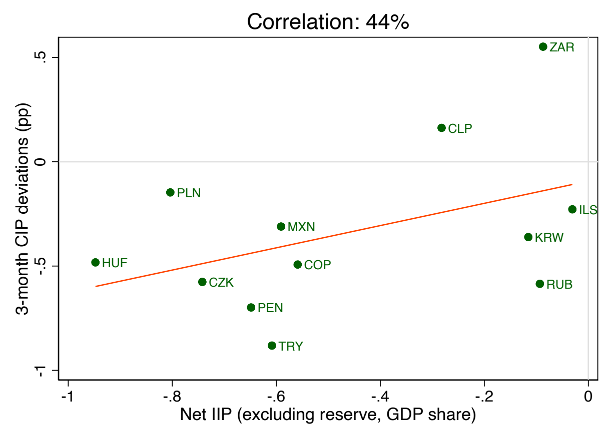
(b) Net IIP (minus reserves) to GDP ratio: EM

Note: Figure B5 plots time-series averages of benchmark 3-month CIP deviations against key macro-financial aggregates of emerging markets and advanced economies. The benchmark 3-month CIP deviations are offshore quotes or quotes on non-deliverable forwards. Interest rate spread for emerging market currencies is calculated by taking the difference between 3-month money market rate and 3-month US A2/P2 commercial paper rate. For advanced economies, dollar interest rate is Libor rate. Net international investment position (IIP) are annual observations from the Milesi-Ferretti and Lane (2017) dataset, updated to 2021 (link: https://www.brookings.edu/research/the-external-wealth-of-nations-database/). We subtract reserves from the aggregate international investment position for each country. Sample period: 2010-2021. The daily deviations from CIP are winsorized at 1% and 99% before being aggregated for the graphs.

Figure B6: CIP deviations and macro correlates across countries (2010-2021), currencies with integrated markets



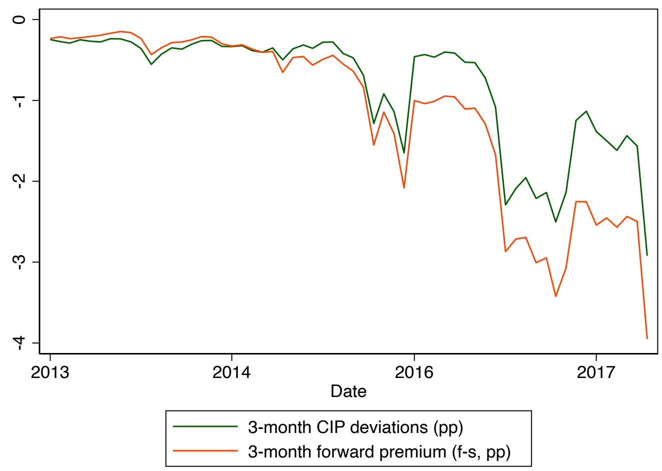
(a1) Interest rate differential: EM with integrated currency markets



