Bank FX hedging needs and the impact on covered interest parity, an Emerging Market perspective

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Abstract

This paper examines the role of banking sector foreign currency hedging demand in the foreign exchange market, the market where banks manage business model driven currency mismatch. First, the paper documents deviations from covered interest parity for 10 emerging economies and tests whether domestic bank FX hedging needs affect these deviations. Next, I exploit data from Mexican regulatory filings on derivatives transactions and bank balance sheets to assess the impact of FX hedging by the domestic banks, and also by foreigners. Hedging measures are included in an econometric model of covered interest parity (under limits to arbitrage) with tenures from 1 month to 12 months, and then interacted with arbitrageur balance sheet constraint variables to test whether these amplify the impact of FX hedging needs. The main result of the paper is that hedging demand directly influenced CIP deviations in the EM panel and the case of Mexico, while interaction effects varied across hedging measures. The direct effect was robust to including foreign exchange bid-ask spreads and arbitrage constraints in the regression model. In addition, the Mexico analysis yields evidence that changes in banks FX liquid assets and foreign currency interbank funding affect changes in the CIP deviations. In sum, the results validate a key mechanism in the theoretical literature, ie that higher bank FX hedging demand (particularly from global banks), can indeed directly increase the cost of hedging. The implication is that the ability of domestic banks in emerging economies to manage currency mismatch can be affected by their global banks as well as by foreign hedging needs and arbitrageur behavior. This paper adds to the literature on CIP deviations by analyzing emerging market currencies, with the unique advantage of using regulatory data and actual FX derivatives transactions data.[1]

Keywords: foreign currency hedging, financial stability, capital flows, currency mismatch, bank funding, covered interest parity

JEL codes: F3, G2, F65, G15, G18

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1 Introduction

Foreign currency funding in the banking sector is a key financial stability concern for financially open economies. The value of foreign currency denominated exposures will be subject to exchange rate movements. Large fluctuations can dramatically change the relative value of a bank's domestic and foreign liabilities and assets. For example, if a bank funds itself primarily through foreign currency and then lends in domestic currency, a large depreciation of the domestic currency reduces the value of the bank's assets and revenues from those assets, while increasing the cost of its liabilities. Thus managing the balance sheet in the context of global capital mobility, requires additional risk management targets to address currency mismatch.

Many countries have macro-prudential regulations requiring banks to manage their foreign currency balance sheets conservatively. For example, according to the dataset on banking regulations from Cerutti et al. (2017), 49 countries as of 2017 had restrictions on foreign currency loans. Foreign currency regulations curtail the size of an individual bank's currency mismatch with the aim of reducing risks from their FX funding gap. To comply with these government regulations as well as internal risk management protocols, banks turn to the foreign exchange markets to close their FX funding gaps thereby fortifying financial sector resilience to external shocks. The more developed and efficient are the foreign exchange markets, the more easily and cost effectively banks are able to manage vulnerabilities due to foreign currency exposures. In particular, the availability of hedging contracts is essential for financial resilience, given a flexible exchange rate regime. Banks with currency mismatches in their core balance sheets can use these derivatives to manage their exposure to foreign exchange shocks.

A metric for an efficient FX market is covered interest parity: through arbitrage, interest rates denominated in different currencies should equalize, once exchange rate differences are accounted for. Before the global financial crisis, empirical research provided evidence that covered interest parity generally held: deviations did not last long and arbitrage transactions closed the differential.[2] However recent research has documented meaningful and persistent deviations from CIP in developed economies during and after the global financial crisis.[3] Avdjiev et al. (2017) analyze the ten most liquid currencies (besides the US dollar) and find non-zero deviations over their sample period of 2007-2015. Borio et al. (2016b) document persistent CIP deviations post crisis for nine developed economy currencies. Du et al. (2018) demonstrate that even after markets had normalized in the crisis aftermath, deviations from CIP persist in a number of interest rate spreads. Cerruti et al. (2019) confirms these findings for the G10

[2]See Akram et al. (2008).

[3]See Avdjiev et al. (2017), Borio et al. (2016a,b), Du et al. (2018).

currencies.

Various explanations for these documented persistent CIP deviations have been proposed. Dominant in the policy debate is the role of post-crisis changes in global banks business models and willingness to expand their balance sheets. After the global financial crisis, there was a structural re-pricing of risk such as counterparty risk and market risk. Regulatory changes have imposed higher capital requirements, and market forces have increased the cost of capital for financial intermediaries, in particular for regulated banks. Furthermore, banks experience heterogeneous marginal funding costs because of the impact of different regulatory requirements for systemically important institutions. More stringent capital requirements increase the cost of deploying the balance sheet, and bail-in resolution regimes increase the costs to bank creditors in the event of trouble, leading to higher pricing for debt financing.[4] These large banks are key potential arbitrageurs. Thus, their increased costs can deter arbitrage in FX markets, leading to CIP deviations persisting.[5]

In addition to their arbitrageur role, a growing literature has focused on identifying monetary policy spillovers propagated via global or foreign banks. The extended period of low or negative interest rates in several major developed economies, the search for yield, and the role of the US dollar (and also some evidence for the Euro) as a funding currency have been highlighted.[6] The authors of Ivashina et al. (2015) model a particular mechanism whereby banks suffer a reduction in wholesale US dollar funding because of a shock to the banks' creditworthiness. In order to maintain USD lending, they must turn to the swap markets to deploy their local currency (Euro) liabilities and make up for the loss of dollar wholesale funding. However that increase in swap demand leads to CIP violations when arbitrage is limited. The CIP deviation makes hedging foreign currency risk more expensive, thus deterring USD lending in favor of Euro-denominated lending. Building on Cetorelli and Goldberg (2012), the authors of Brauning and Ivashina (2017) argue that differences in monetary policy stance cause global banks to use internal capital markets to optimize funding costs by drawing liabilities on the low interest rate jurisdiction, swapping into the (higher interest rate) foreign currency and lending in that currency, and then hedging the resulting currency mismatch. Both models predict a reallocation away from lending in foreign currency (eg. US dollar) towards domestic currency.[7]

[4]See Duffie (2017).

[5]See Boyarchenko et al. (2018), Rime et al. (2017).

[6]See Avdjiev et al. (2017), Ivashina et al. (2015).

[7]Other papers have focused on risk taking behavior by banks, postulating a risk-taking channel of monetary policy spillovers via banks. These papers do not rely on CIP deviations for the predictions but do focus on the direct effect of currency appreciation or relative monetary policy stance on banking leverage and bank cross-border capital flows. See Adrian and Shin (2010), Brauning and Ivashina (2019), Bruno and Shin (2015).

A key point in both the above papers is that increased demand for cross-currency swaps (and hedging), puts pressure on the forward premium (a measure of CIP deviation). The CIP violation is the reason FX funding becomes more expensive, and lending in foreign currency less attractive. However the empirical sections of these papers do not provide evidence that the increased hedging demand of the banks directly affects the forward premium, and to what degree. The Ivashina et al. (2015) results combine both this widening pressure on CIP from global banks demand and some degree of limits to arbitrage to generate a persistent CIP deviation and thus an increased cost for synthetic funding.

This paper hopes to the fill this gap by testing for evidence of a direct widening effect of bank hedging demand on CIP deviations. And in addition, whether there is "capital to take the other side of the swap trade" either from exogenous foreign hedging demand, or arbitrageur balance sheets.

Furthermore, the paper focuses on emerging market currencies, markets where larger US monetary spillover effects have been document by Brauning and Ivashina (2019) and where a direct effect on CIP from bank behavior may be more likely.[8] The post-crisis literature is focused on developed economy currencies.[9] Implicit in the developed market studies, is that currencies trade freely internationally (an absence of capital controls) and financial markets are well developed with minimal frictions or segmentation. For example, for CIP arbitrage to occur, not only are liquid spot and forward foreign exchange markets desirable, but also risk-free securities in the foreign country of the desired maturity, and real time price information to minimize execution risk. Less developed economies may have different dynamics given the institutional features of emerging economies' financial systems and the financial frictions they experience. Or they may have had similar magnitudes and persistence of deviations in CIP but with different primary drivers.

CIP deviations from an emerging market perspective is also of direct interest for several reasons. First, as capital scarce economies, they attract foreign capital inflows and have a history of vulnerability to foreign exchange shocks. Theory predicts capital inflows due to a structurally higher interest rate in an emerging economy versus a developed economy. Post global financial crisis, low for long developed market interest rates have magnified the search for yield motive. Vulnerabilities arising from dependence on external funding are particularly critical for emerging economies as developed markets

[8]The only other paper I am aware of that empirically tests for a direct effect on CIP from hedging demand, Borio et al. (2016b), found none for the Japanese Yen US dollar basis at the 3 month maturity. At the 5-year tenor, the authors found that when hedging demand is interacted with arbitrage variables, there is a widening effect on the CIP deviations, but hedging demand (including banks hedging demand) had no observable direct effect.

[9]For example, in Cerruti et al. (2019), the authors empirically test several hypothesized macro-financial drivers of CIP deviations for significance and time varying effects for the G10 currencies.

pursue monetary policy normalization. For policymakers in those emerging economies that have been able to access global markets, currency mismatches and the financial sector's ability to manage this risk, is a primary financial stability concern.

Second, for emerging economies, financial development is at various stages and can exacerbate inefficiencies and mispricing in financial markets. Most emerging economies are bank-centric financial systems with capital markets at various levels of development. Foreign funding will likely be intermediated by banks, and feature in the domestic banks' balance sheets. Thus currency mismatch in the banking sector is a core policy concern.

Third, the global financial system interlocks developed and developing financial markets and institutions. If the literature is finding that global banks are changing their behavior because of market forces or regulatory changes, this is highly likely to have an impact on emerging economies banks and financial markets. If global banks are deterred from arbitraging away CIP deviations in developed markets, they may be reducing their engagement in arbitrage opportunities in emerging economy FX markets as well and possibly to an even greater degree given the higher risk associated with emerging markets.

The research questions is "Are the hedging needs of resident banks, and/or of foreign investors a proximate driver for CIP deviations in emerging market FX markets?"[10] From the perspective of the emerging economy domestic commercial banks,[11] if their foreign currency denominated core assets are greater than foreign currency denominated liabilities, they need to raise foreign currency denominated liabilities to close the gap. Focusing on the US dollar, the domestic banks can sell US dollars forward to create FX liabilities. This hedging activity will increase supply in the forward market, fostering deviations from covered interest parity. From the counterparty perspective, foreign entities may wish to hedge the foreign currency risk of an investment in Mexican domestic currency bonds, or investments in other emerging economies with less liquid currencies. Therefore they want to buy US dollars forward, which should have the opposite effect on the CIP deviation from that of the domestic banks' hedging. Thus hypothetically, the domestic banks hedging needs are met by these foreign counterparties. If the supply and demand is balanced, then CIP would hold and banks would continue to be able to fund their foreign currency assets. Or if arbitrageurs are not constrained, any CIP violation arising from residual bank hedging needs would be arbitraged away. To test whether domestic bank hedging widens CIP deviations, foreign currency hedging mea-

[10]There are other underlying factors that could be driving hedging activity. For example, in the Mexico case, oil price changes, trade frictions, or central bank interventions could all be drivers of Mexican peso - US dollar hedging. This paper is focused on whether shocks to FX hedging needs, and in particular via domestic banks, impact CIP deviations.

[11]In this paper, domestic banks refers to any banks operating in that jurisdiction, ie the residency basis. For example, the analysis uses the balance sheet of BBVA Bancomer, the foreign subsidiary of BBVA in Mexico, not BBVA's globally consolidated balance sheet.

sures for domestic bank and foreigners are each included in an econometric model of covered interest parity with constraints on arbitrage. Arbitrageur constraints are also interacted with the hedging needs to test for amplification and interaction effects.

The first analysis is conducted on a panel of 10 emerging economy currencies using publicly available data from the Bank of International Settlements (BIS) Locational Banking Statistics database and Bloomberg data. The economies were chosen based on the liquidity of their currency (see Table 1) and data availability. The panel includes Brazil (real), Hong Kong (dollar), Malaysia (ringgit), Singapore (dollar), South Korea (won), Taiwan (dollar), India (rupee), Mexico (peso), South Africa (rand) and Turkey (lira). I construct measures of resident bank hedging needs (total foreign currency or US dollar assets minus liabilities, excluding derivatives) and CIP deviations for the 3-month tenure for their respective currencies versus the US dollar using the underlying data from Bloomberg.[12]

The remainder of the paper exploits bank balance sheet data from regulatory filings in Mexico. First, an aggregate of the entire commercial banking system is constructed from bank level data. I analyze the aggregate banking sector FX balance sheets using both net (FX core assets minus liabilities) and gross hedging measures, and disaggregating by balance sheet category (liquid assets, loans, deposits, wholesale funding).[13]

Mexico provides an ideal setting to study CIP deviations in an emerging economy. The Mexican peso is a highly liquid currency. The peso entered the international payment system in 2008 and according to data from the BIS triennial central bank survey on foreign exchange turnover, USD43bn of Mexican pesos trade daily in the spot market on average and USD54bn in foreign exchange derivatives. The Mexican peso is consistently in the top 15 by amount of turnover, and of EM currencies, is second only to China in the most recent survey Bank for International Settlements (2016). (See Table 1.) Also the Mexican government securities market is well developed. Outstanding local currency risk-free government securities with maturities 12 months and under, known as cetes, are valued at around USD360bn, 32% of GDP. This compares to a local currency bond market valued at around 47% of GDP for Australia.(See Table 1.)

Furthermore, using the Mexican data, both domestic bank and foreign hedging can be analyzed to answer whether these sources of exogenous hedging demand affect the forward market as hypothesized (Mexican banks widening CIP deviations, foreigners narrowing).[14] Regulatory filings are used to construct a balance sheet for the Mexi-

[12] The available data is graphed in Figure 9, and for country level balance sheet details, Figures 11, 12, 13, 14, in the Appendix.

[13] Future work will exploit the bank level data to analyze heterogeneity of FX balance sheets among Mexico's banks.

