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What Do Deviations from Covered Interest Parity and
Higher FX Hedging Costs Mean for Asia?

by Gee Hee Hong, Anne Oeking, Kenneth H. Kang and Changyong Rhee

I N T E R N A T I O N A L M O N E T A R Y F U N D

IMF Working Paper

Asia and Pacific Department

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Abstract

Asian countries have high demand for U.S. dollars and are sensitive to U.S. dollar funding costs. An important, but often overlooked, component of these costs is the basis spread in the cross-currency swap market that emerges when there are deviations from covered interest parity (CIP). CIP deviations mean that investors need to pay a premium to borrow U.S. dollars or other currencies on a hedged basis via cross-currency swap markets. These deviations can be explained by regulatory changes since the global financial crisis, which have limited arbitrage opportunities and country-specific factors that contribute to a mismatch in the demand and supply of U.S. dollars. We find that an increase in the basis spread tightens financial conditions in net debtor countries, while easing financial conditions in net creditor countries. The main reason is that net debtor countries are, in general, unable to substitute smoothly to other domestic funding channels. Policies that promote reliable alternative funding sources, such as long-term corporate bond market or stable long-term investors, including a “hedging counterpart of last resort,” can help stabilize financial intermediation when U.S. dollar funding markets come under stress.

JEL Classification Numbers: F31, G15, G2

Keywords: Covered interest parity, limits to arbitrage, U.S.dollar funding, FX swaps.

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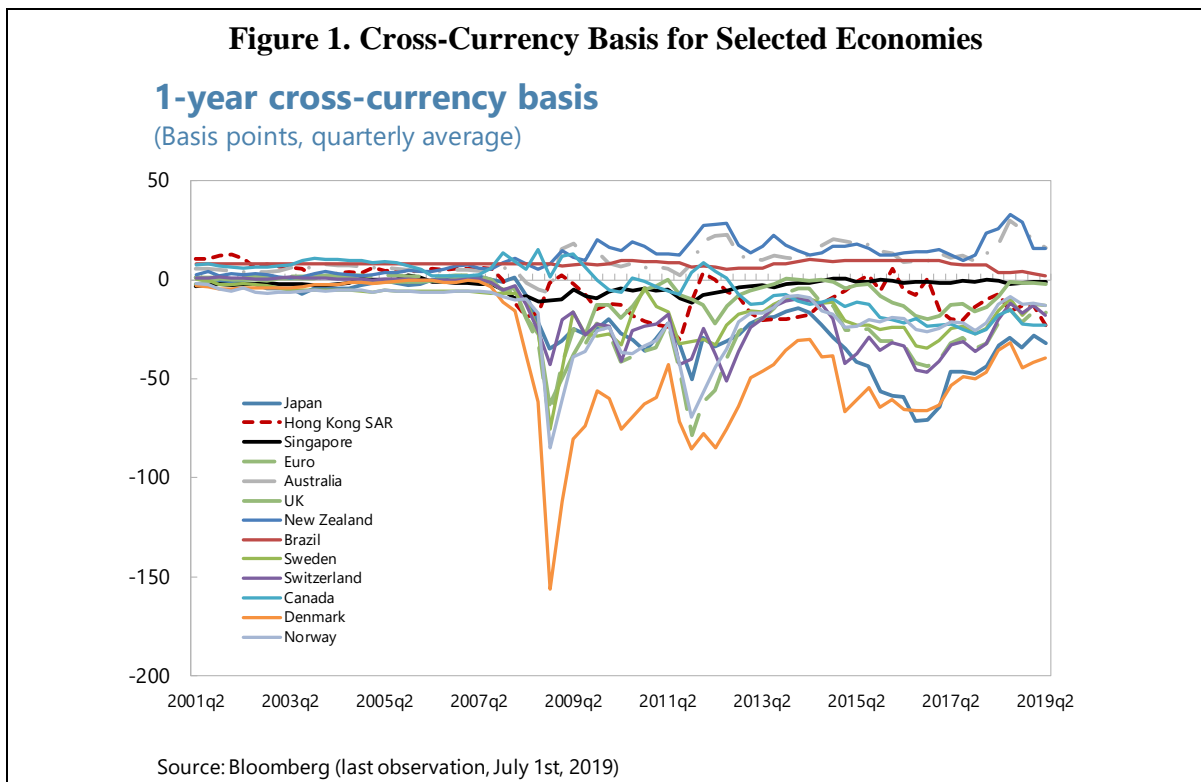
Content	Page
I. Introduction	4
II. Covered Interest Parity Deviations in Asia	7
III. Why Does CIP Fail to Hold?	8
A. Definition of Covered Interest Parity and Cross-Currency Basis	9
B. Counterparty and Credit Risks During Crisis Periods	9
C. Regulatory Reforms	10
D. FX Hedging Demand by Asian Countries	11
E. U.S. Dollar Supply Factors.....	14
F. Movements in CIP Deviations.....	14
IV. Implications of Wider Basis on Domestic Financial Conditions.....	15
A. Empirical Results	15
V. Policy Implications and Conclusion	22
References.....	24
 Figures	
1. Cross-Currency Basis for Selected Economies.....	4
2. Cross-Currency Basis for Selected Asian Economies	8
3. LIBOR-OIS Spread in Selected Currencies.....	10
4. Net Foreign Assets Position and Cross-Currency Basis	11
5. Correlation between Change in Cross-Currency Basis and Domestic Financial Conditions: Japan vs. Indonesia.....	17
6. Impulse Response Functions: A 100-basis point Shock to Cross-Currency Basis.....	18
7. Impulse Response Functions: A 100-basis point Shock to Cross-Currency Basis by Net IIP Positions	19
8. Impulse Response functions: A 100-basis point Shock to Cross-Currency Basis, High Stress vs. Low Stress.....	20
9. Impulse Response Functions: A 100-basis point Shock to Cross-Currency Basis, High Stress vs. Low Stress, by Net IIP Position.....	21
10. Balance Sheet of a Non-U.S. Bank with Positive Demand for FX Swaps	32
 Tables	
1. Subsequent Cumulative Change in Domestic Financial Conditions : A 100-basis point Shock to Cross-Currency Basis	26

2. Subsequent Cumulative Change in Domestic Financial Conditions: A 100-basis point Shock to Cross-Currency Basis by Net IIP Positions	27
3. Subsequent Cumulative Change in Domestic Financial Conditions: A 100-basis point Shock to Cross-Currency Basis, High Stress vs. Low Stress ..	28
4. Subsequent Cumulative Change in Domestic Financial Conditions: A 100-basis point Shock to Cross-Currency Basis, High Stress vs. Low Stress, by Net IIP Positions	29
 Annex	
A Simple Model of FX Hedging Demand	30

I. INTRODUCTION

Covered interest parity (CIP) is a non-arbitrage condition where the covered interest differential between two assets denominated in different currencies should equal to zero. This non-arbitrage condition holds in a frictionless foreign exchange (FX) swap market, as an investor raising foreign currency in the cash spot market should have the same payoffs as in the forward market. Otherwise, riskless arbitrage opportunities would arise, reflecting inefficiencies in the international capital markets.

One of the most striking features in international finance since the global financial crisis (GFC) is that the covered interest parity fails to hold for numerous currencies vis-à-vis the U.S. dollar. This is quite striking, as CIP for the most part held true prior to the GFC (Figure 1).² A more puzzling aspect is that the breach of CIP was not a temporary phenomenon, specific to the financial disruptions of the crisis period. For numerous currencies, the CIP deviations have persisted and varied considerably over time.



What does the failure of covered interest parity mean for borrowers and investors? The most straightforward implication for borrowers is an increase in the U.S. dollar funding premium. The cross-currency basis, a measure of the deviation from CIP, has been negative for major currencies such as the Japanese Yen or the Euro. This means that a Yen-based or Euro-based investor should pay a premium to raise U.S. dollars by borrowing local currency and

² Akram et al. (2008, 2009) and Cerutti et al. (2018) note that even before the GFC, some small and transient – but economically meaningful – departures from CIP were observed at tick-frequency.

exchanging it for U.S. dollars in the swap market, compared with the cost the investor would have paid by borrowing directly in the U.S. dollar spot or interbank market.

For investors, a higher basis swap spread has important implications for cross-border investment decisions by affecting *hedge-adjusted returns*, the sum of interest rate differentials and FX hedging costs. Suppose an investor is deciding between investing domestically and investing abroad on a hedged basis through the cross-currency swap market. If FX hedging costs increase to a point where *hedge-adjusted return* of the offshore investment is lower than the return from the onshore investment, the investor *ceteris paribus* will decide to invest domestically.

In this paper, we explore the behavior of the cross-currency basis and its implication for FX hedging and domestic financial conditions, focusing on Asian countries. We first document developments in the cross-currency basis for Asian countries since the GFC. Then, we study the main drivers of the cross-currency basis across countries and time. Finally, we conduct an empirical analysis of the implications of CIP deviations on domestic financial conditions.

There are several reasons why understanding the implications of CIP deviations are important for economic agents and policy makers in the region.

First, Asian countries heavily rely on the U.S. dollar for financial intermediation and trade. A sharp increase in the U.S. dollar funding premium could significantly disrupt economic activity and raise financial stability concerns. For instance, many Asian countries are deeply involved in international trade through global and regional value chains, where the U.S. dollar is the predominant currency of choice for settlement purposes (Boz et al. 2017; Bruno et al. 2018).