(b1) Net IIP (minus reserves) to GDP ratio: EM with integrated currency markets

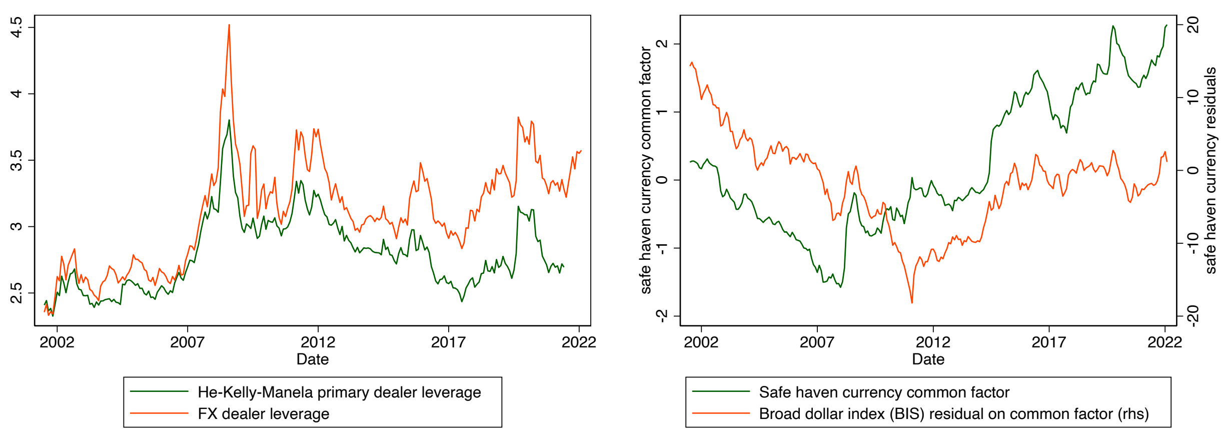
Note: Figure B6 repeats the analysis of Figure 2 to plot the cross-sectional relationship between interest rate differential, net international investment position, and CIP deviations. but restricts the sample to currencies with integrated offshore and onshore FX markets (i.e., dropping the following currencies: BRL, CNY, IDR, INR, MYR, PHP, THB, TWD). The benchmark 3-month CIP deviations are offshore quotes or quotes on non-deliverable forwards. Interest rate spread for emerging market currencies is calculated by taking the difference between 3-month money market rate and 3-month US A2/P2 commercial paper rate. Net international investment position (IIP) are annual observations from the Milesi-Ferretti and Lane (2017) dataset, updated to 2021 (link: `https://www.brookings.edu/research/the-external-wealth-of-nations-database/`). We subtract reserves from the aggregate international investment position for each country. Sample period: 2010-2021. The daily deviations from CIP are winsorized at 1% and 99% before being aggregated for the graphs.

Figure B7: Czech Kruna: 3-month CIP deviations and forward premia during period of exchange rate floor (2013-2017)



Note: Figure B7 plots the 3-month CIP deviations and forward premia for CZK. The exchange rate floor against EUR lasted from 11/07/2013 to 04/06/2017. The forward premium is computed as the difference between log 3-month forward exchange rate and log spot exchange rate, both in units of Kruna per USD.

Figure B8: Evolution of key global factors



(a) Log intermediary leverage

(b) Safe haven currency common factor

Note: Panel (a) plots the monthly evolution of intermediary leverage ratio used in the regressions in Section 4. He-Kelly-Manela primary dealer leverage refers to the He, Kelly and Manela (2017) leverage ratio computed from a set of designated treasury market primary dealers. FX dealer leverage refers to the measure constructed in this paper from a set of FX dealer banks of EM currencies with the largest market share according to Euromoney annual FX survey. Panel (b) plots the safe haven currency common factor used in Cerutti, Obstfeld and Zhou (2021) and the safe haven residuals for USD. The safe haven currency common factor is the first principal component of nominal effective exchange rate for USD, CHF, JPY. The residuals are obtained by regressing the USD nominal effective exchange rate on the common factor.

Table B1: Average CIP deviations by G-10 currency (bps)

	Dollar rate: IBOR		
	02-07 mean/sd	08-09 mean/sd	10-21 mean/sd
AUD	-0.96	1.45	6.61
	(4.05)	(26.41)	(12.51)
CAD	1.05	-5.34	-23.10
	(6.52)	(18.12)	(11.96)
CHF	0.24	-24.12	-22.14
	(3.54)	(28.89)	(19.88)
DKK	-3.16	-88.26	-50.36
	(8.28)	(47.87)	(23.37)
EUR	0.85	-39.58	-25.22
	(4.65)	(32.94)	(23.19)
GBP	-6.27	-44.94	-10.31
	(5.25)	(39.48)	(10.75)
JPY	-2.67	-19.66	-25.42
	(3.55)	(26.52)	(17.37)
NOK	-6.97	-41.56	-24.92
	(4.01)	(35.84)	(18.58)
NZD	0.22	12.52	11.81
	(5.06)	(16.84)	(16.21)
SEK	-5.91	-36.48	-22.42
	(2.79)	(35.57)	(14.59)

Note: Table B1 reports average 3-month CIP deviations by currency for the G-10 currency sample. The CIP deviations are defined according to Equation (1), using USD Libor rate as the dollar interest rate, so that a negative CIP deviation correspond to a lower direct dollar interest rate relative to the synthetic dollar interest rate.