[14] Due to data availability, the Mexico analysis focuses on the period post crisis, when the USD/MXN currency basis was persistently negative.

Table 1: Emerging economy currencies vs. major markets

	OTC Foreign Exchange Daily Turnover		Domestic Currency Gov. Bonds	
	(USD bn)	% nominal GDP	(USD bn)	% nominal GDP
USD	4,438	23.82	17,252	88.97
EUR	1,591	13.32	9,431	74.80
JPY	1,096	22.14	9,427	193.49
GBP	649	24.39	2,669	101.69
AUD	348	27.51	647	46.90
CNY	202	1.80	4,026	33.51
MXN	**97**	**9.00**	**362**	**31.5**
SGD	91	29.38	86	26.55
TRY	73	8.46	147	17.30
RUB	58	4.53	125	8.18
INR	58	2.55	832	31.87
BRL	51	2.84	1,557	75.77
ZAR	49	16.57	156	44.66

Daily turnover includes cash and derivatives markets. USD, GBP, EUR general government total debt securities reported, issuance is primarily in domestic currency. For the rest of the countries, general government domestic debt securities are reported.
Source: Triennial Central Bank Survey, IMF, BIS.

can banking system and calculate the system foreign currency funding gap (a proxy for banks net hedging needs). This data is combined with data on foreign currency derivatives transactions to construct the domestic banking system's net FX derivatives positions by counterparty. This data on derivatives provides an observed measure of foreign hedging demand, rather than a proxy.

Mexican domestic regulations on currency mismatch have been in place in Mexico since the early 1990s. Banks are required to hedge their dollar assets according to the following rule: the gap between foreign currency liabilities and assets (in either direction) must be less than 15% of Tier 1 capital (high-quality bank equity), $|A_{USD} - L_{USD}| < 15\% * T1Capital$. And, banks must hold enough liquid foreign currency assets. Inspecting the daily reporting data required by the Mexican central bank, banks in Mexico seem to be conservative and stay far from this constraint. Thus, I construct the foreign currency balance sheet of the banking system, and observe the FX funding gap between core assets and core liabilities (which exclude derivatives). The paper investigates the relation between this proxy for domestic bank FX hedging demand and the CIP deviations. Next, I ask if foreign hedging demand, measured by the FX derivatives transacted with foreign counterparties, has an impact on the CIP deviation.[15]

[15]There may be some part of these foreign counterparty FX derivatives transactions, as well the FX holdings of the Mexican banks, that are endogenous to the CIP deviation. To address this issue, I

The results for the emerging market panel and the Mexico case study show that hedging directly influenced the CIP deviations, even when foreign exchange bid-ask spreads and arbitrageur factors are also accounted for in the regression model. Interacting the hedging proxies and the arbitrageur balance sheet constraint variables provide mixed evidence that these amplify the affect of bank hedging demand. In sum, the results validate a key mechanism in the theoretical literature, ie that higher bank FX hedging demand (particularly from global banks), can indeed directly increase the cost of hedging. The implication is that the ability of domestic banks in emerging economies to manage currency mismatch can be affected by their global banks as well as by foreign hedging needs and arbitrageur behavior.

This paper adds to the literature on CIP deviations after the Global Financial Crisis by analyzing a panel of emerging market currencies and exploiting regulatory filings and FX derivatives transactions data to conduct an in-depth case study of Mexico. The Mexican FX derivatives data is split by counterparty and therefore the impact of actual foreign hedging transactions, rather than proxies, can be evaluated. And, the Mexican banks FX balance sheets can be disaggregated by type of instrument. In addition, global banks balance sheets can be separated from the commercial banking system as a whole. Prior research on CIP deviations in Mexico include Carstens (1985), Khor and Rojas-Suarez (1991) and Hernandez (2014). Of these, Hernandez (2014) is the most current, analyzing the period 2003 - mid-2012 and focusing on funding liquidity shocks during the crisis. The paper estimates a VECM to assess the role of US and European funding liquidity in CIP deviations for 1-month sovereign securities (US Treasury bills vs Mexican Cetes). Similar to the argument in Borio et al. (2016b) and Khor and Rojas-Suarez (1991), if CIP holds, there should be a cointegrating relationship between the domestic and foreign interest rate. Borio et al. (2016b) find this is true for Japanese yen - US dollar at the 2-year maturity for the post-crisis period, only when exogenous hedging demand is included in the model. Hernandez (2014) finds one cointegrating relationship exists for the 1-month maturity for Mexican peso - US dollar basis but only when the funding liquidity measures are included, providing evidence that funding liquidity is a factor in short-run Mexican CIP deviations.

The following section reviews covered interest parity, discusses the two potential drivers of deviations, hedging demand and limits to arbitrage, and motivates the econometric model to test for hedging effects. Section 3 describes the emerging economy panel analysis, section 4 discusses the Mexico in-depth case study.

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instrument for both hedging variables (foreign and domestic bank hedging). See Section 4 for further detail.

2 Methodological approach

2.1 Covered Interest Parity

Covered interest parity (CIP) is a no-arbitrage condition that states interest rates denominated in different currencies should be equal, once currency risk has been covered.

$$(1 + r_{t,m})S_t = (1 + r^*_{t,m})F_{t,m}$$

The domestic interest rate for maturity m and time t, $r_{t,m}$, and the foreign interest rate, $r^*_{t,m}$, equate when adjusted by the currency components. These are the exchange of domestic for foreign currency at the spot exchange rate (S_t) and the exchange of foreign for domestic currency at a later date at the forward exchange rate ($F_{t,m}$). The spot exchange rate, and interest rates are priced in more liquid markets than the forward market.[16] Thus one can rewrite the above relation as

$$F_{t,m} = S_t \frac{(1 + r_{t,m} + b)}{(1 + r^*_{t,m})}$$

and under covered interest parity, the cross-currency basis $b = 0$.

Theoretically the parity condition rests on the argument that any deviations would be arbitraged away, until there are no arbitrage opportunities. For example, taking the case of the Mexican peso and US dollar, when the cross-currency basis is negative $b < 0$,

$$\frac{F_{t,m}}{S_t}(1 + r^*_{t,m}) > (1 + r_{t,m} + b)$$

an arbitrageur (based outside of Mexico) would borrow US dollars at the cost $r_{t,m}$, swap these for Mexican peso at the spot market exchange rate S_t,[17] buy $S_t MXN$ worth of cetes at $r^*_{t,m}$. This will thus earn $(1+r^*_{t,m})S_t MXN$. The arbitrageur covers the exchange rate risk by buying from a dealer a forward contract $F_{t,m}$. The arbitrageur at maturity thus receives $(1 + r^*_{t,m})\frac{S_t}{F_{t,m}}USD$, and repays $(1 + r_{t,m})USD$. Arbitrage will continue as long as this is profitable, pushing returns in the two currencies closer to parity.[18]

CIP deviations can be measured in various ways, derived from the above equation. Using observed prices in the spot and forward markets, one can back out the implied

[16] A forward is a contract to exchange two currencies at a future date and price, agreed at time t. It is usually collateralized which is why default on the forward contract can induce market risk.

[17] Where the spot exchange rate is defined as MXN/USD, in other words, the number of US dollars per 1 Mexican peso.

[18] How close to parity the returns will be, is the subject of research dating back to the earlier part of the 20th century as discussed in Levich (2017). Estimates from the 1960s of how wide the CIP deviation needed to be to induce arbitrage ranged from 0.25% to 0.06%. Current anecdotal estimates are around 40-60 basis points.

domestic interest rate in the forward market and compare this to the observed interest rate on a zero-risk domestic government security.

2.2 Explanations for Deviations from Covered Interest Parity

Small deviations from covered interest parity have been explained by bid-ask spreads in the foreign currency markets.[19] At shorter maturities this spread may be a proxy for transaction costs, at longer maturities it may account for market liquidity. In addition to transaction costs, funding costs for would-be arbitrageurs and market segmentation have been emphasized.[20] For example, financial firms such as hedge funds may use repo markets to fund their arbitrage activities in foreign markets. Thus tighter relative repo funding conditions may deter arbitrage and prevent the interest rate differential from closing. However, other less easily quantifiable factors post crisis may be affecting economic agents participation and behavior, and consequently interest parity conditions. Compliance with banking regulations implemented after the global financial crisis increases the cost of deploying the balance sheet and may prompt some players to exit certain activities altogether. Internal risk management procedures, including concentration limits, liquidity management, and trading protocols, may have also evolved, altering the covered interest parity relation.

The literature on developed market currencies has emphasized two types of measurable risks as constraints on arbitrage activity: counterparty risk and market risk. Counterparty risk in the interbank market escalated rapidly during the Global Financial Crisis. In particular, this led to US dollar funding constraints as highlighted in Ivashina et al. (2015). As such, counterparty risk has become part of the arbitrage trade assessment. However since the crisis, the magnitude of this risk factor has decreased markedly as financial intermediaries have taken measures to strengthen their balance sheets. Also regulators have encouraged standardizable contracts to move to central clearing, facilitating a shift from currency forwards which are over the counter, to futures, which are centrally cleared and require margin to be posted. A common measure of counterparty risk in the interbank market is the spread between London Interbank Offer Rate (LIBOR) equivalent and the Overnight Indexed Swap (OIS). Market risk affects the value of foreign exchange collateral via unexpected exchange rate movements. Mark to market practices and supervisory pressure have highlighted market risk for FX collateral. In general, higher volatility can signal higher levels of uncertainty and expected risk. Both these factors affect currency contracts and pricing has evolved to

[19]For example see Akram et al. (2008).

[20]See Boyarchenko et al. (2018), Duffie (2017), Rime et al. (2017). In addition, Hernandez (2014) studies the Mexican case in particular and shows how US and European funding liquidity conditions relate to the Mexican peso-US dollar foreign exchange markets.

reflect these risks. Also, if a counterparty defaults on a collateralized forward contract, the collateral will be valued at the current market price. Thus counterparty and market risk can interact.

2.3 Hedging

In an era of financial globalization, and a period of low developed economy interest rates, cross-currency capital flows have induced foreign currency hedging needs. In Borio et al. (2016b), the authors connect exogenous US dollar hedging demand—from three main sectors: banks, institutional investors (like pension funds), and corporates—to CIP deviations. The authors provide time series econometric evidence that hedging demand has an effect in the US dollar-Japanese yen foreign exchange markets at the 3-month and 2-year maturity.[21] From the emerging economy perspective, low interest rates in the developing world offered cheaper borrowing costs, increasing currency mismatch issues, as highlighted in Chui et al. (2016). Much of this corporate activity is intermediated by banks and affects their foreign currency balance sheets. Meanwhile, search for yield motives have increased foreign interest in emerging economy financial assets, a trend supported by, and reenforcing, structural changes such as better macroeconomic management and the development of local currency bond markets in emerging economies.

2.4 The Impact of Hedging Demand on CIP Deviations

To test whether the domestic banking sector's foreign currency funding gap or foreign hedging needs affect the deviations from covered interest parity, I estimate the following econometric model:

$$b_t = \alpha + \beta_1 FXBidAsk_t + \beta_2 RelRepo_t + \beta_3 \theta_t + \beta_4 \sigma_t + \beta_5 Hedge_t + \epsilon_t \tag{1}$$

The first two terms are proxies for transaction costs and relative funding conditions in US dollar and domestic currency repo markets. Higher transaction costs and tighter funding conditions in US repo relative to domestic currency repo are expected to deter arbitrage and widen the basis ($\beta_1 < 0$ and $\beta_2 < 0$). Incorporating factors highlighted in the more recent literature, I include counterparty risk (θ) and market risk (σ) for foreign currency collateral. Both factors are expected to deter arbitrage (because they represent costs to deploying arbitrageur balance sheets) and prevent narrowing of the (negative) CIP deviation ($\beta_3 < 0$ and $\beta_4 < 0$). To proxy for counterparty risks in the

[21] At the shorter tenor, hedging demand only has an effect when interacted with arbitrageur balance sheet constraint variables (including counterparty and market risk). In contrast, hedging demand directly affects the CIP deviation at the longer maturity.

interbank market, I use the spread between the domestic currency interbank rate and the Overnight Indexed Swap (OIS) rate which is considered the least risky contract because it is settled only in differences. I use the options implied FX volatility to proxy for market risk.

The final term, *Hedge*, is the proxy for hedging needs. For the emerging economies panel, it is a a measure of the foreign currency mismatch in the country's banking sector. In the Mexico case study, it is a measure of net and gross domestic bank hedging needs derived from bank balance sheet data, foreigner hedging needs derived from derivatives transactions data, or a measure that aggregates these two offsetting hedging activities. The hypothesis is that exogenous hedging demand is a proximate determinant of the CIP deviations. The alternative is that on its own, hedging has no explanatory power. The Mexico case study can explicitly test the additional hypothesis that foreign investors need to hedge peso exposures, can offset the price effects of domestic bank hedging needs. Thus the expected sign of β_5 will depend on the hedge measure. For example, net domestic banking hedging measure is hypothesized to have the opposite sign from the foreigners' hedging measure.

3 Emerging Economy Panel

Figure 1 plots the cross-sectional average of 10 emerging economy currencies CIP deviations versus resident banks' core foreign currency assets minus liabilities (excluding derivatives). The panel includes Brazil (real), Hong Kong (dollar), Malaysia (ringgit), Singapore (dollar), South Korea (won), Taiwan (dollar), India (rupee), Mexico (peso), South Africa (rand) and Turkey (lira).