Second, since the GFC, the demand for FX hedging has increased rapidly, by some estimates almost twice as fast as GDP growth in Asia (in U.S. dollar (USD) terms). Hedging demands, measured by net USD assets by financial institutions, for countries like Australia, Japan, Korea and Taiwan Province of China, have increased at an annual rate of about 7 percent since 2007, thanks to a significant increase in participation by institutional investors, such as life insurance companies, as well as global banks (Goldman Sachs (2018)).

Third, CIP deviations are likely to persist for many Asian countries in the foreseeable future, partly reflecting changing demographics. Rapid aging in parts of Asia (IMF, 2017) is an important structural factor contributing to higher demand for FX hedging through pension funds and life insurance companies, who typically invest overseas on a hedged basis and may be sensitive to changes in the cross-currency basis.

Finally, the divergence of monetary policy stances between the U.S. and other major central banks could further build up pressures in FX derivatives markets. For example, if the U.S. Federal Reserve continues its path of normalization while other central banks continue easing, investors outside the U.S. may be more inclined to invest in U.S. dollar-denominated assets for higher returns, which will increase further the demand for FX swaps, pushing up the cross-currency basis.

Against this backdrop, our findings can be summarized as follows. First, the cross-currency basis for numerous currencies in Asia opened up during the GFC. While the cross-currency basis has narrowed for most countries following the peak of the GFC and the European sovereign debt crisis, CIP deviations still exist. Second, the cross-currency basis varies considerably across countries, both in terms of the size and the sign. Some countries, like Australia and New Zealand, have a positive basis, while other countries such as Japan and Korea show a negative basis. Third, we find that the drivers for the cross-currency basis have evolved, beginning with banks' counterparty risks and liquidity risks during the crisis period. Post crisis, regulatory reforms to global banks since the GFC, combined with country-specific structural factors related to FX hedging demand, help explain the cross-country differences. Finally, our empirical analysis suggests that an increase in FX hedging costs either mitigates or exacerbates the impact of a shock on domestic financial conditions, depending on a country's net international investment position (IIP) and other costs of related to balance sheet activities.

For the empirical analysis, we use the local projections method proposed by Jorda (2005). On average, domestic financial conditions tend to tighten following a negative shock to the cross-currency basis. Here, we focus on an increase in corporate spread, sovereign spread, and interbank spread as proxies for domestic financial conditions. However, for net positive IIP countries (i.e., net creditor countries), we find the opposite—a widening of the cross-currency basis leads to an easing of domestic financial conditions, as interbank spreads tend to decline by 30 to 80 basis points, cumulatively, within 3 months in response to a negative 100-basis point shock. In contrast, for net negative IIP countries (i.e., net debtor countries), spreads increase by 50 to 100 basis points.

We also find non-linear responses in domestic financial conditions during different periods of financial stress. For net creditor countries, spreads decline more during high financial stress periods (defined as Volatility Index (VIX) above a certain threshold) than in low stress periods. For net debtor countries, spreads increase more during high stress periods than in low stress periods. One possible interpretation is that many investors in net creditor countries tend to turn to onshore investment *more* during high-stress periods, due to flight-to-safety concerns combined with high dollar funding costs, helping to lower borrowing costs and ease domestic financial conditions. On the other hand, for net debtor countries, higher U.S. dollar funding costs accelerate the reduction in balance sheets during high-stress periods, further tightening domestic financial conditions.

Our study builds on a growing literature on the identification of the sources of CIP deviation. Many papers studied deviations from CIP during crisis periods, both during the GFC (e.g., Baba et al., 2009; Baba and Packer, 2009a and 2009b; Coffey et al., 2009; Mancini-Griffoli and Ranaldo, 2011; McGuire and von Peter, 2012) and during the European sovereign debt crisis (e.g., Bottazzi et al., 2012; Ivashina et al., 2015). These papers generally identify U.S. dollar-funding shortage in the wholesale U.S. dollar market and banks' counterparty credit risk concerns as the main drivers of CIP deviations. The basis narrowed after central banks provided dollar funding via swap lines and banks' credit risk improved. For post-crisis CIP deviations, the literature finds that *across countries*, deviations can be explained by structural factors, in particular a mismatch between dollar demand and dollar supply, as well as tighter limits to arbitrage (e.g., Du et al., 2018; Sushko et al., 2016; Borio et al., 2016; Iida et al.,

2016). *Over time*, movements in the basis were related to the strength of the dollar as a proxy for global risk factors (Avdjiev et al., 2017), as well as other idiosyncratic developments.

The contribution of this paper to this body of literature is two-fold. First, while previous studies focused on the drivers of the cross-currency basis, few studies focused on the implications of CIP deviations on the macroeconomy and financial conditions. Second, the focus on Asian countries is new given the strong reliance on the cross-currency swap market as a U.S. dollar funding source. While several studies investigated the deviation of CIP for specific currency pairs (e.g. the Japanese Yen-USD), our work is the first to examine a broader set of Asian currencies to provide cross-country comparisons.

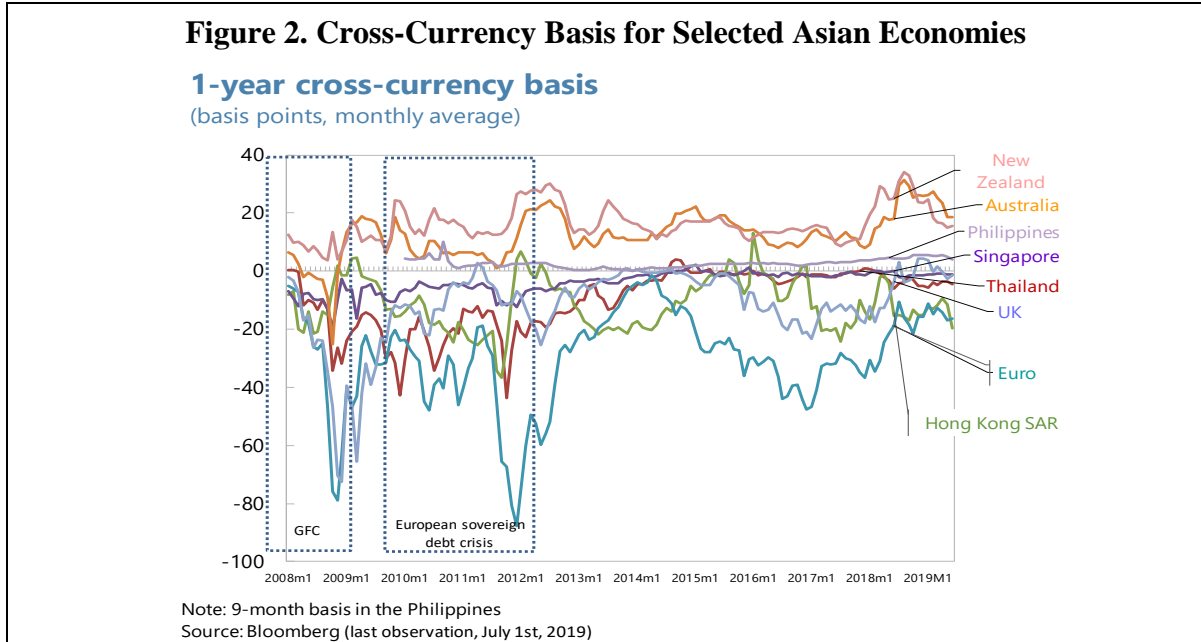
The paper is organized as follows. In section II, we document the pattern of the cross-currency basis for Asian countries over time. In section III, we present potential drivers of the cross-currency basis to explain cross-sectional and time-series variations. In section IV, we analyze the implications of higher basis and FX hedging costs on domestic financial conditions. Section V concludes this paper and presents policy implications.

II. COVERED INTEREST PARITY DEVIATIONS IN ASIA

In this section, we document the developments of cross-currency basis for a set of Asian countries, encompassing both advanced economies (Australia, Hong Kong SAR, Japan, Korea, New Zealand, Singapore) and emerging economies (India, Indonesia, the Philippines, Thailand) (Figure 2).³

First, CIPs deviated significantly during the peak of the financial crisis. A non-zero basis was first observed for most currencies during the GFC, where the deviations were mostly negative for a number of economies including the Euro area, Japan, Denmark, the U.K. and Switzerland, Thailand and Hong Kong SAR. The average basis at the peak of the GFC in 2008Q4 for countries with negative basis was about minus 70 basis points. On the other hand, New Zealand and Canada showed positive basis, albeit with small magnitude, which averaged around 10 basis point. CIP gaps also emerged during the European sovereign debt crisis, where many European currencies featured large negative basis against the U.S. dollar, notably the Euro, the British pound, the Swiss franc, and the Danish krone. While some Asian countries were also affected, particularly Japan, the impact was much less pronounced. On the other side, the cross-currency basis for the New Zealand dollar and the Australian dollar increased further in positive territory.

³ Korea is not shown in the chart due to the large size of CIP deviations. Deviations for the 1-year cross currency basis reached up to 597 basis points in 2008.



Second, the deviations from CIP have narrowed since, even though gaps persist. At the end of 2018, the average cross-currency basis for major currencies and Asian countries in Figure 2 was around negative 30 basis points. The basis of the sterling-USD, which reached negative 70 basis point in 2008Q4, was close to zero and, even positive at times by the end of 2018. 2016 was an exception, as most major currencies in 2016Q4 featured large and negative basis. In fact, the Japanese yen-U.S. dollar cross-currency basis dropped to negative 70 basis point, larger than observed during the financial crisis. On the other hand, positive basis continued for Australia, India, New Zealand, and the Philippines.