Table B2: Regressions: Summary statistics

Panel (a): Global factors

Variable	Obs	Mean	Std. Dev.	Min	Max	P50
log FX dealer leverage ratio	240	3.097	.389	2.332	4.521	3.08
safe haven currency common factor	240	.153	.963	-1.577	2.266	-.172
safe haven residual	240	-1.997	6.288	-18.194	14.847	-1.505

Panel (b): Country-specific regressors

Variable	Obs	Mean	Std. Dev.	Min	Max	P50
3-month offshore CIP deviations (bps)	4368	-28.144	130.112	-537.634	646.177	-20.942
3-month onshore CIP deviations (bps)	2056	-39.599	93.264	-553.043	280.301	-22.853
$r^{US} - r$ (%)	4500	-3.596	4.599	-47.379	4.505	-2.785
offshore fwd bid-ask	4546	25.864	18.715	5.165	156.905	21.023
onshore fwd bid-ask	4397	22.905	17.512	3.262	144.808	18.414
5y residualized cds spread (bps)	4158	-8.228	135.216	-804.393	2642.105	-8.558
FXI (% GDP)	4798	.135	.853	-7.89	10.82	.05

Panel (c): Variable descriptions

Name	Definition
Global factors:	
FX dealer leverage ratio	(Market equity + book debt)/Market equity for largest FX dealers for EM currencies
Safe haven common factor	First principal component of nominal effective exchange rate for USD, CHF, JPY
USD safe haven residuals	Residuals from projecting USD nominal effective exchange rate on safe haven common factor
Country-specific factors:	
FXI	Adler, Mano, Chang and Shao (2021) measure of FX intervention (spot+forward). +: reserve accumulation. Unit: percent GDP.
Forward bid-ask	FX Forward market liquidity: 10000×(ask - bid)/mid.
Residualized CDS spread	Residuals from regressing 5-year USD CDS spread on the first principal component of CDS spread series for all countries in the regression sample. Source: Markit.

Note: This table reports summary statistics and variable descriptions for key regressors introduced in Section 4. The sample runs from 2002M1 to 2021M12. CDS spread data is missing for Taiwan. CIP deviations and liquidity (bid-ask) is winsorized at 1% and 99% tails. The forward market liquidity measure is defined as 10000×(ask forward exchange rate−bid forward exchange rate)/mid forward exchange rate.

Table B3: EM CIP deviations and broad dollar index: Baseline panel regressions

	(1)	(2)	(3)	(4)	(5)	(6)
			Group I: integrated	Group I: no NDF	Group II: segmented	Group II: segmented
	02-21	10-21	10-21	10-21	10-21	10-21
VARIABLES	Δ offshore	Δ offshore	Δ offshore	Δ offshore	Δ offshore	Δ onshore
$\Delta(r^{US} - r)$	0.204*	0.172**	0.104	0.099	0.363***	0.230**
	(0.111)	(0.068)	(0.081)	(0.089)	(0.053)	(0.084)
Δ log broad dollar index	12.054***	11.428***	4.708**	3.838*	21.533***	2.064
	(3.003)	(3.114)	(2.135)	(2.013)	(5.144)	(2.128)
Δ fwd bid-ask	0.842*	0.779***	0.490*	0.520	1.419*	0.196
	(0.407)	(0.265)	(0.239)	(0.280)	(0.628)	(0.292)
Observations	4,128	2,706	1,637	1,110	1,069	1,087
R-squared	0.085	0.061	0.031	0.032	0.114	0.049
Country FE	✓	✓	✓	✓	✓	✓