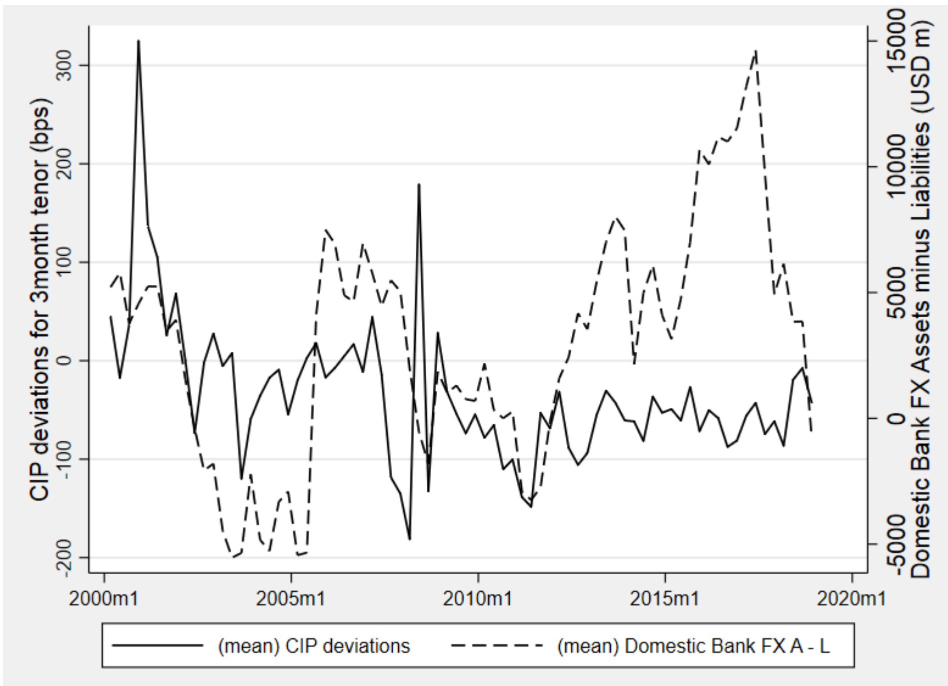
Table 2: 3-month CIP deviations satistics, by country

Country	Max	Min	Mean
Brazil	282.85	-532.67	-140.57
Taiwan	982.62	-479.81	-112.20
Hong Kong	245.36	-198.78	-15.05
India	175.24	-434.84	-91.56
Malaysia	158.16	-373.18	-94.29
Mexico	245.36	-198.78	-35.92
Singapore	74.57	-229.20	-15.18
South Africa	83.64	-134.91	-23.22
South Korea	156.14	-79.96	-13.70
Turkey	2453.92	-221.13	-43.80

The mean for Turkey and Taiwan excludes two positive value outliers.
Source: Bloomberg, authors calculations.

Individual CIP series are plotted in Figure 9 in the Appendix.[22] For most of the sample, the bases are negative, with the largest negative basis in the Brazilian real vs. US dollar, at 532 basis points.[23] Individual foreign currency balance sheets for each of the 10 emerging economies are included in the Appendix, Figures 11, 12, 13, 14. Currency mismatch is calculated for US dollar only, except for Malaysia, Hong Kong and Singapore where total foreign currency assets and liabilities are used instead because of data availability.

Figure 1: Domestic Bank FX funding gap (USD millions) vs. CIP deviations (bps)



Average across 10 emerging economy currencies of system wide FX assets minus FX liabilities plotted against CIP deviations for the 3 month tenor.
Source: Bloomberg, Bank of International Settlements (BIS)

Tables 3 and 4 report regressions results for the panel of 10 emerging economies. All specifications include country fixed effects. For the emerging market panel, overnight indexed swap (OIS) rates were unavailable for several markets. As a result the regression specifications that include the counterparty risk measure (interbank rate minus OIS rate) have fewer observations. In Table 3, columns 1 and 2 include all years of the available data, whereas columns 3 and 4 exclude 2008 and 2000. In 2008, the global financial crisis shocked markets, Turkey's CIP deviation spiked to 2453 basis points.

[22]The unbalanced panel covers the time period March 2000 to December 2018. Hong Kong and Singapore have data from 2000, Malaysia is the smallest time series starting in September 2011.

[23]I find that the emerging economy CIP deviations are comparable to developed market currencies, for example Japanese yen. This is somewhat different to the findings in Frankel and Poonwala (2009) which show that the forward premium (another way to measure CIP deviations) in emerging economy currencies is smaller than for developed. The difference may stem from the different sample periods.

The next highest maximum was in 2000 for Taiwan at 982 basis points. These two years are excluded. All other CIP deviations remain below 282 and the data has no comparable outliers for the negative deviations.

In Table 3, the coefficient estimates for the domestic bank hedging proxy are negative as hypothesized, and in all but one specification, statistically significant. This is evidence that for these emerging economies on average, bank behavior has a direct effect on the short-run basis: higher currency mismatch is associated with wider (more negative) CIP deviations. In Table 3, there is little evidence that the arbitrage constraint variables on their own are important. [24]

Table 3: Resident bank hedging needs direct effect on 3-month CIP deviation

	Dependent variable: CIP deviations (basis, 3m)			
	Full Sample		Excluding 2008 & 2000	
	(1)	(2)	(3)	(4)
Hedge, Dom. Bank	-0.00612	-0.0172*	-0.0214*	-0.0306***
	(0.0158)	(0.0102)	(0.0115)	(0.00927)
Bid-ask spreads	-1.308	4.023	-1.142	34.39***
	(2.378)	(2.551)	(14.57)	(11.25)
Interbank_OIS		-7.404		6.093
		(11.19)		(9.876)
Implied FX Vol		2.688		2.315
		(2.182)		(2.124)
Observations	557	309	516	293
Adjusted R^2	0.066	0.123	0.176	0.160
F	8.291	5.308	10.38	8.411

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.
Country fixed effects included in all regressions.

Table 4 reports the estimation results with interaction terms between the bank hedging variable and arbitrage constraint variables. The hypothesis is that high demand for hedging by domestic banks widens the CIP deviation, but constrained arbitrageurs will not execute arbitrage trades that would narrow the CIP deviation. Higher balance sheet costs (for example capital requirements for market risk and counterparty risk) reduce arbitrageur activity. The domestic bank hedging proxy on its own remains statistically significant in the interaction specifications. The market risk variable, implied volatility of the exchange rate, shows an interaction effect. The coefficient is positive,

[24] Nevertheless, in Table 3 column (4), the inclusion of the arbitrage variables causes the coefficient estimate on the bid-ask spreads to become statistically significant and positive, and this result is also obtained in the specifications with interaction effects between the arbitrage constraint variables and the hedging measure in Table 4. It may be the case that higher transaction costs or less liquidity in the forward and spot markets does not deter arbitrage activity for these emerging market currencies on average. In the case of Mexico, the coefficient estimate is often not statistically different from 0.

Table 4: Resident bank hedging needs interaction with balance sheet cost variables

	Dependent variable: CIP deviations (basis, 3m)			
	(1)	(2)	(3)	(4)
Bid-ask spreads	34.39***	33.47***	25.61**	35.07**
	(11.25)	(11.03)	(12.09)	(14.02)
Interbank_OIS	6.093	7.461	4.148	22.37
	(9.876)	(9.989)	(10.12)	(22.47)
Implied FX Vol	2.315	2.454	2.588	2.357
	(2.124)	(2.161)	(2.148)	(2.200)
Hedge, Dom. Bank	-0.0306***	-0.0243**	-0.0541***	-0.0565***
	(0.00927)	(0.00946)	(0.0134)	(0.0181)
Hedge × Interbank_OIS		-0.0141		-0.0298
		(0.0116)		(0.0242)
Hedge × FX Implied Vol.			0.00568**	0.00720**
			(0.00264)	(0.00313)
Triple Interaction				0.00563
				(0.00379)
Constant	-10.82	-11.06	0.462	2.333
	(9.720)	(9.673)	(11.45)	(12.78)
Observations	293	293	293	293
Adjusted R^2	0.160	0.158	0.165	0.162
F	8.411***	7.829***	7.998***	6.700***

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.
Country fixed effects included in all regressions. Sample excludes 2008.

higher market risk (or expected volatility) is associated with narrower (negative) CIP deviations.

The post-crisis literature on the role of arbitrageur constraints, argues that arbitrageurs are constrained by balance sheet factors like market and counterparty risk, in other words they will not enter arbitrage trades (and narrow the CIP deviations) if market risk is higher. However the evidence in Table 4 suggests that this is not the case for emerging economies. In fact higher expected volatility in the foreign exchange market offsets the widening pressure of the domestic bank hedging needs. This result may be particular to emerging economy currencies where currency volatility has historically been high, and thus the expected volatility may represent a trading opportunity that attracts arbitrageur activity.[25]

For example, using the βs from Table 4, column (4), the estimated interaction effect of the FX implied volatility variable at its mean level is 0.06519, at its maximimum level 0.21648. Thus the widening effect of the bank hedging variable (estimated at -0.0565)

[25] The heterogeneity of financial systems across emerging economies, characteristics such as capital mobility, exchange rate flexibility and depth of local currency bond markets, as well as the presence of large global banks, may also be important.

is completely offset by the effect of the expected FX volatility.[26]

4 Mexico

Exploiting data from regulatory filings, this section focuses on hedging demand in the US dollar-Mexican peso foreign exchange markets at relatively short maturities, up to 1 year, and the econometric model will include controls for the variables highlighted in the literature.[27] The two measures of FX hedging needs under analysis are 1. Mexican banks business model driven currency mismatch, and 2. foreign investor needs driven by international capital flows into peso denominated assets.

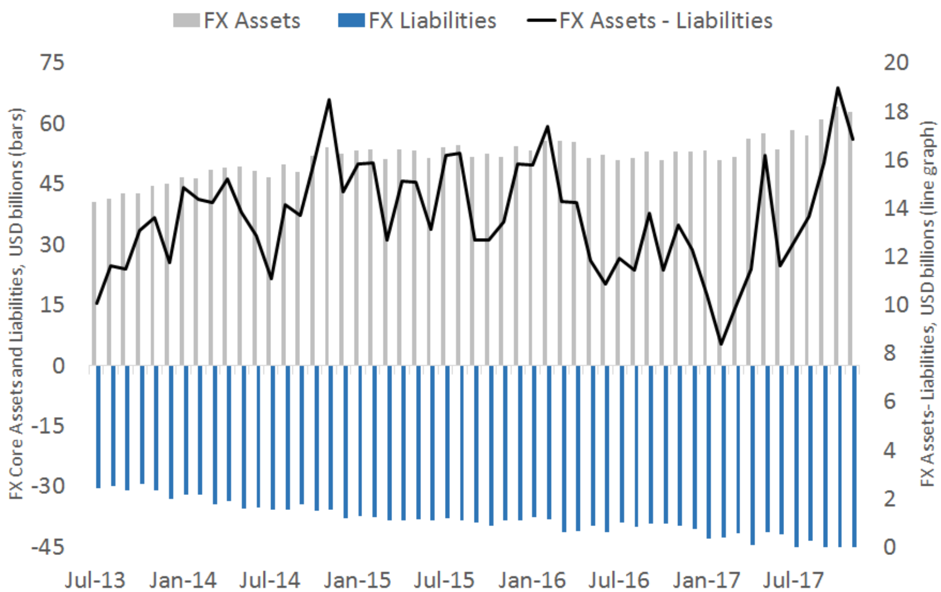
The sample period for the regression analysis begins in July 2013, the starting date for which detailed FX derivatives data is available. With respect to domestic bank hedging demand, Figure 2 shows the total foreign currency denominated core balance sheet of the Mexican banking system. For Mexico, the vast majority of foreign currency assets and liabilities are denominated in US dollars and as such the graph is roughly equivalent to the US dollar denominated balance sheet. Note that foreign currency core assets (grey) are greater than foreign currency core liabilities (blue), and that core assets and core liabilities exclude all FX derivatives transactions. The FX funding gap (line) varies from around USD7bn to USD20bn over the period of interest. Data is the value at the end of each month, unless noted otherwise.

With respect to hedging motives for non-Mexican investors, Figure 3a charts the month-end foreign holdings of Mexican local currency bonds of up to 1-year maturity (cetes), and for longer maturities (bonos). One can see that foreign holdings of peso-denominated bonds overall has been consistently high, although shorter maturities (cetes) began declining in 2015. Foreigners continue to hold a large portion of outstanding local currency bonds, totalling around 70%, see Figure 3b. Of course a proportion of these bonds are involved in unhedged transactions such as carry trades. Therefore, using supervisory data on derivatives transactions, actual hedging behavior is observed via foreign exchange derivatives contracts by counterparty. Figure 4 plots the Mexican banking system's net derivatives transactions involving foreign exchange, by counterparty; the foreign financial entities series will be used as the foreign hedging demand measure in the analysis. We can see that net FX derivative transactions with foreign financial entities declines from a peak of around USD37bn starting around 2015, the same time that foreign holdings of cetes began declining from around USD40bn.

[26] Decomposing the marginal effect of domestic bank net hedging needs calculated as $dy/dx = -0.0565 + 0.00720*\text{FX Implied Vol}$, the second term represents the estimated interaction effect.

[27] Other research on longer term hedging demand and foreign debt positions includes Klingler and Sundaresan (2018) (interest rate hedging) and Borio et al. (2017) (FX hedging).

Figure 2: FX balance sheet of commercial banks in Mexico (USD billions, month-end)



System wide balance sheet constructed using individual bank level data.
Source: Comisión Nacional Bancaria y de Valores (CNBV), Banco de México.

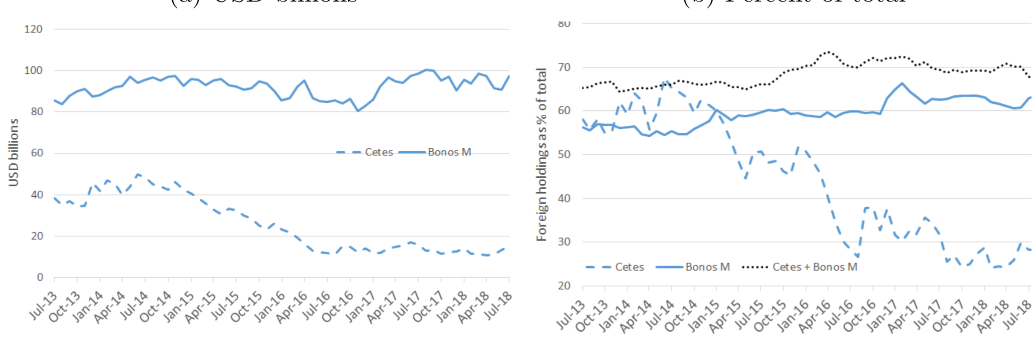
This is consistent with the view that foreigners' local currency bond (cetes) investments motivated foreign FX hedging activity and thus purchases of US dollars forward.