Finally, cross-country and time-series variations of the basis are significant, in terms of both size and level.

III. WHY DOES CIP FAIL TO HOLD?

In this section, we outline factors that help explain the patterns of the cross-currency basis documented in the previous section. While not exhaustive, these include: (1) counterparty and credit risks during the financial crisis; (2) stricter regulations for global banks since the GFC, and (3) changes in FX hedging demand and supply of U.S. dollars. We also confirm that the negative correlation between the cross-currency basis and the U.S. dollar as reported in Avdjiev et al. (2017) also holds for Asian countries.⁴

⁴ We present these possible factors with the caveat that there does not seem to be a factor (or factors) that can be applied uniformly across countries and over time. In this regard, this paper is consistent with Cerutti, Obstfeld and Zhou (2018) who show that these factors do not uniformly apply across currency pairs and over time.

A. Definition of Covered Interest Parity and Cross-Currency Basis

If the FX swap market is frictionless and allows market participants to instantaneously exploit arbitrage opportunities, the following condition of covered interest parity, expressed in logs, holds:

$$\underbrace{r_t^{\$}}_{\text{cash market}} = \underbrace{r_t^* - (f_t - s_t)}_{\text{swap market}}$$

with $r_t^{\$}$ the risk-free U.S. dollar interest rate, r_t^* the foreign risk-free interest rate, s_t the exchange rate between dollar and the foreign currency, and f_t the forward rate between the currencies. As an example, a Japanese bank needing U.S. dollars can either borrow U.S. dollar directly through the wholesale cash market or raise U.S. dollars in the FX swap market, by borrowing domestically in yen and swapping for U.S. dollars. If CIP was to hold, the cost of this “synthetic” dollar borrowing should be equal to that in the cash market.

The cross-currency basis measures the deviations from CIP. Simply put, the basis is the difference between the direct U.S. dollar interest rate and the synthetic U.S. dollar interest rate using swaps such as forward contracts:

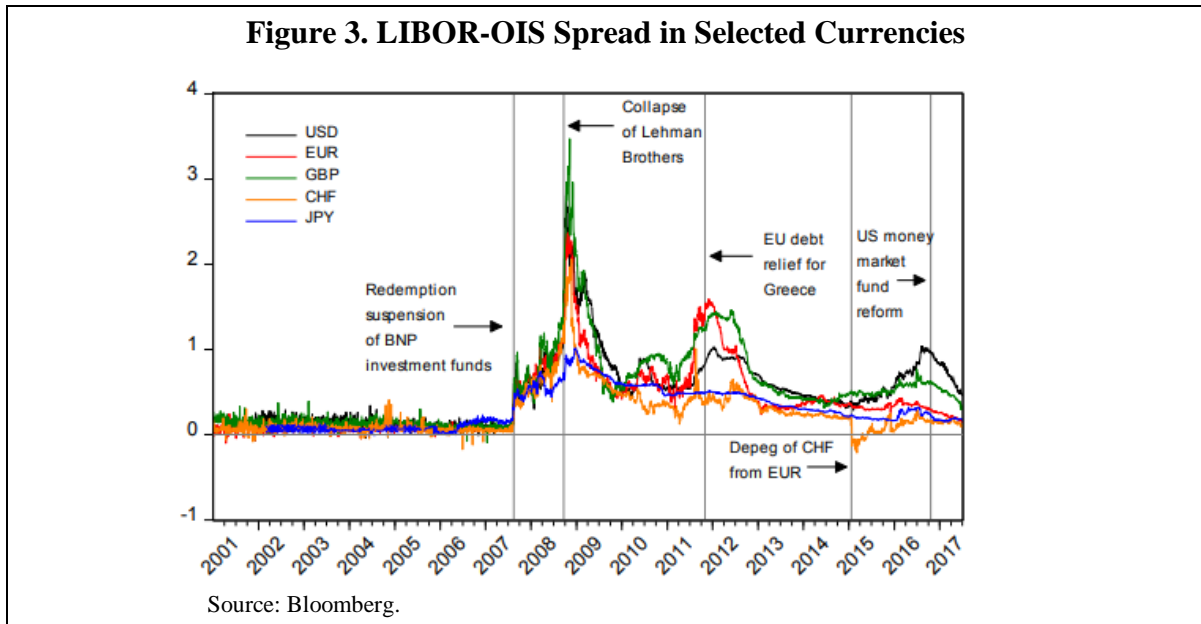
$$\underbrace{b_t}_{\text{cross-currency basis}} = \underbrace{r_t^{\$}}_{\text{cash market}} - \underbrace{[r_t^* - (f_t - s_t)]}_{\text{swap market}}$$

This implies that in the case of a negative basis, the direct U.S. dollar interest rate is lower than the synthetic U.S. dollar interest rate (and vice versa for a positive basis). For instance, for Japanese banks, it would cost for them more to obtain U.S. dollar funding via the FX swap market than from directly borrowing in the U.S. dollar cash market.

B. Counterparty and Credit Risks During Crisis Periods

Increased counterparty credit risk is often cited as a prominent reason why the covered interest parity failed in recent crisis periods (see Baba and Packer (2008), Coffey et al. (2009), Ivashina et al. (2015), Wong and Zhang (2017)).⁵ Counterparty credit and funding liquidity risk in the U.S. dollar skyrocketed during the GFC. This is shown in the sharp increase of the LIBOR-OIS spread in the interbank funding market across most major currencies during the GFC, which spiked again during the European sovereign debt crisis (Figure 3).

⁵ Coffey et al. (2009) show that an increased supply of U.S. dollars by the Federal Reserve to foreign central banks via reciprocal currency arrangements (swap lines) did not have significant effect on narrowing the basis in the post-Lehman period. They explain that a heightened counterparty risk dominated, leading to a breakdown of arbitrage transactions.



While counterparty risk has the most immediate impact on unsecured lending and borrowing in the interbank market, it could also spill over to the FX derivatives market as seen during the crisis periods.

U.S. dollar shortage in the interbank market was significant, as participants in the interbank market hoarded liquidity amid counterparty risk concerns. As a result, financial institutions turned away from the interbank market towards the FX derivatives market where they swapped domestic currency for U.S. dollars. As a result, disruptions in the interbank market spilled over to the FX derivatives market, leading to deviations from the covered interest parity.

C. Regulatory Reforms

In the post-crisis period, tighter regulations on global banks were seen as a key factor preventing CIP deviations from being arbitrated away even as market stress eased after the crisis periods (Du et al. (2017)). Regulations on leverage ratio and risk-weighted capital requirements increased the cost for banks to expand their balance sheets to arbitrage away CIP deviations

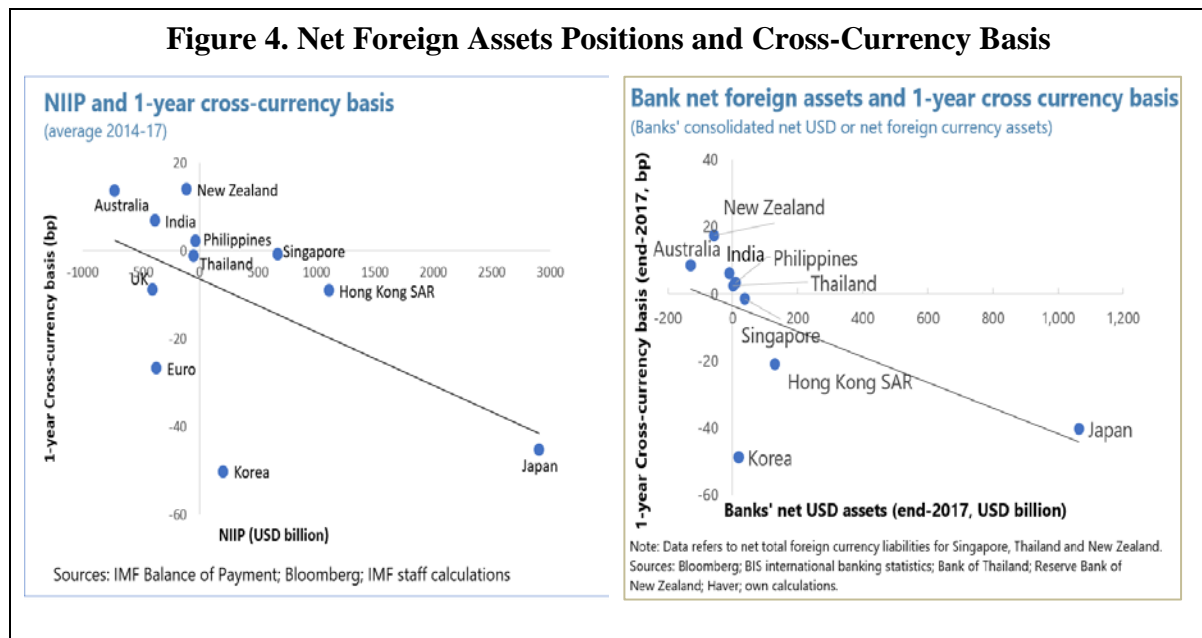
For instance, the leverage ratio requires banks to hold a minimum amount of capital against on-balance-sheet assets and off-balance-sheet exposures, regardless of their risk. While short-term CIP trades have very little market risk, they still expand balance sheets and raise the leverage ratio. For foreign banks, Basel II introduced a leverage ratio of 3 percent, raising the required rate of return on CIP arbitrage, i.e., the basis, for banks to profit from arbitrage activities. This is consistent with Du et al. (2018) who showed that CIP deviations increase towards the end of the quarter when regulation becomes binding and investors need to meet regulatory filing obligations.