Note: Monthly regressions of first differences. The dependent variable is changes in the 3-month CIP deviations (offshore/NDF for columns (1)-(4) in both panels, and onshore for column (5)), based on USD A2/P2 commercial paper interest rate. The independent variables include changes in the (nominal) USD A2/P2 commercial paper rate–local nominal money market rate differential, log of broad USD nominal effective exchange rate (BIS), and forward bid-ask spread normalized by mid price of forward exchange rate. In Panel (b), the safe haven common factor is the first principal component of nominal effective exchange rate of safe-haven currencies (USD, CHF, JPY), and the residual refers to estimated error term after projecting the dollar nominal effective exchange rate onto the common factor, following Cerutti, Obstfeld and Zhou (2021). Columns (1) and (2) report regression results for all currencies from 2002 to 2021 (column (1)) and from 2010 to 2021 (column (2)). In columns (3) to (6), we focus on the 2010-2021 subperiod, and divide the sample into two groups. Group I include currencies with little FX forward market segmentation across border, as well as non-deliverable currencies with a small offshore-onshore forward spread based on available data (CLP, COP, KRW, PEN, who are further dropped in column (4)). Group II refers to currencies with substantial FX forward market segmentation (BRL, CNY, IDR, INR, MYR, PHP, THB, TWD). The CIP deviations and forward market liquidity measure are winsorized at 1% and 99%. Two-way clustered standard errors by currency and time are reported. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table B4: G10 currency CIP deviations (IBOR) and intermediary leverage factor

Panel (a): He, Kelly and Manela (2017) primary dealer leverage

	(1)	(2)	(3)	(4)
			drop AUD/NZD	drop AUD/NZD
	02-21	10-21	02-21	10-21
VARIABLES	Δ Libor basis	Δ Libor basis	Δ Libor basis	Δ Libor basis
$\Delta(r^{US} - r)$	-4.635	-11.659	-3.619	-11.149
	(2.658)	(7.869)	(2.846)	(10.178)
Δ log primary dealer leverage	-0.094	-0.201**	-0.127*	-0.233**
	(0.061)	(0.083)	(0.063)	(0.095)
Δ fwd bid-ask	-0.458	-0.290	-0.622	-0.327
	(0.398)	(0.472)	(0.471)	(0.551)
Observations	2,242	1,344	1,813	1,077
R-squared	0.020	0.047	0.023	0.049
Country FE	✓	✓	✓	✓

Panel (b): FX dealer leverage

	(1)	(2)	(3)	(4)
			drop AUD/NZD	drop AUD/NZD
	02-21	10-21	02-21	10-21
VARIABLES	Δ Libor basis	Δ Libor basis	Δ Libor basis	Δ Libor basis
$\Delta(r^{US} - r)$	-4.879*	-11.922	-3.984	-11.580
	(2.615)	(7.815)	(2.774)	(10.081)
Δ log fx dealer leverage	-0.074	-0.132*	-0.088	-0.145*
	(0.046)	(0.062)	(0.052)	(0.073)
Δ fwd bid-ask	-0.445	-0.307	-0.621	-0.367
	(0.395)	(0.482)	(0.465)	(0.566)
Observations	2,242	1,344	1,813	1,077
R-squared	0.023	0.050	0.026	0.050
Country FE	✓	✓	✓	✓

Note: Monthly regressions of first differences. The dependent variable is changes in the 3-month CIP deviations for G-10 currencies. In Panel (a), the global factor considered is the He, Kelly and Manela (2017) primary dealer leverage ratio. In Panel (b), the global factor is equal-weighted FX dealer leverage ratio. Columns (1) and (2) focus on the entire set of G-10 currencies over the 2002 (2010)-2021 sample, and columns (3) and (4) drop AUD and NZD (currencies with a positive CIP deviations). The CIP deviations and forward market liquidity measure (fwd bid-ask) are winsorized at 1% and 99%. Two-way clustered standard errors by currency and time are reported. *** p<0.01, ** p<0.05, * p<0.1.