4.1 CIP Deviations

CIP deviations for the four short-run cetes maturities (1, 3, 6 and 12 months) are calculated using Bloomberg data. As seen in Figure ??, for the case of Mexico, the differential between the forward market implied rate and the observed risk free rate post crisis was persistently negative from 2010 until around 2016. The spread for different maturities tend to move together, although there are periods early in the

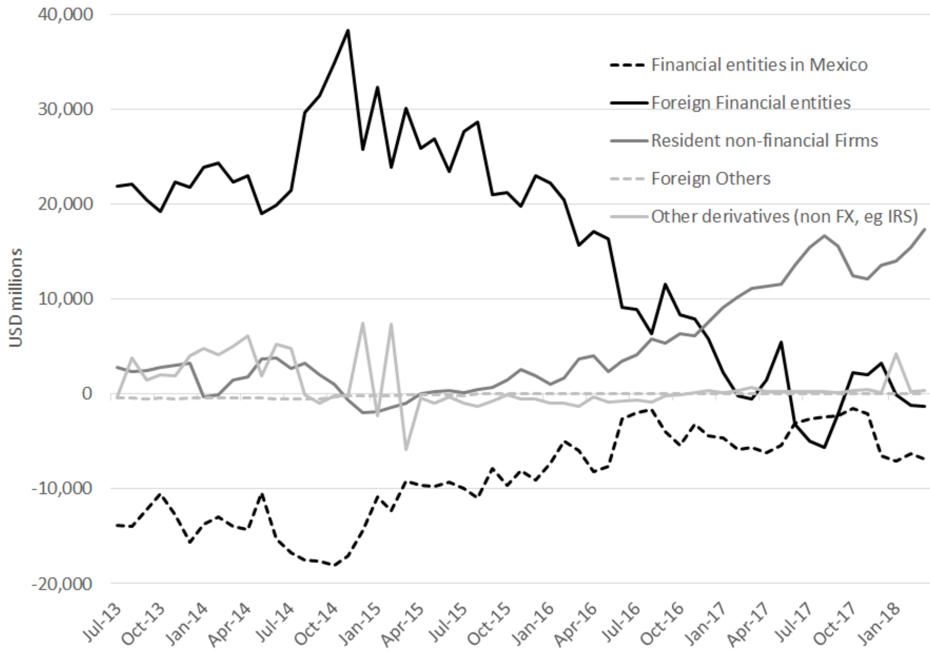
Figure 3: Foreign holdings of Mexican local currency bonds, month-end

(a) USD billions (b) Percent of total



Total foreign holdings in USD billions and as percent of total outstanding.
Source: Banco de México.

Figure 4: Mexican banking system's FX derivatives, by counterparty, month-end



System wide liabilities net of assets, constructed using individual bank balance sheet data.
Source: Comisión Nacional Bancaria y de Valores (CNBV), Banco de México.

sample where the 12-month and 6-month seem to move in opposite directions to the shorter maturities.

Using principal component analysis on the four maturities, a single measure of CIP deviation is constructed for graphical analysis. The first principal component (explaining 86% of the joint variation in the bases) is persistently different from zero.[28] Note that the principal component of the negative of the bases (the Mexican peso risk free rate (cetes) minus the forward market implied interest rate) was used for comparison with the hedge variables in Figure 5b and 6b.

4.2 Domestic Bank Hedging Demand

Mexican domestic regulations on currency mismatch have been in place in Mexico since the early 1990s. Banks are required to hedge their dollar assets according to the following rule: the gap between foreign currency liabilities and assets (in either direction) must be less than 15% of Tier 1 capital (high-quality bank equity), ie the net open position $|A_{USD} - L_{USD}| < 15\% * T1Capital$. And, banks must hold enough liquid foreign currency assets.[29] However, from inspecting Mexican regulatory data on daily

[28] The overall Kaiser-Meyer-Olkin measure of sampling adequacy scored 0.7070, slightly higher than the score when using daily data.

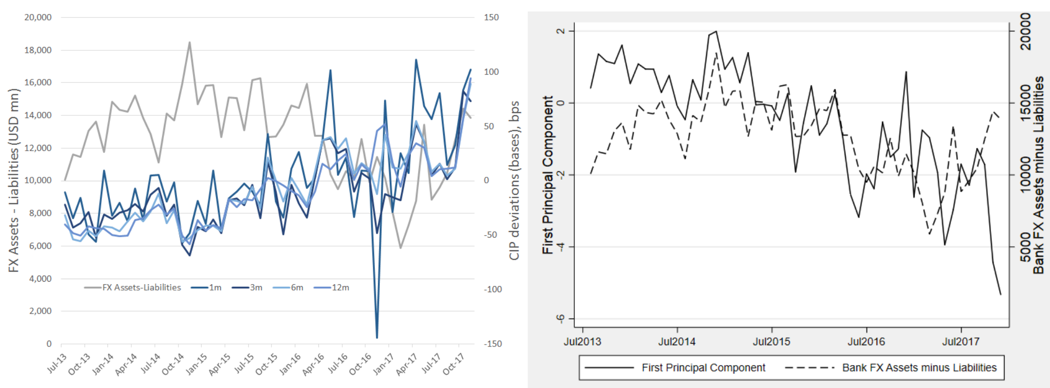
[29] Liquid assets include the bank's own FX deposits with highly-rated institutions, US Treasuries, Central Bank deposits, and highly rated short-term securities (which are preferred because of their non-zero yield). See Section 4.7 for more detail.

positions, banks are far from this constraint and thus seem to manage foreign currency funding more conservatively than the regulation threshold.

I assume that management of the foreign funding gap is the dominant hedging motive for banks in Mexico and use foreign currency core assets net of core liabilities (excluding FX derivatives) as a proxy for Mexican bank demand for US dollar hedging. Using bank filing data from the banking authority Comisión Nacional Bancaria y de Valores (CNBV), monthly balance sheet data has been compiled for the Mexican banking system as a whole for the period July 2013 to November 2017. Figure 5a plots the domestic banking sector foreign funding gap and the four Mexican peso - US dollar bases. Using the first principle component, Figure 5b plots the Mexican banking system balance sheet currency mismatch with the first principal component of the negative of the four different bases for ease of visual comparison.

Figure 5: Domestic bank FX funding gap (USD millions) vs. CIP deviations (bps)

(a) Basis for each tenor (b) PC of 4 bases



The plot compares the dynamics of the bases to the Mexican resident banks' hedging needs variable. Panel b uses the negative of the principal component of the bases.
Source: Bloomberg, Comisión Nacional Bancaria y de Valores (CNBV), Banco de México.

4.3 Foreigner Hedging Demand

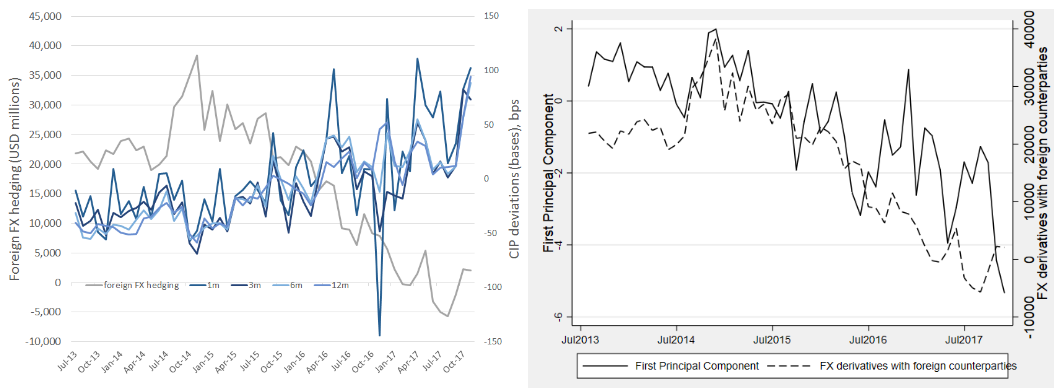
Search for yield by institutional investors has driven the development of new investment products and intermediation channels. Foreign investor appetite for local currency bond holdings rises as these domestic markets develop. Global asset management companies can offer mutual funds with diversified local currency fixed income portfolio opportunities. I assume that the dominant motive for these foreigners is to hedge some portion of their peso denominated investments.

Daily derivatives transactions data from Banxico and balance sheet data from Comisión Nacional Bancaria y de Valores (CNBV), are used to construct monthly net transactions data for the Mexican banking system for the period July 2013 to November

2017. I use the foreign counterparty foreign exchange derivatives transactions data as the measure for foreign FX hedging demand. The bulk of foreign counterparty foreign exchange derivatives transactions are with foreign financial entities. Figure 6a plots the amount of FX derivatives with foreign counterparties (liabilities net of assets) and the four Mexican peso - US dollar bases. Figure 6b plots the amount of FX derivatives with foreign counterparties (liabilities net of assets) against the first principal component of the negative of the four different bases for ease of visual comparison.[30]

Figure 6: FX derivatives with Foreign (USD millions) vs. CIP deviations (bps)

(a) Basis for each tenor (b) PC of 4 bases



The plot compares the dynamics of the bases to the foreign hedging need variable. Panel b uses the negative of the principal component of the bases.
Source: Bloomberg, Comisión Nacional Bancaria y de Valores (CNBV), Banco de México.

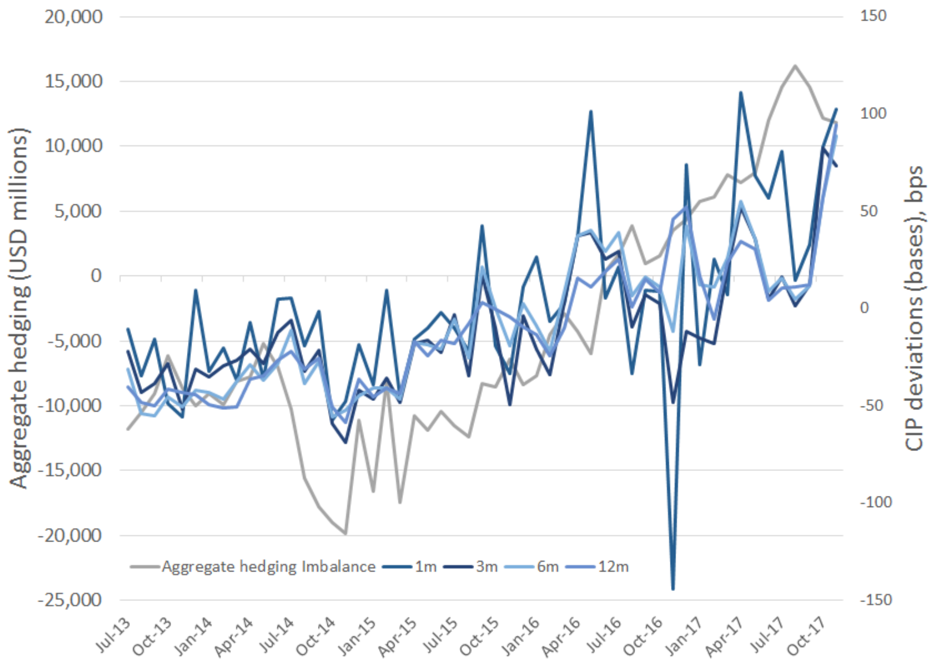
The graphs give support to the story that the Mexican banking system creates USD liabilities by selling dollars forward in order to manage the gap between its US dollar assets and liabilities, while foreign investors were lending US dollars via FX swaps in order to hedge their purchases of cetes. These two hedging measures exert offsetting pressure on the CIP deviation. Thus the banks benefited from the foreign participation. Aggregating the two hedging measures (Mexican banks' funding gap minus the foreign counterparty hedging), Figure 7 plots the aggregate hedging imbalance (Mexican banks funding gap minus the foreign counterparty hedging) against the four different bases. We can see the remaining imbalance and its link to CIP deviations.

4.4 Regression Analysis

To test whether the domestic banking sector's foreign currency funding gap and foreign hedging needs affect the deviations from covered interest parity, I estimate the following econometric model on monthly data for Mexico for July 2013 to November 2017:

[30] See Table 15 in the Appendix for Summary Statistics for the sample period.

Figure 7: Bank FX funding gap minus foreign FX hedging vs. CIP deviations (bps)



The plot shows the aggregated hedging measure and the four local currency bond bases. Source: Bloomberg, Comisión Nacional Bancaria y de Valores (CNBV), Banco de México.

$$b_t = \alpha + \beta_1 FXBidAsk_t + \beta_2 RelRepo_t + \beta_3 \theta_t + \beta_4 \sigma_t + \beta_5 Hedge_t + \epsilon_t \quad (2)$$

Mexican repo is only overnight, therefore I use the same relative repo measure for all four maturities. To proxy for counterparty risks in the interbank marke (θ)t, I use the spread between Mexican LIBOR (TIIE) and OIS. All variables have been standardized (0 mean and variance of 1) to allow for ease of interpretation of the coefficient estimates β. A 1 standard deviation change in the covariate X, induces a β times standard deviations change in the CIP deviation. This transformation also obviates the need for a constant term in the implemented regression. The final term, $Hedge$, is the proxy for hedging needs.

There may be some part of the foreign counterparty FX derivatives transactions that are endogenous to the CIP deviation. To address this issue econometrically, I instrument for foreign hedging demand using appropriately lagged values of the FX derivatives transactions with foreigners variable. Table 16 in the Appendix demonstrates that the 3rd lagged value and beyond, satisfy the exclusion restriction requirement. Using the third lag alone, the regression model weakly passes endogeneity tests. Using more than two lags results in failing overidentification tests. Consequently, I use two lags, the 3rd and 4th lags, as instruments for the contemporaneous value. This specification passes the endogeneity test with p-values of 0.24 (the null is exogeneity).