Other arbitrageurs besides banks—hedge funds, money market funds, foreign currency reserve managers, corporate issuers—are also affected by tighter bank regulation, as they rely on global banks as their prime brokers. Nonbanks also face funding constraints, such as from the October 2016 U.S. money market funds (MMF) reforms, which made it more difficult to raise short-term U.S. dollar funds.

D. FX Hedging Demand by Asian Countries

International imbalances between offshore investment demand and foreign currency funding supply have also opened CIP deviations across countries (see Borio et al., 2016, Sushko et al., 2016, and Du et al., 2018). The literature proxies FX hedging demand by the *U.S. dollar funding gap*--the difference between consolidated global on-balance sheet assets and liabilities in U.S. dollar.⁶ Given tight FX prudential regulations, banks and other institutional investors need to hedge the currency risk arising from the gap between their on-balance assets and liabilities in foreign currency, including by using FX swaps and other derivatives.

Following this idea, we first look at the net international investment position (IIP) to proxy for a country's net FX exposure at the aggregate level (Figure 4, left panel). In this figure, Japan has the largest positive net IIP position, close to US\$ 3 billion at the end of 2018. While most countries in Asia are net creditors, some like Australia, India, along with the U.K. and the Euro Area are net debtors. Philippines and Thailand have broadly balanced net IIP positions. Overall, we find a positive correlation between a country's net IIP position and its U.S. dollar funding premium, measured by the cross-currency basis. That is, countries with positive net IIP have more negative cross-currency basis and face a higher premium to borrow and hedge U.S. dollars in the FX swap market.



⁶ FX derivatives are off-balance-sheet assets and it is difficult to have a direct measure of FX hedging demand.

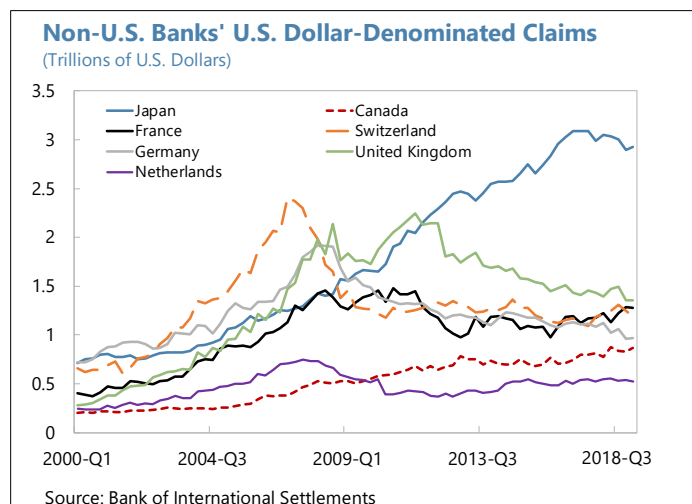
After analyzing at the aggregate level, we look at the FX hedging demand by banks using the BIS international banking statistics (Figure 4, right panel). Here, net foreign assets position is a proxy measure for bank's FX hedging demand.⁷ We again confirm the negative correlation observed at the aggregate level using the bank-level data. Interestingly, an economy's net foreign assets position for banks largely resembles that of an economy's overall net IIP position--Japan and to a lesser extent, Korea and Hong Kong SAR, have long positions, while Australia and New Zealand have short positions. Philippines and Thai banks have balanced net foreign assets positions.

On this basis, we classify countries into three broad groups based on their cross-currency basis and net foreign assets positions: those that exhibit a mostly positive basis, those with a negative basis, and those for which CIP broadly holds. Some common features are observed for each group:

- Countries with a **positive basis** (Australia, India, New Zealand) generally exhibit a negative net international investment position (IIP). They tend to be net debtor countries with low domestic savings, current account deficits, and relatively high interest rates.
- Countries with a **near-zero basis** (the Philippines, Singapore, Thailand) generally exhibit balanced external funding positions, with hedging done more on balance sheet rather than through the derivatives market.
- Countries (economies) with a **negative basis** (Japan, Korea, and to a lesser degree Hong Kong SAR) are generally net creditor nations as seen by positive net IIPs, with high domestic savings, but with relatively low interest rates.

Country-specific factors should also be taken into consideration. For example,

- *Japan.* Japanese banks have the largest US-dollar denominated claims in the world. While other European countries reduced their U.S. dollar-based assets since the financial crisis, Japanese banks have increased their claims. Unlike others in Asia where institutional investors account for a larger share of hedging demand than the banks, in Japan, the banks have a larger net FX asset positions and drive the demand for hedging. A strong search-for-yield due to thin lending margins and low return on domestic investments, including JGBs, is driving the strong demand for overseas assets. Under these circumstances,



⁷ According to this data, Australia, Japan, Korea, Taiwan POC and Thailand account for about 80 percent of open forex positions of all BIS banks in Asia region.

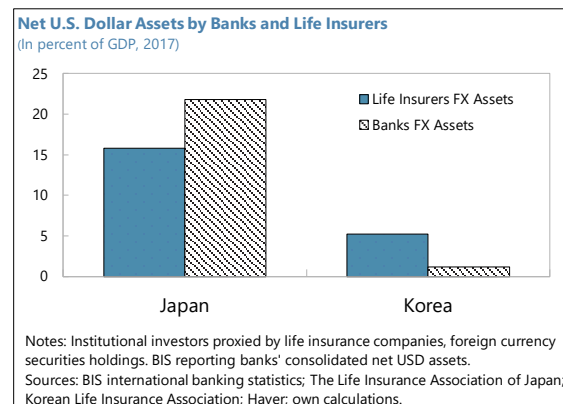
Japanese banks face strong incentives to invest abroad, mobilizing their large yen deposit base to fund their overseas investment while hedging their foreign currency risk in the FX swap market. This strong demand for FX hedging of overseas investment through the FX swap market has helped keep the cross-currency basis wide even after the GFC.⁸

- *Korea.* During the crisis period, Korea experienced one of the most severe deviations in covered interest parity, as FX swap and cross-currency swap markets were not deep enough to handle the U.S. dollar funding pressures. Several studies focus on the structural demand-supply imbalance in the FX forward market due to massive selling of FX forwards by Korean shipbuilder, heavy industry companies and Korean investors in foreign stocks (Baba and Shim, 2011, Kim et al. 2009, Hwang, 2010, for instance). Despite bilateral swap between the U.S. Federal Reserve and the Bank of Korea, the basis spread still persists. This partly reflects the high hedging demand by Korean institutional investors, particularly life insurers who target very high hedging ratios to avoid capital charges on open FX positions.
- *Australia.* On the other side, Australian banks have large net forex liability position (20 percent of GDP) reflecting banks' offshore wholesale funding. With a small domestic deposit base relative to a large domestic currency mortgage market, Australian banks have relied on the FX swap market to meet the large demand for mortgage funding and hedge their forex liabilities. This has contributed to a persistent positive cross-currency basis.

Rising role of institutional investors in FX swap market. In addition to banks, institutional investors such as insurance companies and pension funds, have become major participants in FX derivatives market. Like banks, institutional investors use FX swaps to hedge their foreign currency investments.

In Asia, institutional investors account for nearly 65 percent of the increase in FX-hedging demand in Asia since 2007 (Goldman Sachs (2018)), with the rest coming mainly from banks. In Korea, life insurance companies' hedging demand is estimated to exceed banks' hedging demand by five-fold. Many institutional investors face mandates to fully hedge their foreign currency exposures.

Rising hedging demand by institutional investors also reflects the rapidly aging populations in Japan, Korea and many other countries in Asia, implying that life insurance companies and pension funds will continue to be key players in FX derivatives market, pushing up the basis spread. One estimate suggests that Korean life insurers' foreign assets could more than double by 2022, reaching US\$ 280

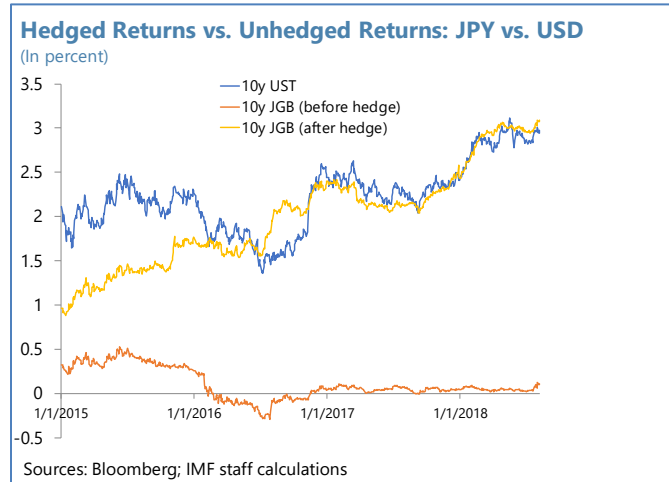


⁸ For additional analyses of the impact of interest rate differentials on the Japanese yen, see Han and Westelius (2019).

billion, suggesting that without an adequate FX supply response, deviations in CIP and a U.S. dollar premium will persist.