Table B5: EM CIP deviations and global factors: 1-month tenor

Panel (a): FX dealer leverage

	(1)	(2)	(3)	(4)	(5)	(6)
			Group I: integrated	Group I: no NDF	Group II: segmented	Group II: segmented
	02-21	10-21	10-21	10-21	10-21	10-21
VARIABLES	Δ offshore	Δ offshore	Δ offshore	Δ offshore	Δ offshore	Δ onshore
$\Delta(r^{US} - r)$	0.154	0.049	0.034	0.032	0.050	0.198***
	(0.124)	(0.124)	(0.180)	(0.192)	(0.157)	(0.038)
Δ log dealer leverage	1.189***	0.933**	0.450*	0.398	1.697**	0.192
	(0.406)	(0.328)	(0.223)	(0.263)	(0.643)	(0.237)
Δ fwd bid-ask	1.695**	1.621*	0.915	1.358	3.714***	0.384
	(0.659)	(0.849)	(1.086)	(1.273)	(1.016)	(0.289)
Observations	3,888	2,630	1,558	1,142	1,072	1,110
R-squared	0.038	0.021	0.015	0.027	0.038	0.036
Country FE	✓	✓	✓	✓	✓	✓

Panel (b): Add dollar factors

	(1)	(2)	(3)	(4)	(5)	(6)
			Group I: integrated	Group I: no NDF	Group II: segmented	Group II: segmented
	02-21	10-21	10-21	10-21	10-21	10-21
VARIABLES	Δ offshore	Δ offshore	Δ offshore	Δ offshore	Δ offshore	Δ onshore
$\Delta(r^{US} - r)$	0.143	0.046	0.031	0.032	0.066	0.196***
	(0.119)	(0.121)	(0.179)	(0.192)	(0.155)	(0.040)
Δ log dealer leverage	0.796**	0.575*	0.296	0.370	1.039	0.218
	(0.371)	(0.305)	(0.230)	(0.289)	(0.654)	(0.194)
Δ fwd bid-ask	1.570**	1.413	0.834	1.323	3.239***	0.378
	(0.640)	(0.822)	(1.082)	(1.268)	(0.845)	(0.302)
safe haven common factor	50.303	37.987	17.566	-8.065	67.190	-17.112
	(35.191)	(34.093)	(19.991)	(18.013)	(70.916)	(20.779)
safe haven residual	10.663***	13.563***	5.595**	3.545	25.042**	2.412
	(3.635)	(4.272)	(2.382)	(2.280)	(8.229)	(1.721)
Observations	3,888	2,630	1,558	1,142	1,072	1,110
R-squared	0.051	0.038	0.021	0.029	0.069	0.039
Country FE	✓	✓	✓	✓	✓	✓

Note: Monthly regressions of first differences. The dependent variable is changes in the 1-month CIP deviations (offshore/NDF for columns (1)-(4) in both panels, and onshore for column (5)), based on USD A2/P2 commercial paper interest rate. The independent variables include changes in the (nominal) USD A2/P2 commercial paper rate–local nominal money market rate differential, log of aggregate EM currency FX dealer leverage ratio, and forward bid-ask spread normalized by mid price of forward exchange rate. In Panel (b), the safe haven common factor is the first principal component of nominal effective exchange rate of safe-haven currencies (USD, CHF, JPY), and the residual refers to estimated error term after projecting the dollar nominal effective exchange rate onto the common factor, following Cerutti, Obstfeld and Zhou (2021). Columns (1) and (2) report regression results for all currencies from 2002 to 2021 (column (1)) and from 2010 to 2021 (column (2)). In columns (3) to (6), we focus on the 2010-2021 subperiod, and divide the sample into two groups. Group I include currencies with little FX forward market segmentation across border, as well as non-deliverable currencies with a small offshore-onshore forward spread based on available data (CLP, COP, KRW, PEN, who are further dropped in column (4)). Group II refers to currencies with substantial FX forward market segmentation (BRL, CNY, IDR, INR, MYR, PHP, THB, TWD). The CIP deviations and forward market liquidity measure (fwd bid-ask) are winsorized at 1% and 99%. Two-way clustered standard errors by currency and time are reported. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table B6: CIP deviations, global and country-specific factors: IBOR basis