Mexican bank behavior may also be influenced by the CIP deviation. Thus to address the endogeneity of the bank currency mismatch variable, I use lagged values as instruments. The lagged values are statistically insignificant in the main equation, and the first few lags are well correlated with the value of the contemporaneous currency mismatch. I use two lags, the 1st and 2nd, as instruments for the contemporaneous value. The specification passes endogeneity tests with p-values of 0.25 (the null is exogeneity).

Table 5 reports the estimation results for the 3-month maturity, the tenor typically analyzed in the literature on short-term CIP deviations. In column (1), the standard CIP deviations variables are included. Columns (2) - (7) include the additional regressors. The coefficient on the bid-ask spreads in the forward and spot FX markets (Transaction Cost) is correctly signed (higher transaction costs or lower liquidity drive the (negative) basis wider) but statistically significant in only two of the regression specifications. Counterparty risk (Mexican LIBOR-OIS, θ) is also correctly signed (higher counterparty risk, wider CIP deviation) and statistically significant in all but one of the specifications.[31] In contrast, there is no evidence that relative repo funding or market risk (FX Implied Volatility, σ) on their own are key drivers of the 3-month CIP deviation. Both hedging variables have coefficient estimates with the correct signs (domestic USD hedging demand widens the negative basis, foreign peso hedging narrows the basis), and are statistically significant. Furthermore, the estimated coefficient on the net hedging imbalance (domestic - foreign), Agg Hedge, is also statistically significant and negative.

Tables 6, 7 and 8 report results for all four cetes maturities, showing the estimated direct effect of Mexican banking system or foreign hedging or the aggregate hedge demand measure on covered interest parity deviations during this time period.

The coefficient estimates on the domestic bank FX funding gap variable are statistically significant for three out of four of the maturities. The estimates range from -0.357 to -0.603. The interpretation is that domestic bank hedging needs (to create USD liabilities, i.e. hedge USD assets) widen the basis, a 1 standard deviation increase in domestic bank hedging needs (around USD2.6bn), widens the 3-month CIP deviation by an estimated 0.603 of a standard deviation (about 19 basis points). Table 7 reports results showing estimates for the effect of foreign hedging demand. These are slightly more precisely estimated and of greater magnitude, ranging from 0.596 to 0.771. Thus when the basis is negative, foreign hedging needs narrow the CIP deviation (make it

[31] Given that the dependent variable contains information from Mexican LIBOR (TIIE), I conduct the Durbin-Wu-Hausman augmented regression test to check whether endogeneity problems arise when using the TIIE-MXNOIS spread as a regressor. The test result shows no evidence of inconsistency: the p-value for the coefficient on the first equation residuals are all high: Table 5 Column (2) 0.55, Column (4) 0.58, Column (5) 0.58, Column (6) 0.48, thus rejecting the null of endogeneity.

Table 5: Hedging needs direct effect on 3-month CIP deviation

	Dependent variable: CIP deviations (basis, 3m)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Transaction Cost	-0.164*	-0.201*	-0.112	-0.166	-0.062	0.071	-0.047
	(0.098)	(0.102)	(0.109)	(0.115)	(0.104)	(0.114)	(0.095)
RelRepoFF	-0.122	-0.012	-0.096	-0.007	-0.058	-0.102	-0.078
	(0.109)	(0.117)	(0.119)	(0.121)	(0.123)	(0.103)	(0.111)
LIBOR_OIS 3M		-0.248*		-0.225*	-0.206*	-0.150	-0.200*
		(0.130)		(0.133)	(0.106)	(0.122)	(0.100)
FX Implied Vol.			0.148	0.087	-0.117	-0.109	-0.130
			(0.122)	(0.116)	(0.125)	(0.139)	(0.096)
Hedge, Dom. Bank					-0.603***		
					(0.201)		
Hedge, For. Fin.						0.771***	
						(0.184)	
Agg Hedge							-0.301***
							(0.059)
Observations	53	53	53	53	51	49	53
Adjusted R^2	0.019	0.053	0.017	0.039			0.284
Root Mean Sqrd. Error	0.981	0.964	0.982	0.971	0.915	0.754	0.838

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.

Hegde, Dom. Bank is instrumented by its 1st and 2nd lags, passing exogeneity tests.

Hegde, For. Fin. is instrumented by its 3rd and 4th lags, passing exogeneity tests.

Aggregate Hegde defined as Domestic bank - foreign hedging.

Table 6: Bank hedging needs direct effect on CIP deviations

	basis, 1m (1)	basis, 3m (2)	basis, 6m (3)	basis, 12m (4)
Hedge, Dom. Bank	-0.357*	-0.603***	-0.514**	-0.121
	(0.216)	(0.201)	(0.201)	(0.119)
Transaction Cost	-0.181	-0.062	-0.134	0.059
	(0.110)	(0.104)	(0.098)	(0.095)
RelRepoFF	0.034	-0.058	-0.042	0.050
	(0.108)	(0.123)	(0.092)	(0.061)
LIBOR_OIS	-0.055	-0.206*	0.001	-0.125
	(0.083)	(0.106)	(0.158)	(0.083)
FX Implied Vol.	-0.058	-0.117	0.187	-0.130
	(0.119)	(0.125)	(0.154)	(0.101)
Observations	51	51	51	51
Root Mean Sqrd. Error	0.933	0.915	0.807	0.455

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.

Hegde, Dom. Bank is instrumented by its 1st and 2nd lags, passing exogeneity tests.

a. The first difference is used for the 12month basis to correct a unit root.

Table 7: Foreign investor hedging needs direct effect on CIP deviations

	basis, 1m (1)	basis, 3m (2)	basis, 6m (3)	basis, 12m (4)
Hegde, For. Fin.	0.596***	0.771***	0.738***	0.0327
	(0.151)	(0.184)	(0.181)	(0.137)
Transaction Cost	-0.0865	0.0715	0.0287	0.0477
	(0.103)	(0.114)	(0.101)	(0.0988)
RelRepoFF	0.0380	-0.102	-0.0107	0.0600
	(0.110)	(0.103)	(0.0800)	(0.0591)
LIBOR_OIS	-0.0347	-0.150	-0.134	-0.143
	(0.0696)	(0.122)	(0.113)	(0.0949)
FX Implied Vol.	-0.107	-0.109	0.111	-0.105
	(0.127)	(0.139)	(0.118)	(0.113)
Observations	49	49	49	49
Root Mean Sqrd. Error	0.858	0.754	0.629	0.475

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.

Hegde, For. Fin. is instrumented by its 3rd and 4th lags.

a. The first difference is used for the 12month basis to correct a unit root.

Table 8: Aggregate hedging needs direct effect on CIP deviations

	basis, 1m (1)	basis, 3m (2)	basis, 6m (3)	basis, 12m (4)
Agg Hedge	-0.248***	-0.301***	-0.297***	-0.048
	(0.058)	(0.059)	(0.052)	(0.044)
Transaction Cost	-0.152	-0.047	-0.125	0.063
	(0.108)	(0.095)	(0.093)	(0.092)
RelRepoFF	0.015	-0.078	-0.053	0.056
	(0.114)	(0.111)	(0.091)	(0.062)
LIBOR_OIS	-0.052	-0.200*	-0.073	-0.127
	(0.084)	(0.100)	(0.140)	(0.090)
FX Implied Vol.	-0.123	-0.130	0.068	-0.108
	(0.114)	(0.096)	(0.128)	(0.098)
Observations	53	53	53	52
Adjusted R^2	0.148	0.284	0.394	-0.018
Root Mean Sqrd. Error	0.915	0.838	0.771	0.487

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.

a. The first difference is used for the 12month basis to correct a unit root.

Aggregate Hedge defined as Domestic bank - foreign hedging.

more positive). A 1 standard deviation increase in foreign hedging transactions (around USD11.2bn), narrows the 3-month CIP deviation by an estimated 0.771 of a standard deviation (about 26 basis points). The coefficient on Agg. Hedge also has a negative sign, implying that during this period on average, widening pressure comes from the residual hedging need (which is from Mexican banks).

Results for the three shorter maturities are broadly similar, all hedging variables have a statistically significant direct effect on the interest rate differential, with the foreign hedging effect stronger. However, for the 12-month maturity, the estimated effect of hedging needs are not statistically different from 0. This could be because Mexican LIBOR is not available at a 12-month tenure, and as such a direct measure of counterparty risk is not available. Instead the 6-month counterparty risk measure is used as a proxy in this regression. There may also be different dynamics that affect the 12-month maturity.[32]

With regards to the other covariates, the results are mixed. In the foreign hedging regression, Table 7, the additional covariates are not significant and only the estimated coefficient on counterparty risk is correctly signed for all four maturities. In the bank hedging regression, Table 6, estimates of the effect of bid/ask spreads in the forward and spot FX markets (Transaction Costs) have negative coefficients (as expected) but are not statistically significant. Counterparty risk (Mexican LIBOR-OIS, θ) is correctly

[32]The first difference of the 12-month CIP deviation is used as the dependent variable, since stationarity tests showed the presence of a unit root.

signed for 1, 3 and 12 month tenors, however the coefficient estimate is only statistically significant at the 3-month maturity.[33] Similarly, implied volatility (market risk, σ) has an estimated widening effect for 1, 3 and 12 month tenors, as expected, but this is not statistically significant. This suggests that variables that are important for developed market currency markets may not be the key factors in the peso market, and that the 12-month maturity has distinct dynamics from the shorter maturities.

The hedging demand result discussed above is different from Borio et al. (2016b) who find that for the short maturity (3 month) Japanese yen - US dollar CIP deviations, hedging demand affects the CIP deviation only when interacted with the arbitrageur balance sheet cost variables. The hedging demand variable directly affects the JPY/USD CIP deviation only at the 2-year maturity. For the Mexican peso, the above results show hedging needs have the direct effect at the shorter maturities.

4.5 Arbitrage Constraints Interaction with Hedging Needs

Table 9: Domestic bank hedging interaction with balance sheet cost variables

	Dependent variable: CIP deviations (basis, 3m)				
	(1)	(2)	(3)	(4)	(5)
Transaction Cost	-0.128	-0.116	-0.131	-0.127	-0.142
	(0.0962)	(0.0995)	(0.0939)	(0.101)	(0.0993)
RelRepoFF	-0.0430	-0.0674	-0.0370	-0.0711	-0.0338
	(0.115)	(0.122)	(0.109)	(0.125)	(0.110)
LIBOR_OIS 3M	-0.225**	-0.257*	-0.242**	-0.227	-0.214
	(0.111)	(0.152)	(0.109)	(0.167)	(0.137)
FX Implied Vol.	-0.0634	-0.0779	-0.0713	-0.0919	-0.0778
	(0.109)	(0.107)	(0.0937)	(0.107)	(0.0951)
Hedge, Dom. Bank	-0.603***	-0.609***	-0.646***	-0.640***	-0.738***
	(0.201)	(0.198)	(0.190)	(0.186)	(0.271)
Hedge*LIBOR_OIS		-0.0268		0.0338	0.160
		(0.0934)		(0.0745)	(0.163)
Hedge*FX Implied Vol.			0.226*	0.239**	0.302**
			(0.118)	(0.118)	(0.135)
Triple Interaction					-0.275
					(0.307)
Observations	51	51	51	51	51
Root Mean Sqrd. Error	0.915	0.916	0.907	0.905	0.925

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.

Hegde, Dom. Bank is instrumented by its 1st and 2nd lags, passing exogeneity tests.

[33] This complements evidence in Hernandez (2014) that LIBOR-OIS spreads are important for Mexican CIP deviations.

Table 10: Aggregate hedging interaction with balance sheet cost variables

	Dependent variable: CIP deviations (basis, 3m)				
	(1)	(2)	(3)	(4)	(5)
Transaction Cost	-0.047	-0.038	-0.066	-0.088	-0.068
	(0.095)	(0.099)	(0.092)	(0.103)	(0.110)
RelRepoFF	-0.078	-0.089	-0.078	-0.054	-0.042
	(0.111)	(0.117)	(0.106)	(0.120)	(0.124)
LIBOR_OIS 3M	-0.200*	-0.214*	-0.212**	-0.185**	-0.229**
	(0.100)	(0.107)	(0.097)	(0.087)	(0.103)
FX Implied Vol.	-0.130	-0.133	-0.142	-0.137	-0.101
	(0.096)	(0.096)	(0.085)	(0.086)	(0.100)
Agg Hedge	-0.301***	-0.303***	-0.298***	-0.294***	-0.327***
	(0.059)	(0.058)	(0.054)	(0.052)	(0.076)
AggHedge*LIBOR_OIS		-0.025		0.053	0.083
		(0.054)		(0.045)	(0.056)
AggHedge*FX Implied Vol.			0.113***	0.140***	0.150***
			(0.033)	(0.038)	(0.040)
Triple Interaction					-0.080
					(0.075)
Observations	53	53	53	53	53
Adjusted R^2	0.284	0.271	0.319	0.311	0.305
Root Mean Sqrd. Error	0.838	0.846	0.818	0.822	0.826

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.

Aggregate Hedge defined as Domestic bank - foreign hedging.

Tables 9 and 10 report estimation results for regressions that include interaction terms between the *Hedge* variables and arbitrageur balance sheet cost variables (counterparty risk and market risk). Transaction costs and relative funding conditions have the expected signs, although they are not statistically significant. The estimated coefficients on the hedging demand variables are signed as expected and remain statistically significant in all the regressions.