E. U.S. Dollar Supply Factors

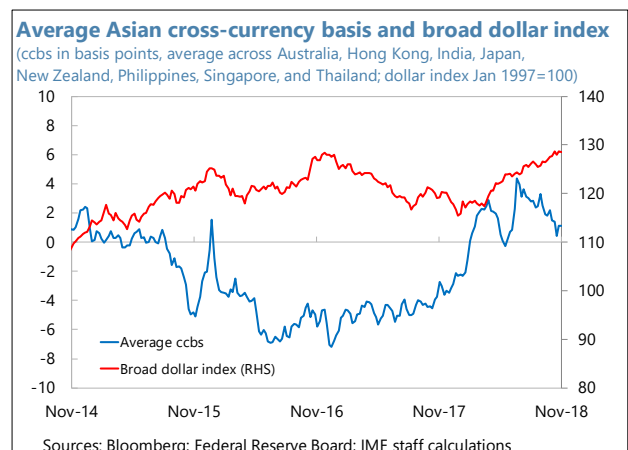
Foreign reserve managers and sovereign wealth funds are key suppliers of U.S. dollar liquidity in cross-currency swap markets. Taking advantage of the cross-currency basis, large FX reserve holders have earned a higher yield than U.S. treasuries without taking on foreign exchange risk. For example, large reserve holding central banks, by lending U.S. dollars in exchange for Japanese yen in the swap market and investing the yen in Japanese government bonds, can earn a hedged-returns on JGBs that is higher than a comparable yield in U.S. Treasuries.



However, the supply of U.S. dollars seems also to be procyclical (see Debelle, 2017). Market stress, weaker emerging market currencies and lower commodity prices may constrain the ability of large reserve holders to supply U.S. dollar via the swap market (Arai et al. 2016). For example, during periods of market stress, central banks may wish to invest in more liquid U.S. dollar assets instead of supplying U.S. dollars in the FX swap market if they face the need to intervene in the FX market to defend their currencies. Lower commodity prices can also worsen fiscal balances in some countries, putting pressure on sovereign wealth funds to fund their budgets with their reserve holdings rather than supply U.S. dollar liquidity to cross-currency swap markets. The reduced supply of U.S. dollars for the swap market during times of market stress could also explain the difficulties in arbitraging away deviations from CIP.

F. Movements in CIP Deviations

Besides cross-country differences in the level and sign of CIP deviations, what can explain their movement over time? A study Avdjiev et al. (2017) suggests a close negative correlation between the strength of the U.S. dollar—as measured by the broad dollar index—and the cross-currency basis since the GFC. Here, the U.S. dollar is seen as a proxy for global risk appetite. A stronger U.S. dollar, perhaps reflecting a flight to quality, implies a higher shadow cost of banks' balance sheet capacity and lower bank leverage, leading to a decline in cross-border lending and wider CIP deviations.



To some extent, we confirm the negative correlation between the strength of U.S. dollar and the cross-currency basis for Asian countries. Like other major currencies, since the GFC, movements in the broad dollar index and the basis in Asia have largely mirrored each other.

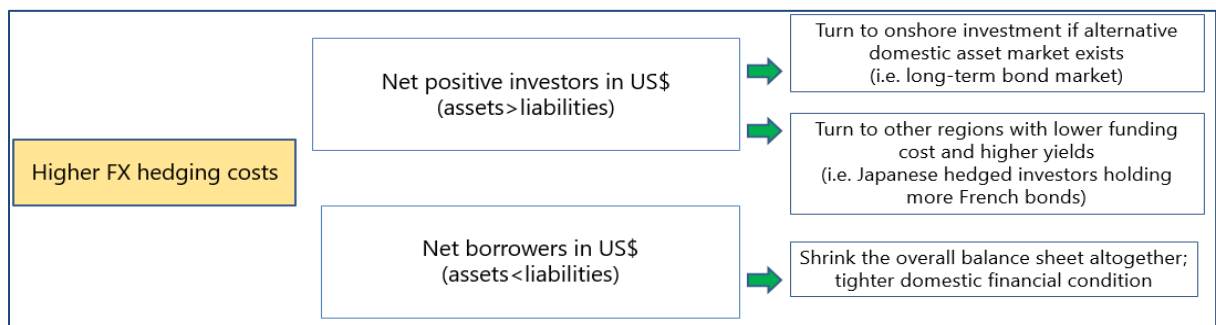
IV. IMPLICATIONS OF WIDER BASIS ON DOMESTIC FINANCIAL CONDITIONS

So far, we looked at various reasons why cross-currency basis could widen, pushing up U.S. dollar funding and hedging costs. In this section, we assess the implication of a wider cross-currency basis on domestic financial conditions. We argue that higher U.S. dollar funding costs will have different implications on an economy's domestic financial conditions, depending on its net position vis-à-vis the U.S. dollar and other costs related to balance sheet activities.

For an economy with positive net IIP vis-à-vis the U.S. dollar (i.e., a net creditor), an increase in the basis and hedging costs would lower the attractiveness of overseas investment in U.S. dollar-denominated assets. If these flows could turn inward to onshore assets, domestic financial conditions may actually improve. Alternative non-U.S. offshore investments (e.g. in euros) could be another option, depending on their hedge-adjusted returns, in which case, the implications on domestic financial conditions may still be negative.

In contrast, for an economy with negative net IIP vis-à-vis the U.S. dollar (i.e., a net debtor), an increase in hedging costs may be associated with tighter domestic financial conditions. For instance, many emerging economies rely on foreign funding due to limited long-term domestic funding sources. An increase in FX hedging costs could lead banks or corporates to shrink their balance sheets, as they be unable to replace more expensive U.S. dollar funding with domestic funding. In such cases, domestic selling of assets combined with higher demand for domestic funding to replace external borrowing could push up domestic interest rates and further tighten domestic financial conditions. Annex A presents a simple theoretical model to motivate the intuition.

The following flow chart summarizes the argument.



A. Empirical Results

In this section, we examine empirically the implications of higher U.S. dollar funding premium on domestic financial conditions.

We calculate the impulse response using the local projections method proposed by Jorda (2005). We consider 25 economies in the baseline, representing both advanced economies and emerging economics, in Asia and elsewhere. Ten advanced economies as major participants in the FX derivatives markets are considered: Australia, Canada, Denmark, Euro Area, Hong Kong SAR, Korea, Japan, New Zealand, Norway, Sweden, Switzerland, and U.K. In addition, we include emerging economies in Asia: India, Indonesia, Malaysia, Philippines, Singapore and Thailand. Finally, we also include other emerging economies: Brazil, Chile, Colombia, Mexico, South Africa and Turkey.

The baseline equation is as follows, for each time horizon h ($h=0, \dots, 5$):

$$\Delta y_{i,t+h} = \alpha_h + \beta_h(L)X_{i,t-1} + \gamma_{i,h}shock_{i,t} + \theta_i + \varepsilon_{i,t+h}$$

in which i denotes the country, and t denotes the time period. $\Delta y_{i,t+h} = y_{i,t+h} - y_{i,t-1}$ is the change in y between period $t-1$ and $t+h$, where y represents domestic financial conditions, such as the change in 3M-interbank spread, the change in corporate spread and the change in sovereign spread. $shock_t$ is the shock to the U.S. dollar funding costs, which is the monthly percent change of the cross-currency basis rate over one year. $X_{i,t-1}$ is a vector of controls, including the U.S. broad dollar index (as in Avdjiev et al. 2017, Cerutti et al. 2018), log of VIX, CPI inflation, industrial production, exchange rate, interest rate differential between domestic rate and the world (U.S.) rate, and domestic credit growth rate and lagged dependent variable. θ_i represent country fixed effects. All series are at monthly frequency, starting from January 2008 to December 2018.

The impulse response functions (IRFs) of different measures of domestic financial conditions are calculated in response to a 100-basis point shock to the change in cross-currency basis, which is a very large shock. To give a sense of the magnitude of this shock, the mean change in cross-currency basis in the sample is negative 0.05 basis point, with a standard deviation of 9.6. With this background, we test the following two hypotheses.

Hypothesis 1. The impact of U.S. dollar funding costs on domestic financial conditions depends on a country's net IIP position.