Panel (a): Baseline panel regressions

VARIABLES	(1) 02-21 Δ offshore	(2) 10-21 Δ offshore	(3) Group I: integrated 10-21 Δ offshore	(4) Group I: no NDF 10-21 Δ offshore	(5) Group II: segmented 10-21 Δ offshore	(6) Group II: segmented 10-21 Δ onshore
$\Delta(r^{US} - r)$	0.127	0.138*	0.098	0.092	0.229**	0.150**
	(0.080)	(0.068)	(0.091)	(0.099)	(0.082)	(0.060)
Δ log dealer leverage	0.670**	0.434	-0.036	0.015	1.157*	-0.225*
	(0.251)	(0.263)	(0.127)	(0.147)	(0.584)	(0.106)
Δ fwd bid-ask	0.504	0.736*	0.208	0.188	1.835*	0.036
	(0.317)	(0.387)	(0.315)	(0.416)	(0.958)	(0.258)
Observations	4,205	2,780	1,682	1,142	1,098	1,108
R-squared	0.025	0.018	0.010	0.011	0.048	0.025
Country FE	✓	✓	✓	✓	✓	✓

Panel (b): Add safe haven dollar factor and residualized CDS spread

VARIABLES	(1) 02-21 Δ offshore	(2) 10-21 Δ offshore	(3) Group I: integrated 10-21 Δ offshore	(4) Group I: no NDF 10-21 Δ offshore	(5) Group II: segmented 10-21 Δ offshore	(6) Group II: segmented 10-21 Δ onshore
$\Delta(r^{US} - r)$	0.126	0.175**	0.145	0.146	0.258**	0.136
	(0.088)	(0.070)	(0.100)	(0.111)	(0.092)	(0.069)
Δ log dealer leverage	0.341	0.188	-0.052	-0.003	0.689	-0.181*
	(0.210)	(0.219)	(0.143)	(0.176)	(0.635)	(0.081)
Δ fwd bid-ask	0.486	0.527	0.103	0.092	1.434	0.060
	(0.308)	(0.327)	(0.211)	(0.273)	(0.797)	(0.257)
safe haven common factor	35.045	18.071	-2.611	-12.144	63.531*	-4.331
	(20.563)	(12.419)	(10.708)	(10.623)	(26.602)	(7.562)
safe haven residual	7.685**	9.359**	2.574	2.194	23.189**	1.553
	(2.889)	(3.718)	(1.894)	(2.007)	(8.780)	(2.261)
Δ 5y residualized cds spread	0.144	0.459*	0.479	0.517	0.555	-0.119
	(0.098)	(0.222)	(0.307)	(0.359)	(0.508)	(0.114)
Observations	3,729	2,505	1,682	1,142	823	827
R-squared	0.046	0.050	0.038	0.052	0.128	0.029
Country FE	✓	✓	✓	✓	✓	✓

Note: Monthly regressions of first differences. The dependent variable is changes in the Libor 3-month deviations from CIP (offshore/NDF for columns (1)-(4) in both panels, and onshore for column (5)). The independent variables include changes in the USD Libor rate–local money market rate differential, log FX dealer leverage ratio, and forward bid-ask spread normalized by mid price of forward exchange rate. In Panel (b), the safe haven common factor is the first principal component of nominal effective exchange rate of safe-haven currencies (USD, CHF, JPY), and the residual refers to estimated error term after projecting the dollar nominal effective exchange rate onto the common factor, following Cerutti, Obstfeld and Zhou (2021). 5-year residualized CDS spread refers to the projection error estimated from regressing 5-year dollar-denominated CDS spread of each EM country (source: Markit) onto the first principal component of all CDS spreads in our sample. Columns (1) and (2) report regression results for all currencies from 2002 to 2021 (column (1)) and from 2010 to 2021 (column (2)). In columns (3) to (5), we focus on the 2010-2021 subperiod, and divide the sample into two groups. Group I include currencies with little FX forward market segmentation across border, as well as non-deliverable currencies with a small offshore-onshore forward spread based on available data (CLP, COP, KRW, PEN). Group II refers to currencies with substantial FX forward market segmentation (BRL, CNY, IDR, INR, MYR, PHP, THB, TWD). The CIP deviations are winsorized at 1% and 99%. Two-way clustered standard errors by currency and time are reported. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table B7: EM CIP deviations (IBOR) and global factors: European currencies