With respect to arbitrageur balance sheet variables, the estimated coefficients on counterparty risk (Mexican LIBOR-OIS) and market risk (FX Implied Volatility) are correctly signed in all the regressions. For domestic bank hedging demand and the Agg hedge net measure (Tables 9 and 10), counterparty risk is significant on its own, but has no amplifying effect. For market risk it is the opposite, the variable has no direct estimated effect but does interact with the domestic bank and net FX hedging measures. As in the emerging economy panel analysis, the coefficient on the interaction between bank hedging demand and FX Implied volatility is positive. The arbitrageur constraint hypothesis argues that increased implied FX volatility is a risk factor that could amplify the widening effect of bank's hedging because it prevents arbitrage activity from narrowing the negative CIP deviation. However, the results show higher implied volatility is associated with more positive (narrower) CIP deviations. This estimated offsetting effect may be the result of increased volatility attracting trade, rather than the hypothesized deterent balance sheet cost. The triple interaction term is not statistically significant. These results corroborate the earlier regressions in Table 5 for the 3 month tenor showing counterparty risk is important, and provide evidence that market risk is actually important when interacted with domestic bank hedging needs, but not in the manner suggested in the literature on developed market arbitrageur constraints.

4.6 Robustness

4.6.1 Emerging Market Risk

It may be the case that the pricing of emerging market sovereign bonds used in an arbitrage strategy does not capture fully their riskiness. One independent measure of creditworthiness is the CDS spread for the bond, a market price for the cost of default insurance. The buyer of CDS does not have to own the underlying bond, so the CDS captures a broad set of market participants perceptions. Table 11 reports estimation results including the most commonly traded Mexican CDS spread and Emerging Market CDS spread.[34] The estimated coefficients are the correct sign (a wider spread is

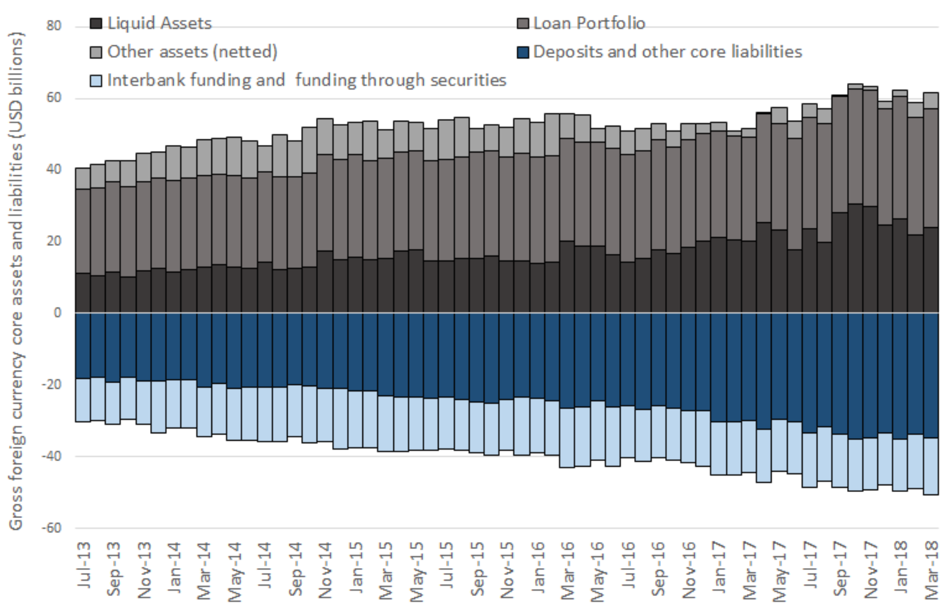
[34]The most commonly contracted credit default swap is for a 5-year maturity. The lack of statistical significance of the CDS in the regressions may be because for the shorter maturity FX contracts, the

associated with a wider basis), however the CDS spreads are not statistically significant. The model that includes only the Mexican CDS spread (column (4)) has slightly better global statistics, but the estimated coefficient on the Mexican CDS spread is not statistically different from zero.

4.7 Gross and Disaggregated Measures of Bank Hedging Need

As pointed out in Chui et al. (2016), currency mismatch can be measured in many ways. For banks, gross measures include total core foreign currency assets or total core foreign currency liabilities, rather than netting out the foreign currency balance sheet by subtracting foreign currency liabilities from assets. These gross variables are also proxies for bank foreign currency hedging needs. To check whether gross measures of bank hedging needs are driving the results, the benchmark regressions are run with each gross measure, total core foreign currency assets and total core foreign currency liabilities.[35] However, the coefficient estimates are not significantly different from zero. This also holds for sparser specifications that do not include arbitrage variables.

Figure 8: Gross core foreign assets and liabilities by type, USD billions



Gross foreign currency assets and liabilities for the Mexican banking system, excluding derivatives.
Source: Banco de México.

One can disaggregate gross foreign currency assets and liabilities by type. The Mexican balance sheet data is divided into several accounting categories: on the asset side, core assets include Loans, Liquid Assets and Other Assets. Of these categories, foreign

risk measure for a 5 year period may not be of strong relevance.

[35]See Table 17 in the appendix for details of the estimation results.

Table 11: Hedging needs direct effect on CIP deviations, with CDS

	Dependent variable: CIP deviations (basis, 3m)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Transaction Cost	-0.062	0.071	-0.047	-0.183	-0.166	-0.200	-0.051	0.068	-0.042
	(0.104)	(0.114)	(0.095)	(0.120)	(0.114)	(0.122)	(0.105)	(0.115)	(0.101)
RelRepoFF	-0.058	-0.102	-0.078	-0.011	-0.041	0.032	-0.056	-0.072	-0.050
	(0.123)	(0.103)	(0.111)	(0.144)	(0.121)	(0.131)	(0.131)	(0.121)	(0.128)
Libor_OIS 3M	-0.206*	-0.150	-0.200*	-0.206	-0.190	-0.236*	-0.213*	-0.187	-0.217*
	(0.106)	(0.122)	(0.100)	(0.143)	(0.130)	(0.133)	(0.111)	(0.130)	(0.108)
FX Implied Vol.	-0.117	-0.109	-0.130	0.100	0.109	0.084	-0.132	-0.148	-0.142
	(0.125)	(0.139)	(0.096)	(0.118)	(0.118)	(0.117)	(0.132)	(0.145)	(0.091)
Hedge, Dom. Bank	-0.603***						-0.633***		
	(0.201)						(0.232)		
Hedge, For. Fin.		0.771***						0.811***	
		(0.184)						(0.200)	
Agg Hedge			-0.301***						-0.313***
			(0.059)						(0.062)
D.Mexico CDS				-0.240	-0.350		0.097	0.268	0.180
				(0.359)	(0.224)		(0.422)	(0.347)	(0.369)
D.EM CDS				-0.131		-0.276	0.033	-0.056	-0.087
				(0.340)		(0.216)	(0.302)	(0.213)	(0.269)
Observations	51	49	53	52	52	52	51	49	52
Adjusted R^2			0.284	0.023	0.041	0.038			0.255
Root Mean Sqrd. Error	0.915	0.754	0.838	0.987	0.978	0.980	0.921	0.754	0.862
F			8.744	3.653	4.513	3.771			6.787

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.

Hegde, Dom. Bank is instrumented by its 1st and 2nd lags, passing exogeneity tests.

Hegde, For. Fin. is instrumented by its 3rd and 4th lags, passing exogeneity tests.

Aggregate Hedge defined as Domestic bank - foreign hedging.

currency liquid assets should not be hedged given that by definition they can easily be sold if needed and are in fact meant to be held as a foreign currency buffer.[36] Thus for this asset category, the expected sign of the coefficient is positive. On the liability side, core foreign currency liabilities are split between two categories: Deposits, and Interbank plus funding through securities. Figure 8 plots the foreign currency balance sheet disaggregated by balance sheet category. Over the sample period, Deposits and other core liabilities account for an average of 62% of foreign currency liabilities, ranging from 55 to 71 percent. On the asset side, the loan portfolio share is relatively stable averaging 54% and ranging from 50 to 59 percent. Loans to total assets had a standard deviation of 0.027, compared to 0.063 for Liquid assets to total assets.

The regression analysis shows that none of the individual balance sheet categories directly affect the level of CIP deviations.[37] However, there is evidence that some of the categories affect *changes* in the CIP deviation. Table 12 reports estimation results using the first difference of the CIP deviations as the dependent variable. The coefficient on foreign currency Liquid Assets is statistically significant and positive as expected. Funding via the interbank market or securities also has a positive coefficient, evidence that an increase in these is associated with a more positive basis, (reduced widening pressure on the negative basis). Foreign currency Other Assets (and possibly Loans) are associated with the basis becoming more negative (widening pressure for a negative basis). These results support the argument that Mexican banks have foreign currency assets that they need to hedge and this exerts widening pressure on the (negative) basis. Liquid foreign currency assets are an offset, as is foreign currency funding via the interbank market and securities.

5 Conclusion

This paper analyzes a panel of 10 emerging markets with the most highly traded currencies to ascertain whether hedging needs by domestic banks have an effect on the CIP deviations for those countries, either directly or when interacted with arbitrageur balance sheet constraints. Granular data from regulatory filings for Mexico are used to implement an in-depth case study which also analyzes the impact of hedging by foreign counterparties, domestic banks' gross foreign currency balance sheet positions, and the particular importance of global or foreign banks in Mexico.

In both the panel analysis and the case study, I find that the FX funding gap of the

[36] In Mexico, foreign currency regulations include liquidity requirements. Institutions must hold enough liquid assets to cover the sum of the largest gap (between liabilities and assets) for 4 different maturity ranges.

[37] See Table 18 in the Appendix. Estimated coefficients on the components of core foreign currency assets and liabilities were not statistically different from zero.

Table 12: Gross bank hedging needs by type, direct effect on changes in CIP deviations

	Dependent variable: first difference of CIP deviations (basis, 3m)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Transaction Cost	-0.186	-0.202	-0.217	-0.224*	-0.187	-0.206	-0.135
	(0.142)	(0.123)	(0.143)	(0.131)	(0.131)	(0.136)	(0.137)
RelRepoFF	0.031	0.036	0.019	0.056	0.034	0.043	-0.000
	(0.105)	(0.091)	(0.108)	(0.087)	(0.100)	(0.103)	(0.101)
Libor_OIS 3M	-0.003	-0.038	0.002	-0.055	0.003	-0.006	0.020
	(0.123)	(0.119)	(0.125)	(0.121)	(0.121)	(0.121)	(0.118)
FX Implied Vol.	-0.026	-0.048	-0.049	-0.087	-0.025	-0.043	0.021
	(0.130)	(0.122)	(0.127)	(0.108)	(0.126)	(0.122)	(0.125)
D.Assets	0.072						
	(0.319)						
D.Liquid Assets		0.459**					
		(0.178)					
D.Loans			-0.281				
			(0.510)				
D.Other Assets				-0.410**			
				(0.158)			
D.Liabilities					0.538*		
					(0.312)		
D.Deposits						0.317	
						(0.340)	
D.Interbank + Sec.							0.260**
							(0.127)
Observations	52	52	52	52	52	52	52
F	0.736	2.598**	0.798	2.139*	1.279	0.736	1.890
Root Mean Sqd. Error	0.792	0.753	0.789	0.751	0.777	0.789	0.773

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.

The balance sheet category variables enter as their first difference because the levels are non-stationary.

domestic banking system has a direct impact on the CIP deviations, ie. bank balance sheet hedging needs have an impact on the foreign exchange market. There is also evidence that foreign hedging has a direct and significant impact. These effects are robust to including variables proposed in the CIP literature such as bid-ask spreads, funding costs and measures of counterparty and market risk, as well as CDS spreads and US dollar LIBOR. Furthermore, with respect to balance sheet components, the regression analysis using Mexican balance sheet data provides evidence that domestic banks have foreign currency assets that they need to hedge and this exerts widening pressure on the (negative) CIP deviation. Liquid foreign currency assets have the opposite effect, as does foreign currency funding via the interbank market and securities.

Given the evidence that in emerging economies bank hedging needs exert direct widening pressure on the cross-currency basis, the second hypothesis is does constraints on arbitrage activity amplify the impact of this widening pressure? In the emerging market panel and the Mexico case study, interacting hedging demand and arbitrageur balance sheet cost variables (counterparty and market risk) gives mixed results, suggesting arbitrage constraints may not be a primary factor in emerging market currency markets. In particular, market risk as measured by implied volatility in the foreign exchange market, seems to have the opposite effect. The arbitrageur constraint hypothesis argues that increased implied FX volatility is a risk factor that could amplify the widening effect of bank's hedging because it prevents arbitrage activity from narrowing the negative CIP deviation. However, the results show higher implied volatility is associated with more positive (narrower) CIP deviations. The estimated offsetting effect may be the result of increased volatility attracting trade, rather than the hypothesized deterent balance sheet cost.

In sum, the results for the emerging market panel and the Mexico case study show that bank hedging directly influenced the CIP deviations, even when arbitrageur factors are also accounted for in the regression model. Interacting the hedging proxies and the arbitrageur balance sheet constraint variables provide mixed evidence that these amplify the affect of bank hedging demand. The results validate a key mechanism in the theoretical literature, ie that higher bank FX hedging demand (particularly from global banks), can indeed directly increase the cost of hedging. The implication is that the ability of domestic banks in emerging economies to manage currency mismatch can be affected by their global banks as well as by foreign hedging needs and arbitrageur behavior.

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6 Appendix

Table 13: Summary statistics for EM panel variables

	count	mean	sd	min	max
Basis, 3m	557	-48.01023	155.0468	-532.6713	2453.917
Total USD Claims	645	288594.4	393855.3	14390	1928605
Total USD Liabilities	645	285234.7	365836.9	10907	1820787
Domestic Bank Hedge (FX Assets-Liabilities)	645	3359.667	37330.96	-79082.22	133877.2
Transaction Cost	778	-.0898185	2.062069	-38.24994	23.09998
Interbank_OIS, 3m	367	.4921525	.7397751	-1.53	4.74
FX Implied Vol., 3m	738	9.291052	5.822322	.275	41.315

Summary statistics for EM panel regression analysis variables.