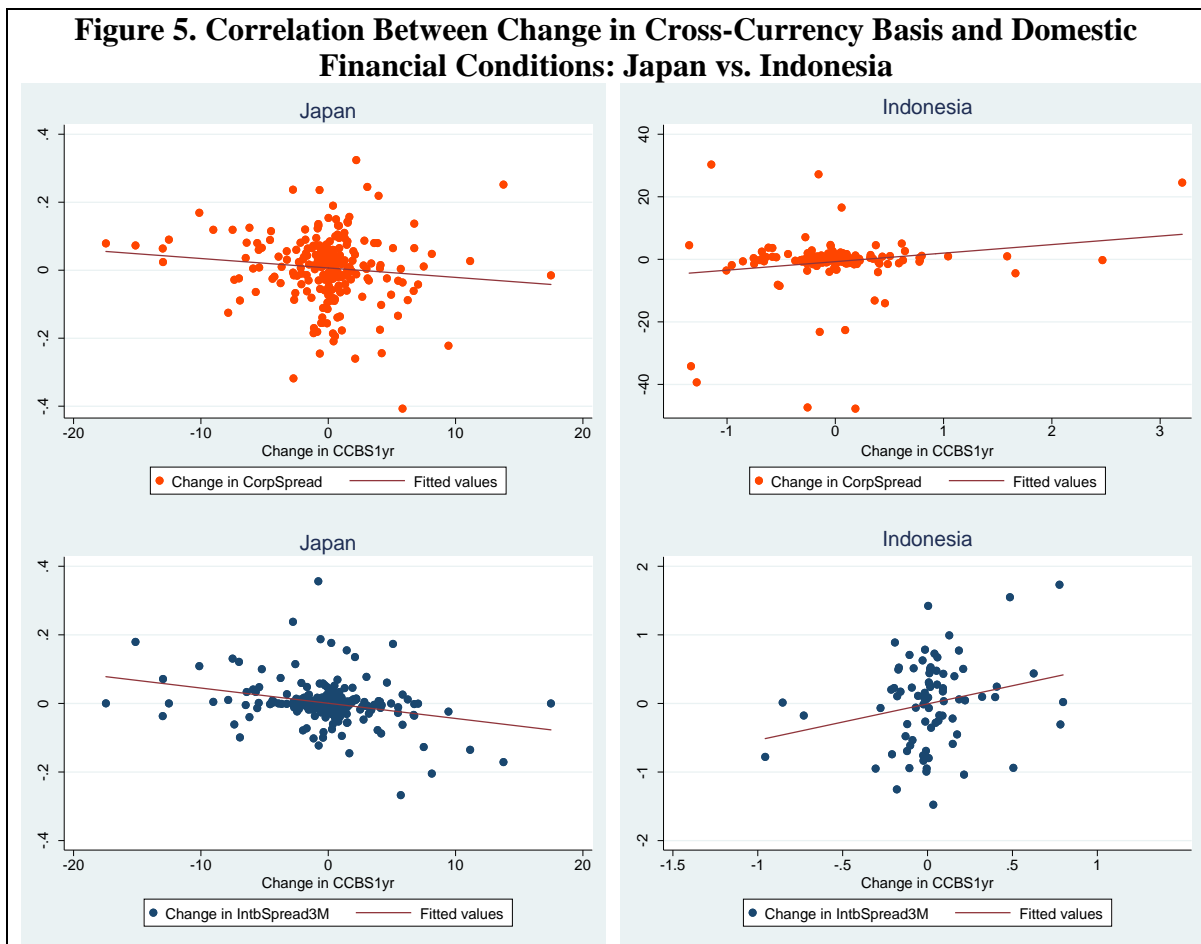
In addition to the linear model, we expand the model by exploring the effects of the U.S. dollar funding costs in high financial stress times vs. other times. Following the approach by Ramey and Zubairy (2018) to estimate the U.S. government spending multiplier in periods of recessions and expansion, we introduce a dummy variable to capture high financial stress times defined as VIX taking a larger value than two standard deviations above the historical mean (from January 2000), which is about 35 ($19 + 2*8.06$).

The regression line to consider for non-linearity is as follows:

$$y_{t+h} = I_{t-1}(\alpha_{High,h} + \beta_{High,h}(L)X_{i,t-1} + \gamma_{High,h}shock_t + \theta_{High,i}) \\ + (1 - I_{t-1})(\alpha_{Low,h} + \beta_{Low,h}(L)X_{i,t-1} + \gamma_{Low,h}shock_t + \theta_{Low,i}) + \varepsilon_{i,t+h}$$

Hypothesis 2. In addition, during the period of high market stress, an increase in U.S. dollar funding cost may have non-linear relationship with domestic financial conditions. For net creditor economies, domestic financial conditions may improve more during high stress periods compared to normal times, as investors find it more attractive to invest onshore (for instance, flight-to-safety motives). On the other hand, for net debtor economies, an increase in U.S. dollar funding costs could tighten domestic financial conditions more during the high stress period due to pressures to downsize balance sheets.

Before we run the regression, we show the correlations between the change in cross-currency basis and domestic financial conditions for Japan, a positive net IIP country, and Indonesia, a negative net IIP country (Figure 5). A simple correlation between the change in 1-year cross-currency basis and the change in corporate spread (orange dots) and the change in 3M interbank spread (blue dots) shows a starkly different picture for Japan and Indonesia. A negative correlation for both spreads is observed for Japan, which is suggestive of some easing of domestic conditions following an increase in the U.S dollar-funding premium. On the other hand, in Indonesia a higher U.S. dollar funding premium is associated with higher corporate and interbank spreads.

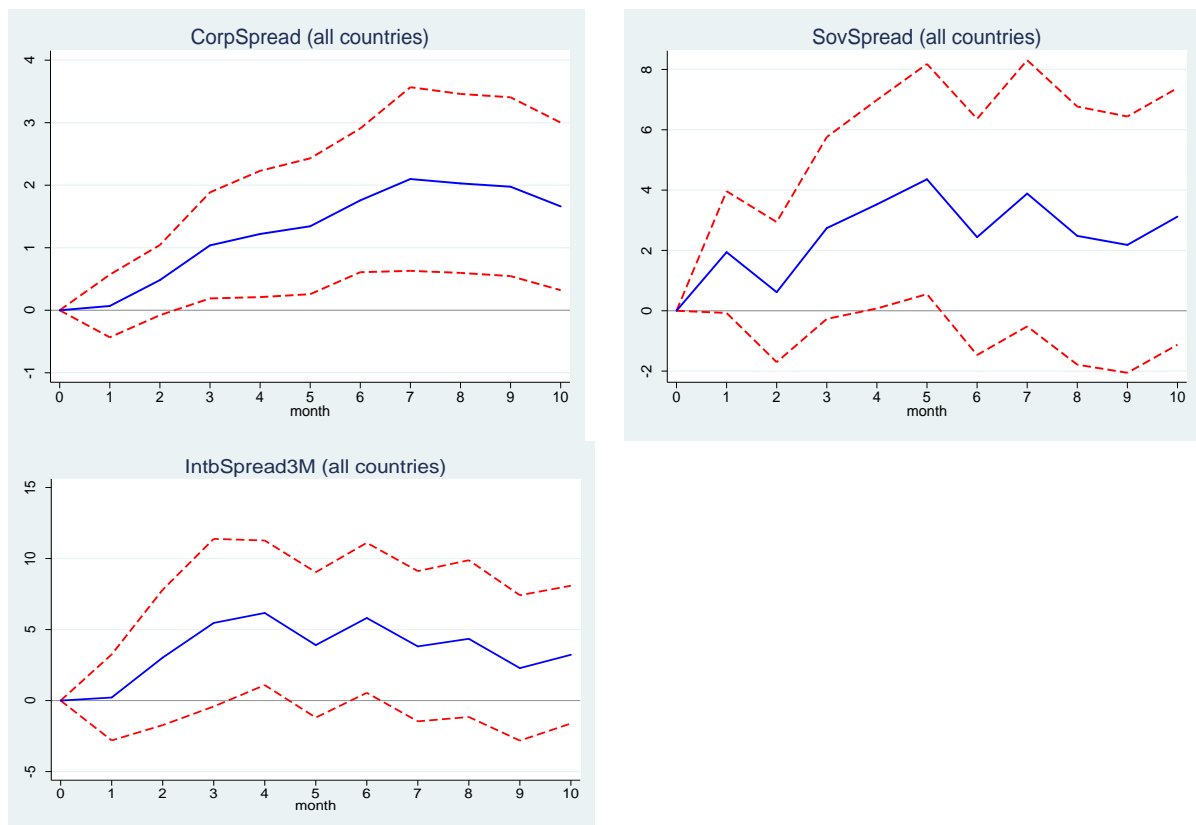


Empirical results for Hypothesis 1. We find that on average, a 100-basis point shock to cross-currency basis leads to tighter domestic financial conditions (Figure 6 and Table 1). While the effects are insignificant over the long term, spreads remain at an elevated level. For instance, corporate spread increase by maximum 20 basis point after 6-7 months, cumulatively.

However, the implications on domestic financial conditions differ depending on a country's net IIP position (Figure 7 and Table 2). For countries with a positive net IIP, we find that domestic financial conditions tend to ease, following a negative shock to the cross-currency basis. For instance, a 100-basis point widening of the cross-currency basis leads to about 80 basis point decline in corporate spread for 5 months. Sovereign spread declines by 32 basis points in 3 months. Cumulative decline in interbank rate ranges around 20 to 30 basis points. Results with statistical significance are observed for the effects within three to five months, while the statistical significance weakens over time. However, spreads remain in negative territory. On the other hand, for countries with negative net IIP, spreads increase in response to a negative shock to the cross-currency basis, with corporate spreads responding most sensitively by 300 basis points.