	(1)	(2)	(3)	(4)
	02-21	10-21	02-21	10-21
VARIABLES	Δ offshore	Δ offshore	Δ offshore	Δ offshore
$\Delta(r^{US} - r)$	0.125*	0.214***	0.116*	0.209***
	(0.044)	(0.035)	(0.037)	(0.031)
Δ log dealer leverage	0.665*	0.689	0.503	0.597
	(0.246)	(0.320)	(0.221)	(0.324)
Δ fwd bid-ask	0.229	0.126	0.147	0.083
	(0.152)	(0.258)	(0.130)	(0.244)
safe haven common factor			50.250	33.060
			(22.628)	(18.059)
safe haven residual			-0.747	-0.944
			(2.069)	(3.695)
Observations	857	537	857	537
R-squared	0.111	0.114	0.133	0.125
Country FE	✓	✓	✓	✓

Note: Monthly regressions of first differences. The dependent variable is changes in the 3-month CIP deviations for EM European currencies (CZK, HUF, PLN, RUB), based on USD A2/P2 commercial paper interest rate. The independent variables include changes in the (nominal) USD A2/P2 commercial paper rate–local nominal money market rate differential, log of broad USD nominal effective exchange rate (BIS), and forward bid-ask spread normalized by mid price of forward exchange rate. In Panel (b), the safe haven common factor is the first principal component of nominal effective exchange rate of safe-haven currencies (USD, CHF, JPY), and the residual refers to estimated error term after projecting the dollar nominal effective exchange rate onto the common factor, following Cerutti, Obstfeld and Zhou (2021). Columns (1) and (2) report regression results for all four currencies from 2002 to 2021 (column (1)) and from 2010 to 2021 (column (2)). In columns (3) to (4), we add the safe haven currency common factor and residual into the regressions. The CIP deviations and forward market liquidity measure are winsorized at 1% and 99%. Two-way clustered standard errors by currency and time are reported. *** p<0.01, ** p<0.05, * p<0.1.

Table B8: EM forward premium and global factors

Panel (a): FX dealer leverage

VARIABLES	(1) 02-21 Δ offshore	(2) 10-21 Δ offshore	(3) Group I: integrated 10-21 Δ offshore	(4) Group I: no NDF 10-21 Δ offshore	(5) Group II: segmented 10-21 Δ offshore	(6) Group II: segmented 10-21 Δ onshore
$\Delta(r^{US} - r)$	-0.005**	-0.007***	-0.007***	-0.007***	-0.006***	-0.008***
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Δ log dealer leverage	0.010*	0.007*	0.003	0.003	0.013*	0.001
	(0.005)	(0.003)	(0.002)	(0.002)	(0.007)	(0.003)
Δ fwd bid-ask	0.011**	0.012*	0.005**	0.004*	0.026	0.007
	(0.005)	(0.006)	(0.002)	(0.002)	(0.014)	(0.005)
Observations	4,159	2,720	1,634	1,102	1,086	957
R-squared	0.091	0.102	0.228	0.307	0.073	0.292
Country FE	✓	✓	✓	✓	✓	✓