Source: Bloomberg, Bank of International Settlements (BIS)

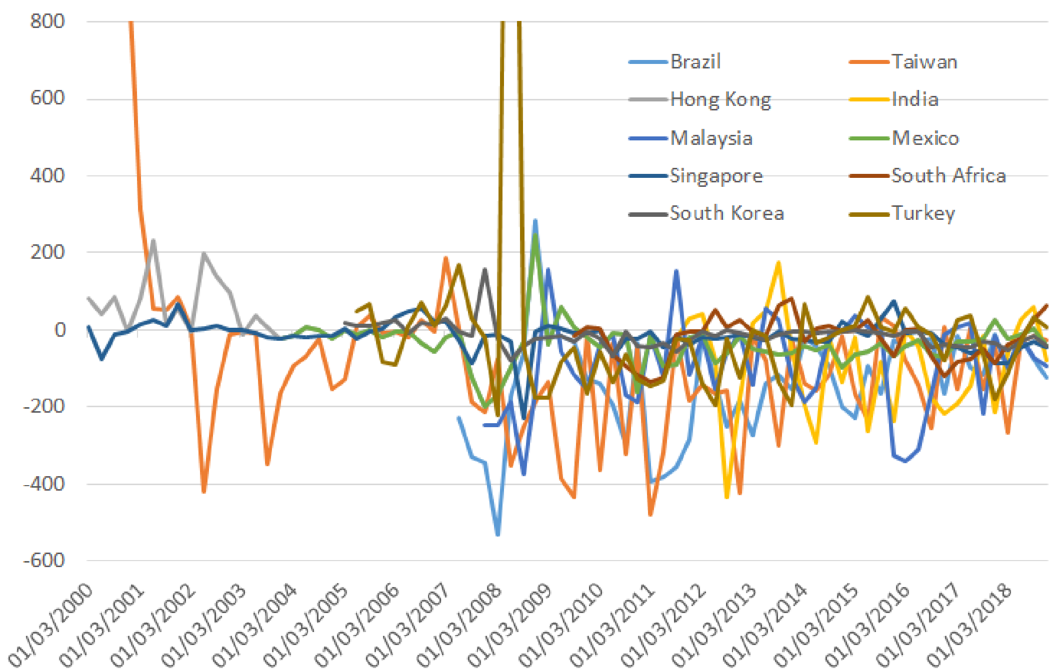
Table 14: Summary statistics for EM panel variables Excluding 2008

	count	mean	sd	min	max
Basis, 3m	525	-49.31125	108.078	-479.8112	982.6175
Total_Claims	609	290457.5	398191.7	14390	1928605
Total_Liabilities	609	286920.6	369736.8	10907	1820787
Domestic Bank Hedge (FX Assets-Liabilities)	609	3536.892	37787.31	-79082.22	133877.2
Transaction Cost	738	-.0455508	1.736148	-38.24994	23.09998
Interbank_OIS	347	.4638932	.685585	-1.53	4.04
Implied FX Vol	698	9.054438	5.494993	.275	30.065

Summary statistics for EM panel regression analysis variables.

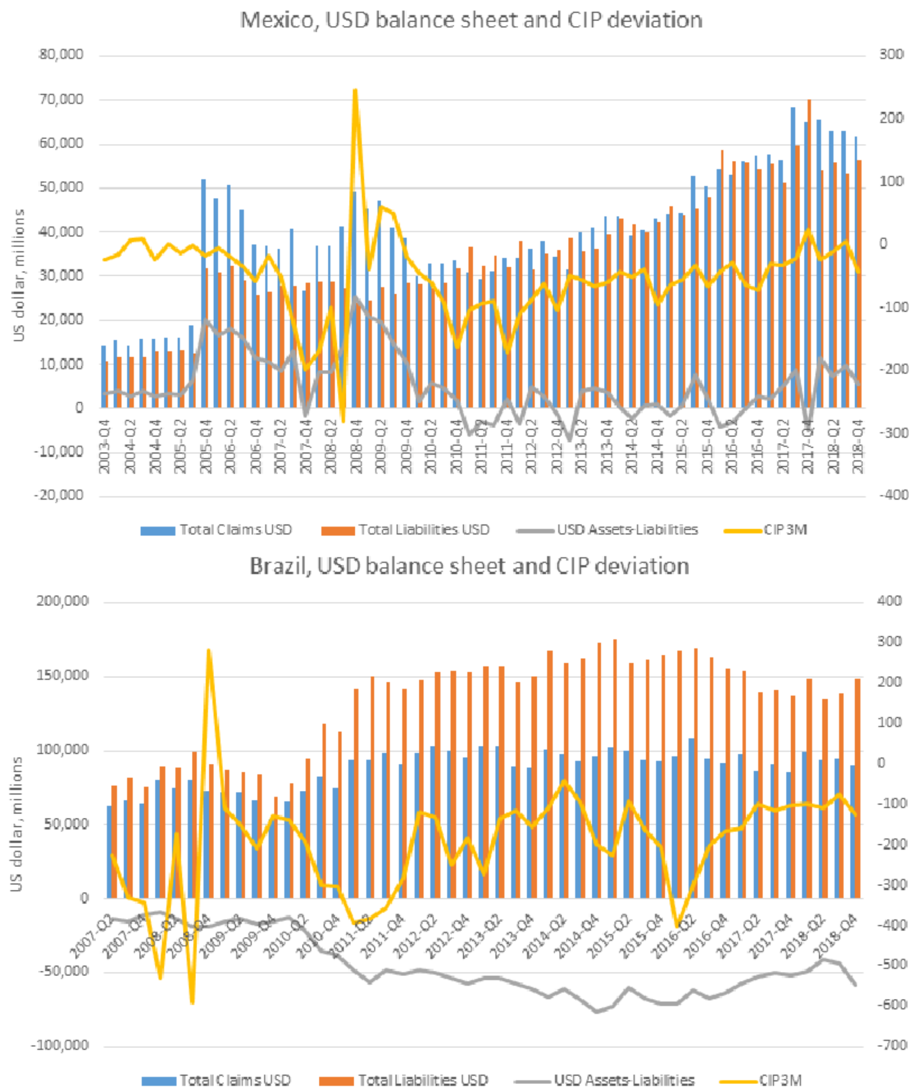
Source: Bloomberg, Bank of International Settlements (BIS)

Figure 9: 3-month CIP deviations for emerging market economies, basis points



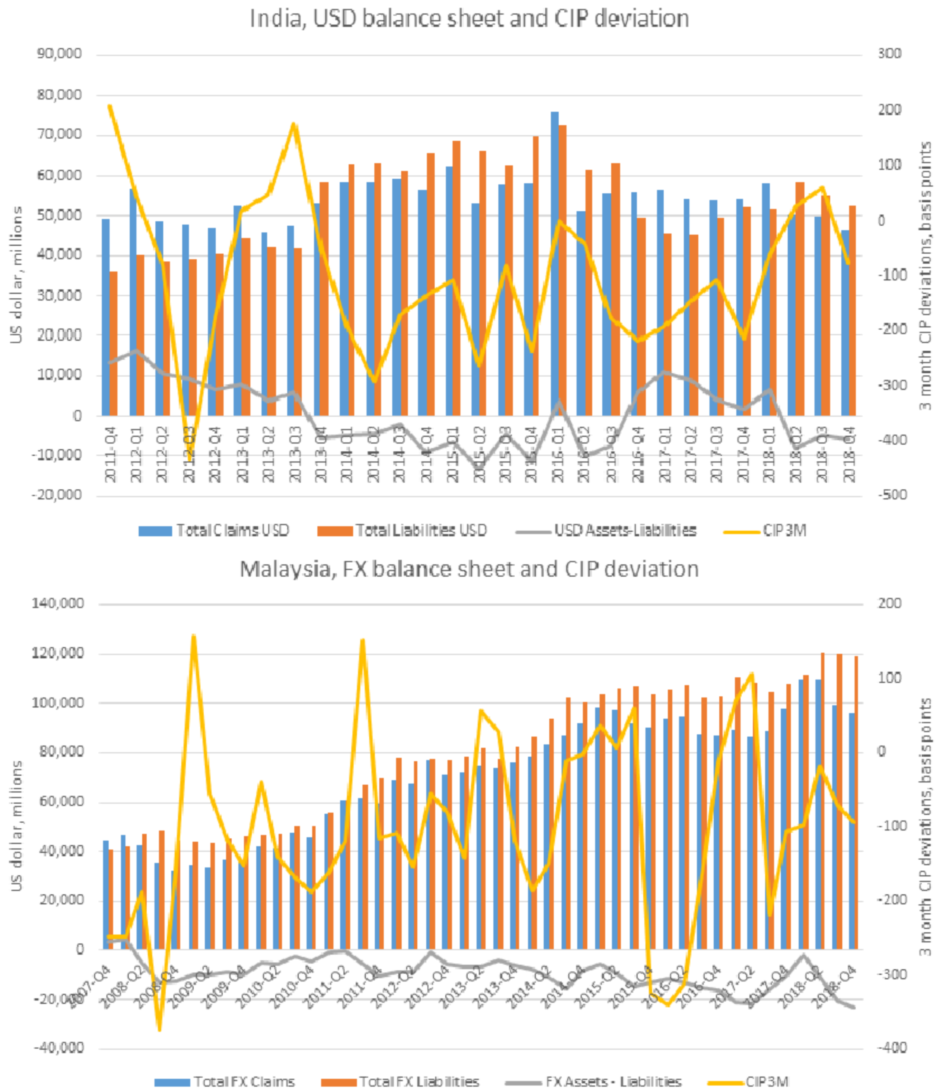
CIP deviations measured as the cross currency basis with the US dollar, the Forward market implied interest rate minus the interest rate on a government security.
Source: Bloomberg, Banco de México.

Figure 10: Resident banks' USD or FX balance sheet (BIS data) vs. CIP deviation



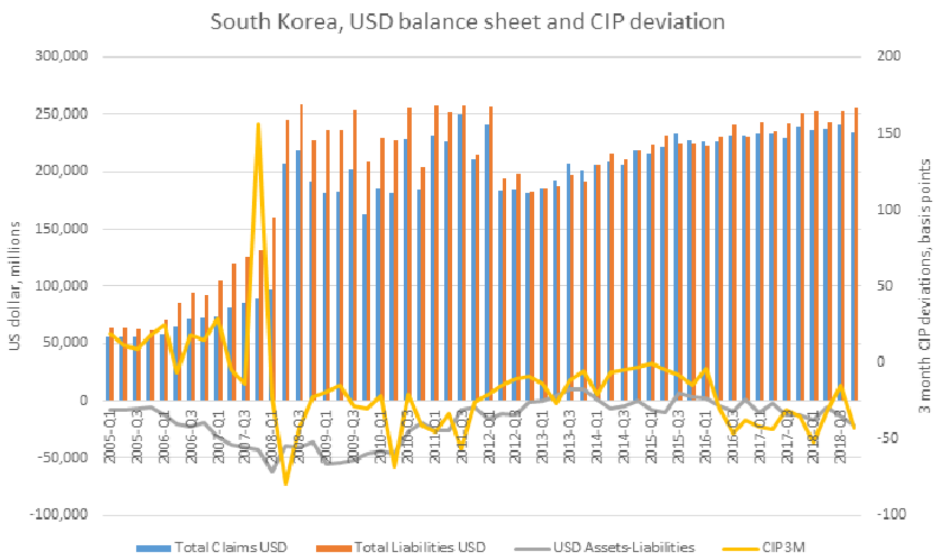
CIP deviations measured as the cross currency basis with the US dollar, the Forward market 3-month implied interest rate minus the interest rate on a government security. Source: Bloomberg, BIS.

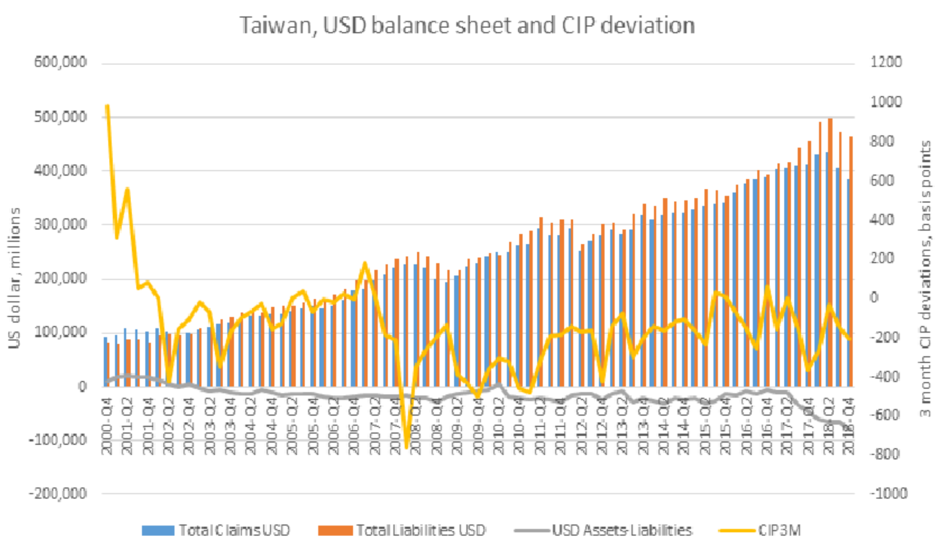
Figure 11: Resident banks' USD or FX balance sheet (BIS data) vs. CIP deviation



CIP deviations measured as the cross currency basis with the US dollar, the Forward market 3-month implied interest rate minus the interest rate on a government security. Source: Bloomberg, BIS.