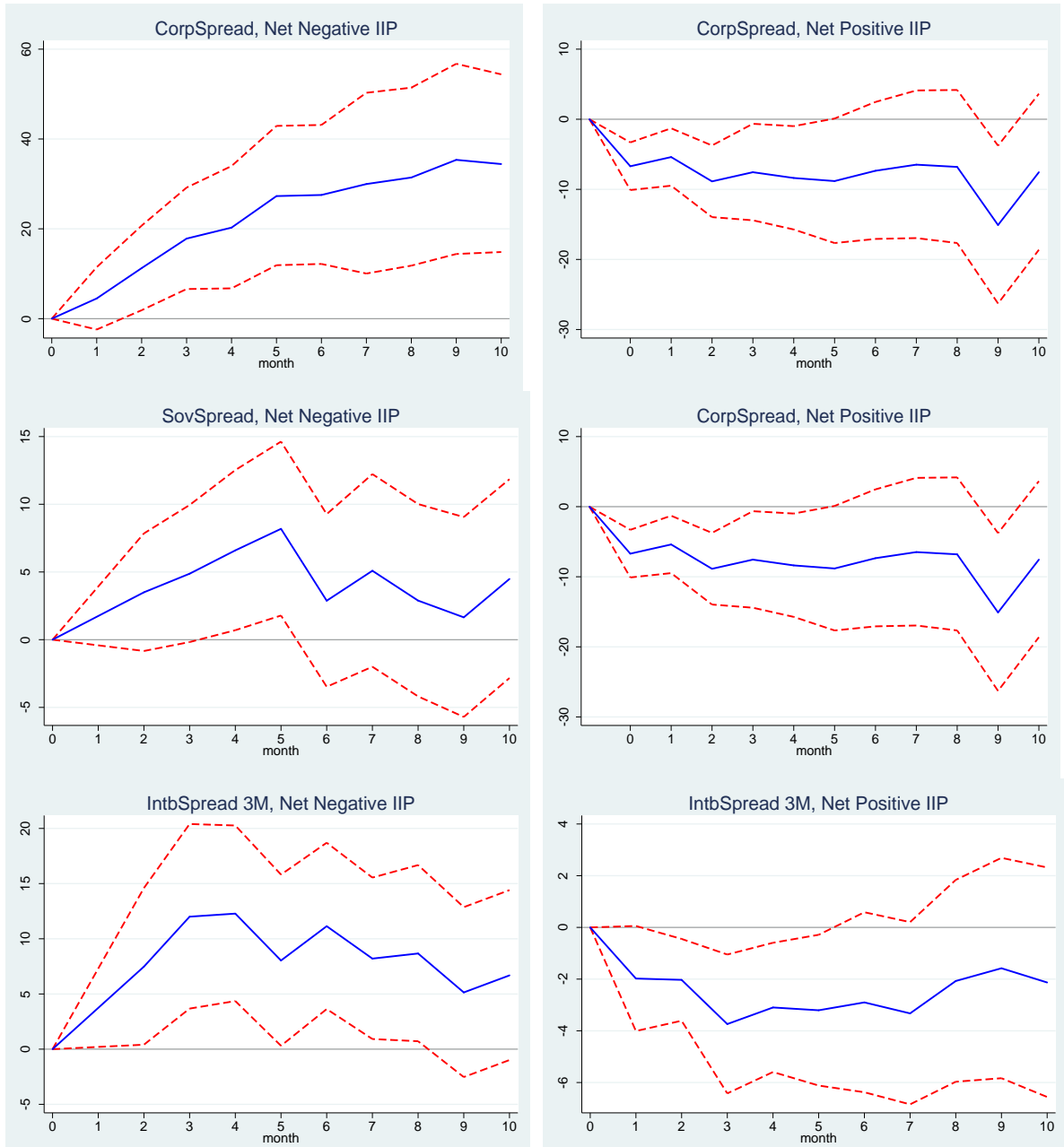
The results show that the demand for domestic assets differs greatly across economies. In the event of an increase in cross-currency basis combined with financial stress, economies that rely on U.S. dollar funding and face limited domestic financial sources to offset higher U.S. dollar funding costs experience a tightening of domestic financial conditions. *In other words, CIP deviations for net debtor countries can amplify the impact of a shock on domestic financial conditions.* Simultaneous increase in global risk aversion along with the friction in dollar funding market could be one explanation behind the amplification mechanism.

Figure 6. Impulse Response Functions: A 100-basis point Shock to Cross-Currency Basis



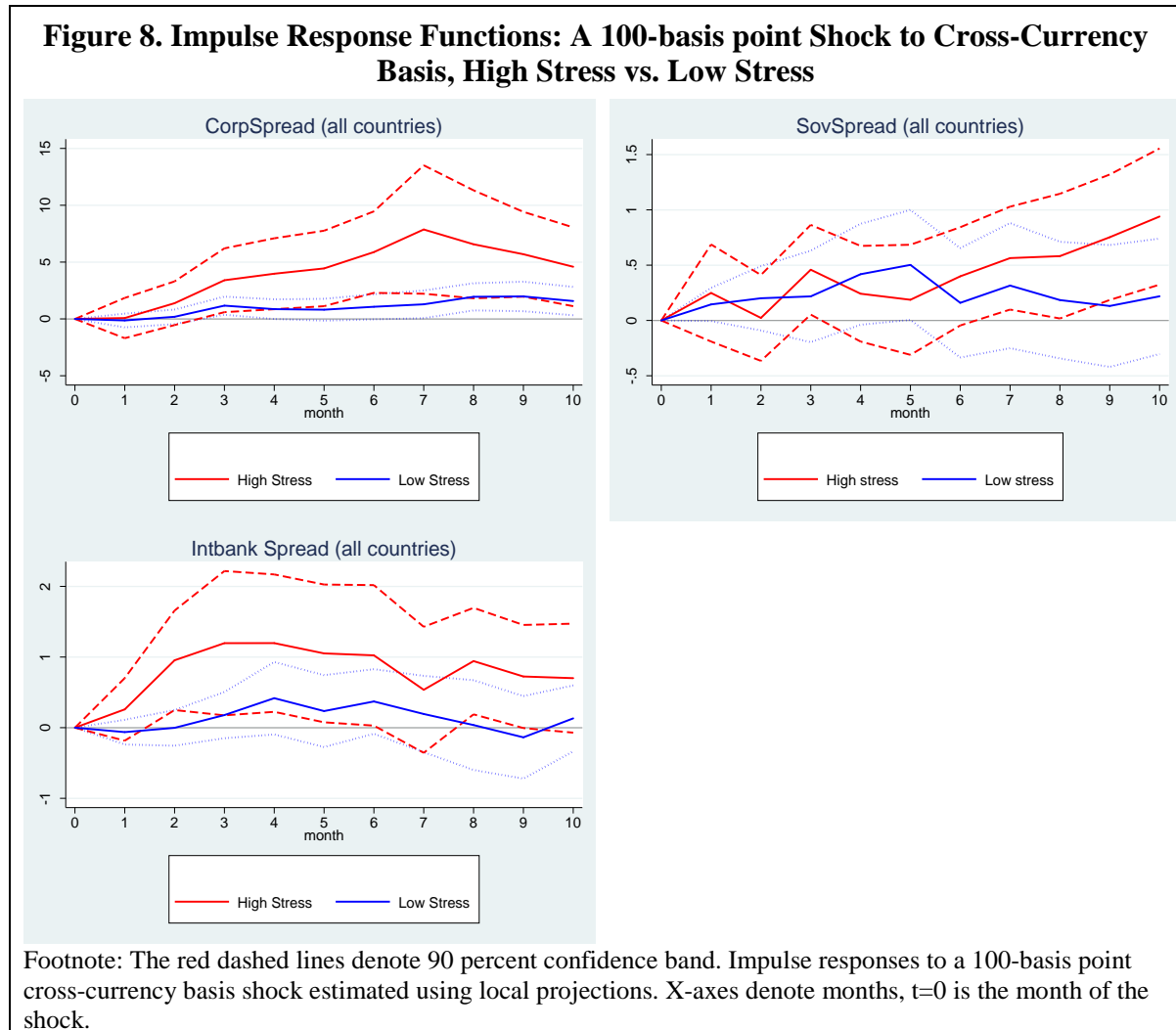
Footnote: The red dashed lines denote 90 percent confidence band. Impulse responses to a 100-basis point cross-currency basis shock estimated using local projections. X-axes denote months after the shock occurs, $t=0$ is the month of the shock.

Figure 7. Impulse Response Functions: A 100-basis point Shock to Cross-Currency Basis by Net IIP Positions



Footnote: The red dashed lines denote 90 percent confidence band. Impulse responses to a 100-basis point cross-currency basis shock estimated using local projections. X-axes denote months, t=0 is the month of the shock.

Empirical results for Hypothesis 2. We find that domestic financial conditions tighten during high-stress periods. In response to the same basis shock, we find that all indicators increase much more during the high-stress period than during calm times and that the spreads remain at an elevated level for an extended period (Figure 8).