Panel (b): Add dollar factors

VARIABLES	(1) 02-21 Δ offshore	(2) 10-21 Δ offshore	(3) Group I: integrated 10-21 Δ offshore	(4) Group I: no NDF 10-21 Δ offshore	(5) Group II: segmented 10-21 Δ offshore	(6) Group II: segmented 10-21 Δ onshore
$\Delta(r^{US} - r)$	-0.005***	-0.007***	-0.007***	-0.007***	-0.006***	-0.008***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Δ log dealer leverage	0.004	0.003	0.001	0.001	0.007	0.001
	(0.003)	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)
Δ fwd bid-ask	0.010**	0.011*	0.004**	0.002	0.023*	0.007
	(0.005)	(0.005)	(0.002)	(0.002)	(0.012)	(0.005)
safe haven common factor	1.147**	0.704**	0.482*	0.546	1.104*	0.122
	(0.483)	(0.253)	(0.234)	(0.325)	(0.483)	(0.212)
safe haven residual	0.072**	0.087**	0.023	0.010	0.181**	0.009
	(0.030)	(0.035)	(0.027)	(0.029)	(0.062)	(0.016)
Observations	4,159	2,720	1,634	1,102	1,086	957
R-squared	0.116	0.126	0.238	0.318	0.121	0.294
Country FE	✓	✓	✓	✓	✓	✓

Note: See next page for detailed information on the tables.

Table B8: EM forward premium and global factors (cont'd)

Panel (c): Log broad dollar index as the global factor

	(1)	(2)	(3)	(4)	(5)	(6)
			Group I: integrated	Group I: no NDF	Group II: segmented	Group II: segmented
	02-21	10-21	10-21	10-21	10-21	10-21
VARIABLES	Δ offshore	Δ offshore	Δ offshore	Δ offshore	Δ offshore	Δ onshore
$\Delta(r^{US} - r)$	-0.005***	-0.007***	-0.007***	-0.007***	-0.005***	-0.008***
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Δ log broad dollar index	0.132**	0.109**	0.043	0.037	0.210**	0.014
	(0.047)	(0.038)	(0.026)	(0.030)	(0.072)	(0.022)
Δ fwd bid-ask	0.011**	0.012*	0.005**	0.003	0.024*	0.007
	(0.005)	(0.006)	(0.002)	(0.002)	(0.013)	(0.005)
Observations	4,159	2,720	1,634	1,102	1,086	957
R-squared	0.112	0.123	0.234	0.311	0.116	0.293
Country FE	✓	✓	✓	✓	✓	✓

Note: Monthly regressions of first differences. The dependent variable is changes in the 3-month CIP deviations (offshore/NDF for columns (1)-(4) in both panels, and onshore for column (5)), based on USD A2/P2 commercial paper interest rate. The independent variables include changes in the (nominal) USD A2/P2 commercial paper rate–local nominal money market rate differential, log of aggregate EM currency FX dealer leverage ratio, and forward bid-ask spread normalized by mid price of forward exchange rate. In Panel (b), the safe haven common factor is the first principal component of nominal effective exchange rate of safe-haven currencies (USD, CHF, JPY), and the residual refers to estimated error term after projecting the dollar nominal effective exchange rate onto the common factor, following Cerutti, Obstfeld and Zhou (2021). In Panel (c), we use log changes in the broad dollar index as the global factor, following Avdjiev, Du, Koch and Shin (2019). Columns (1) and (2) report regression results for all currencies from 2002 to 2021 (column (1)) and from 2010 to 2021 (column (2)). In columns (3) to (6), we focus on the 2010-2021 subperiod, and divide the sample into two groups. Group I include currencies with little FX forward market segmentation across border, as well as non-deliverable currencies with a small offshore-onshore forward spread based on available data (CLP, COP, KRW, PEN, who are further dropped in column (4)). Group II refers to currencies with substantial FX forward market segmentation (BRL, CNY, IDR, INR, MYR, PHP, THB). The CIP deviations and forward market liquidity measure are winsorized at 1% and 99%. Two-way clustered standard errors by currency and time are reported. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.