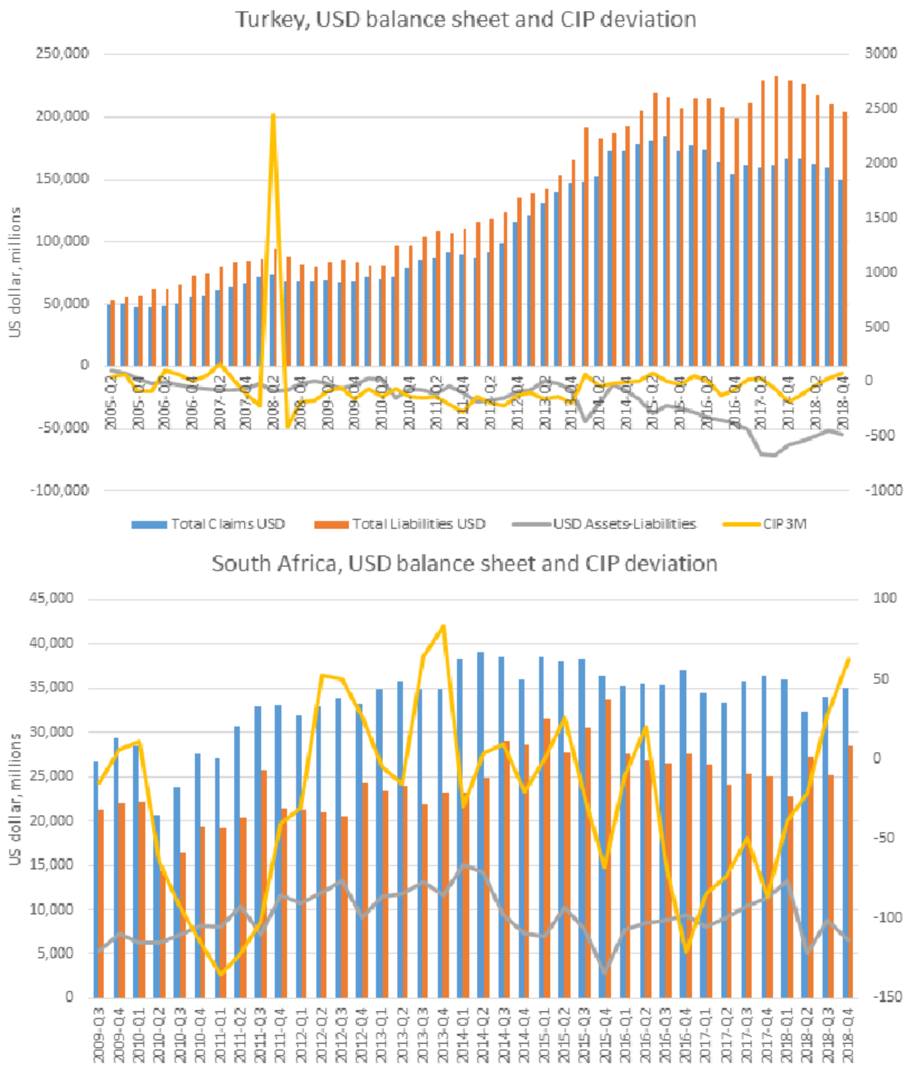
Figure 12: Resident banks' USD or FX balance sheet (BIS data) vs. CIP deviation





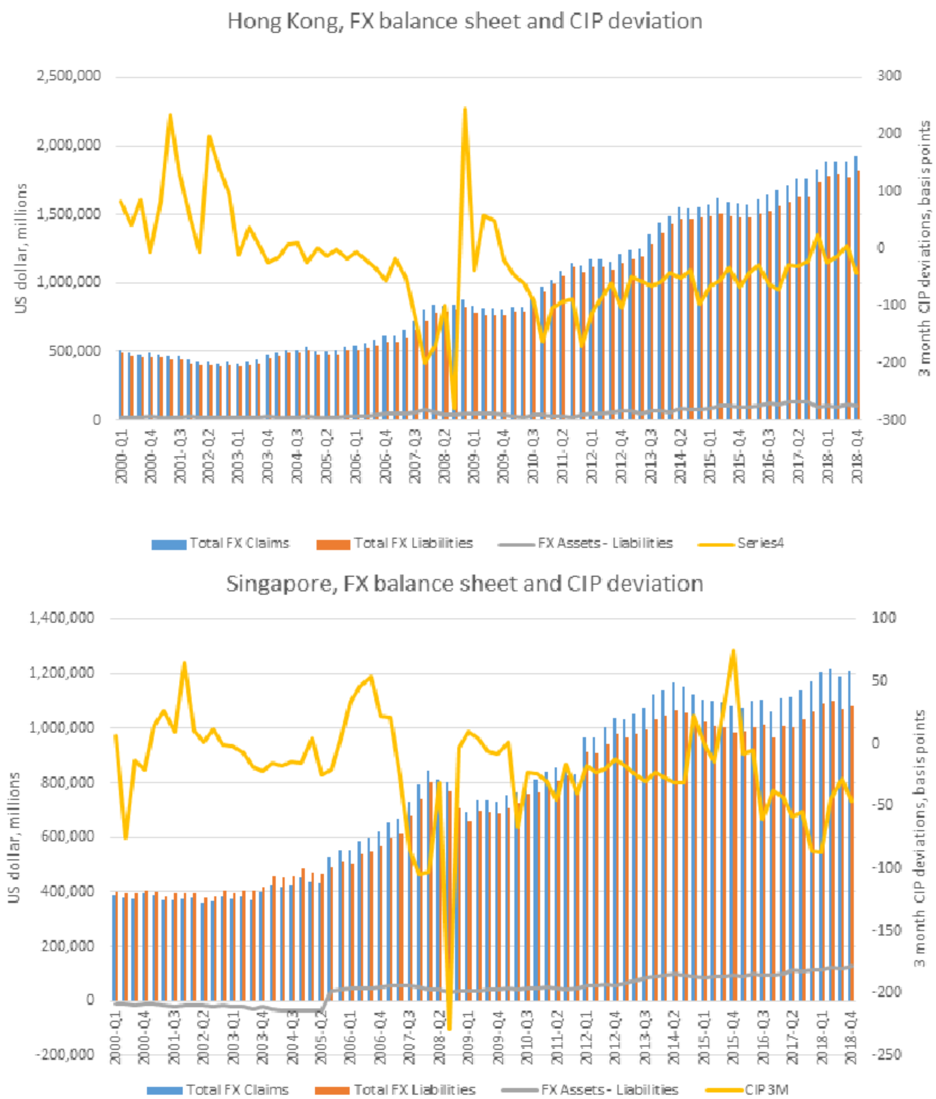
CIP deviations measured as the cross currency basis with the US dollar, the Forward market 3-month implied interest rate minus the interest rate on a government security. Source: Bloomberg, BIS.

Figure 13: Resident banks' USD or FX balance sheet (BIS data) vs. CIP deviation



CIP deviations measured as the cross currency basis with the US dollar, the Forward market 3-month implied interest rate minus the interest rate on a government security. Source: Bloomberg, BIS.

Figure 14: Resident banks' USD or FX balance sheet (BIS data) vs. CIP deviation



CIP deviations measured as the cross currency basis with the US dollar, the Forward market 3-month implied interest rate minus the interest rate on a government security. Source: Bloomberg, BIS.

Table 15: Summary statistics for Mexico banking system variables

	count	mean	standard deviation	min	max
Basis, 1m	53	1.849434	46.60147	-144.1	111.15
Basis, 3m	53	-11.07302	32.40309	-68.69	82.15
Basis, 6m	53	-8.060755	34.52957	-55.92	88.89
Basis, 12m	53	-10.00283	33.15115	-58.44	94.28
RelRepoFF	53	.0932076	.1804777	-.6999999	.3800001
Transaction Costs, 1m	53	-.019717	.0178243	-.0699997	0
Transaction Costs, 3m	53	-.0242453	.0227527	-.1049995	0
Transaction Costs, 6m	53	-.0264152	.0241067	-.1050005	-.0049996
Transaction Costs, 9m	53	-.0274528	.0234238	-.1049995	-.0049996
Transaction Costs, 12m	53	-.0284907	.0235867	-.1049995	-.0049996
LIBOR-OIS, 1m	53	.0103189	.0593938	-.0124002	.4042001
LIBOR-OIS, 3m	53	-.0209434	.053266	-.243	.125
LIBOR-OIS, 6m	53	-.0238057	.0765594	-.2999997	.1199999
FX Implied Vol., 1m	53	11.63509	2.92992	6.02	21.89
FX Implied Vol., 3m	53	11.86245	2.477982	6.91	18.43
FX Implied Vol., 6m	53	12.10208	2.111715	7.49	16.21
FX Implied Vol., 12m	53	12.55132	1.774412	8.42	15.9
CDS_EM	53	278.6849	57.64491	174.364	403.094
CDS_MEX	53	125.6359	33.72226	67.82	198.221
Hedge measures					
Domestic Bank	53	12685.92	2577.703	5877	18492
Foreign Financial	53	-16839.57	11211.25	-38354	5684
Core FX Assets	53	51796.3	4848.966	40434	64099
Loans	53	28222.94	2359.256	23425	33246
Liquid Assets	53	16580.17	4697.859	10000	30542
Other Assets	53	6993.189	3225.138	342	12798
Core FX Liabilities	53	39110.38	5250.085	29483	49671
Deposits and Other Core	53	24452.6	4725.527	17686	35245
Interbank and Securities	53	14657.77	1173.377	11586	16918

Summary statistics for regression analysis variables.

Core FX Liabilities = Deposits and Other Core + Interbank and Securities

Core FX Assets = Loans + Liquid Assets + Other Assets

Table 16: Exclusion restriction for
FX derivatives with Foreign counterparty

	Dependent variable: CIP deviations (basis, 3m)				
	(1)	(2)	(3)	(4)	(5)
RelRepoFF	-0.0956	-0.0996	-0.0838	-0.107	-0.0697
	(0.0957)	(0.0975)	(0.0986)	(0.115)	(0.110)
Transaction Cost	0.0410	0.0293	0.0418	0.0450	0.0393
	(0.0950)	(0.0936)	(0.108)	(0.118)	(0.114)
LIBOR_OIS 3M	-0.196**	-0.163*	-0.172	-0.162	-0.149
	(0.0926)	(0.0944)	(0.123)	(0.127)	(0.132)
FX Implied Vol.	-0.0889	-0.0568	-0.0567	-0.0532	-0.0728
	(0.0993)	(0.103)	(0.127)	(0.122)	(0.125)
Hedge, For. Fin.	0.217	0.221	0.355*	0.490**	0.698***
	(0.219)	(0.225)	(0.181)	(0.203)	(0.191)
L.1	0.489*				
	(0.248)				
L.2		0.487*			
		(0.272)			
L.3			0.374		
			(0.232)		
L.4				0.214	
				(0.272)	
L.5					-0.0660
					(0.226)
Observations	52	51	50	49	48
Adjusted R^2	0.427	0.430	0.415	0.387	0.372
F	10.75	10.36	8.853	8.027	7.650

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.

Table 17: Gross bank hedging needs direct effect on CIP deviations

	Dependent variable: CIP deviations (basis, 3m)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Transaction Cost	-0.062	-0.166	-0.163	-0.176	-0.170	-0.164	-0.159
	(0.104)	(0.123)	(0.117)	(0.119)	(0.112)	(0.125)	(0.123)
RelRepoFF	-0.058	-0.006	-0.007	-0.041	-0.046	-0.001	0.001
	(0.123)	(0.123)	(0.123)	(0.122)	(0.122)	(0.138)	(0.140)
Libor_OIS 3M	-0.206*	-0.224	-0.225	-0.189	-0.190	-0.224	-0.227
	(0.106)	(0.134)	(0.135)	(0.130)	(0.130)	(0.135)	(0.135)
FX Implied Vol.	-0.117	0.086	0.089	0.099	0.107	0.088	0.093
	(0.125)	(0.121)	(0.117)	(0.116)	(0.116)	(0.125)	(0.124)
Hedge, Dom. Bank	-0.603***						
	(0.201)						
D.Assets		-0.071		-0.127		-0.065	
		(0.398)		(0.399)		(0.381)	
D.Liabilities			-0.171		-0.309		-0.175
			(0.499)		(0.499)		(0.514)
D.Mexico CDS				-0.368*	-0.396		
				(0.216)	(0.237)		
D.US LIBOR-OIS						0.033	0.056
						(0.363)	(0.396)
Observations	51	52	52	52	52	52	52
Adjusted R^2		0.017	0.019	0.024	0.029	-0.004	-0.002
Root Mean Sqrd. Error	0.915	0.990	0.989	0.987	0.984	1.001	1.000
F		4.028***	3.931***	4.135***	3.955***	3.333***	3.284***

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.

Hegde, Dom. Bank is instrumented by its 1st and 2nd lags, passing exogeneity tests.

The core FX gross Assets and Liabilities variables enter as their first difference since the levels are non-stationary.

Table 18: Gross bank hedging needs by type, direct effect on CIP deviations

	Dependent variable: CIP deviations (basis, 3m)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Transaction Cost	-0.166	-0.165	-0.169	-0.178	-0.163	-0.154	-0.173
	(0.123)	(0.118)	(0.113)	(0.128)	(0.117)	(0.128)	(0.122)
RelRepoFF	-0.006	-0.005	-0.011	0.007	-0.007	-0.011	0.000
	(0.123)	(0.123)	(0.135)	(0.127)	(0.123)	(0.124)	(0.121)
Libor_OIS 3M	-0.224	-0.235*	-0.221	-0.251*	-0.225	-0.222	-0.228*
	(0.134)	(0.138)	(0.138)	(0.140)	(0.135)	(0.135)	(0.134)
FX Implied Vol.	0.086	0.086	0.086	0.062	0.089	0.097	0.081
	(0.121)	(0.123)	(0.123)	(0.127)	(0.117)	(0.123)	(0.126)
D.Assets	-0.071						
	(0.398)						
D.Liquid Assets		0.162					
		(0.261)					
D.Loans			-0.094				
			(0.519)				
D.Other Assets				-0.217			
				(0.232)			
D.Liabilities					-0.171		
					(0.499)		
D.Deposits						-0.151	
						(0.613)	
D.Interbank + Sec.							-0.054
							(0.178)
Observations	52	52	52	52	52	52	52
Adjusted R^2	0.017	0.024	0.017	0.035	0.019	0.018	0.018
F	4.028***	3.589***	3.818***	4.113***	3.931***	3.884***	3.938***
Root Mean Sqrd. Error	0.990	0.987	0.990	0.981	0.989	0.990	0.990

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HAC robust standard errors.

The balance sheet category variables enter as their first difference since the levels are non-stationary.