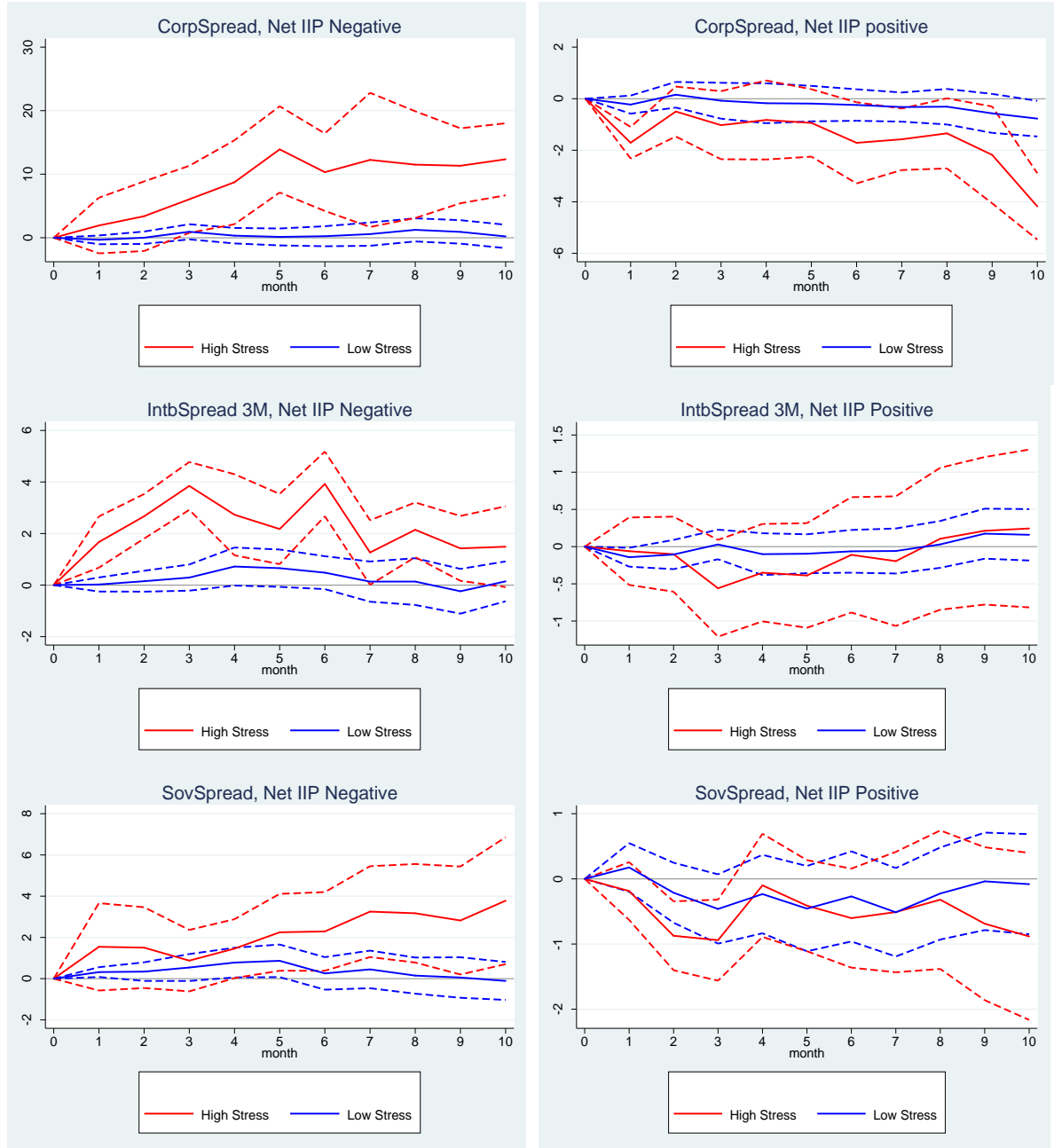


However, when we re-run the same analysis looking at countries' net IIP position, we find contrasting results (Figure 9). For net creditor economies, spreads rather than increasing, actually decline and even more so during high stress periods than in low stress periods. Corporate spreads, which do not react to a higher basis during calm periods, decline within the first month of the shock. These effects are statistically significant. *These results suggest that investors in net creditor countries shift to domestic assets more during periods of global financial stress, helping to ease domestic financial conditions, perhaps reflecting a flight-to-safety behavior or a response to higher FX hedging costs.*

The opposite is observed for net debtor economies who are hit harder during times of financial stress. As many rely on the U.S. dollar funding, an increase in U.S.-dollar funding premium combined with a lack of domestic alternative options pushes banks to shrink their

balance sheets by drawing down domestic currency-denominated assets, leading to a tightening of financial conditions (see IMF 2018a, 2018b).

Figure 9. Impulse Response Functions: A 100-basis point Shock to Cross-Currency Basis, High Stress vs. Low Stress, by Net IIP Position.



Footnote: The red dashed lines denote 90 percent confidence band. Impulse responses to a 100-basis point cross-currency basis shock estimated using local projections. X-axes denote months, t=0 is the month of the shock.

V. POLICY IMPLICATIONS AND CONCLUSION

In this paper, we document several factors that could explain deviations from covered interest parity and assess the implications of higher U.S. dollar funding costs for Asian economies. Deviations can be explained by a combination of factors, including cyclical movements and structural drivers such as regulatory changes and country-specific mismatch between demand and supply of U.S. dollars. Going forward, such deviations are likely to persist due to demographic trends and regulatory requirements for financial stability.

Heightened financial risks during times of significant market stress could lead to a sharp and rapid increase in hedging costs. As it did during the previous episodes of the global financial crisis and the European sovereign debt crisis, a sharp and rapid increase in hedging costs could trigger severe funding problems for financial institutions that rely heavily on the U.S. dollar for funding.

Looking ahead, as financial institutions (particularly in Asia) expand their overseas investments as their populations age and/or investors diversify their portfolios, demand for U.S. dollar funding and FX hedging will increase. Policies should focus on closer monitoring of financial institutions' FX exposures and hedging activities, expanding the supply of stable U.S. dollar funding and deepening domestic capital markets to provide alternative sources of funding in the event of market distress. Here, policy options could include:

- *Enhanced monitoring.* Regulators should monitor for possible maturity and/or currency mismatches in FX hedging through market-based instruments. Cross-currency swap markets in Asia, for example, typically offer 3- to 6- month contracts which are rolled over to hedge longer-term investments and are therefore vulnerable to changes in market conditions and risk appetite by global banks. Counterparty or liquidity risk may emerge during periods of financial distress, causing a spike in the basis spread as financial institutions scramble to repay obligations, cover unhedged exposures, or sell domestic assets in a fire sale. In this situation, policymakers may face pressure to respond.
- *Hedging counterparty of last resort.* Ex ante, central banks with ample reserves may consider creating a “hedging counterparty of last resort” instrument that can be activated quickly during periods of extreme distress to help financial institutions unwind their open FX positions or failed hedges in an orderly fashion. This could take the form of a long-term FX swap or auction facility.⁹ Providing a backstop may help address tail risk concerns about disorderly fire sales but should be structured in a way that mitigates moral hazard, for example, by applying a high surcharge.
- *Investing international reserves in the cross-currency swap market.* Central banks with large reserve holdings or sovereign wealth funds could invest a small portion of their international reserves in the cross-currency swap market, expanding the market supply of

⁹ For example, see Kohlscheen and Andrade (2013) on the effects of currency swaps auctions carried out by the Brazilian Central Bank between the second half of 2011 to 2012 on the BRL/USD swap exchange rate.

stable, long-term U.S. dollar funding. This could be a “private” alternative to expanding central bank swap lines as done during the global financial crisis. This is already happening among some large central banks, who have earned higher returns on a hedged basis through the swap market than by investing directly in comparable U.S. Treasuries.¹⁰ Large central banks and sovereign wealth funds could be an effective hedging counterpart in the cross-currency swap market, as they do not face the same regulatory requirements as global banks, have a long time horizon, and can maintain their FX exposure under more stressful market conditions. They could in turn help arbitrage away CIP deviations and reduce FX hedging costs, spurring the development of FX hedging markets in the region.

- *Developing alternative sources of longer-term domestic funding.* Our analysis shows that for both net debtor and net creditor countries, having suitable, alternative domestic funding sources and investment assets can help mitigate the impact of external shocks on domestic financial conditions by allowing financial institutions and corporates to smoothly adjust their balance sheets. In Asia, the lack of deep capital markets has left several countries vulnerable to widening current account deficits or capital flow reversals. Here, developing further longer-term corporate and sovereign bond markets, as well as institutional investors, such as pension funds and insurance companies, can help corporates and financial institutions switch funding and investments smoothly in response to changes in FX hedging or funding rates, smoothing their impact of domestic financial conditions and the macro economy. This in turn will help develop other longer-term, onshore hedging markets such as those for FX deliverable forwards and other derivative instruments in Asia.

¹⁰ The annual report by the Reserve Bank Australia (2016) notes “Reflecting this, the bulk of the foreign currency the Bank obtains from swaps against Australian dollars is Japanese yen. For the same reason, the Bank also swaps other currencies in its reserves portfolio against the yen to enhance returns. As a consequence, while the Bank’s exposure to changes in the value of the yen remains small (consistent with the yen’s 5 per cent allocation in the Bank’s benchmark), around 58 per cent of the Bank’s foreign exchange reserves were invested in yen-denominated assets at the end of June 2016.” More details could be found here: <https://www.rba.gov.au/publications/annual-reports/rba/2016/operations-in-financial-markets.html>. Also, the speech by the Deputy Governor of the RBA at the BIS Symposium in 2017 shows the investment in JGBs benefiting from negative basis of the JPY/USD FX swaps (<https://www.rba.gov.au/speeches/2017/sp-dg-2017-05-22.html#fn3>).

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Table 1. Subsequent Cumulative Change in Domestic Financial Conditions: A 100-basis point Shock to Cross-Currency Basis

Time	1	2	3	4	5	6	7	8	9	10
Corporate Spread										
Change in CCBS	0.48 (0.34)	1.04 (0.52)	1.22 (0.61)	1.34 (0.66)	1.76 (0.70)	2.10 (0.89)	2.03 (0.87)	1.98 (0.87)	1.66 (0.81)	1.99 (0.78)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.146	0.195	0.206	0.209	0.230	0.213	0.211	0.220	0.252	0.286
Number of observations	1,469	1,463	1,453	1,442	1,430	1,418	1,406	1,394	1,382	1,370
Sovereign Spread										
Change in CCBS	0.62 (0.14)	2.74 (0.18)	3.53 (0.21)	4.36 (0.23)	2.44 (0.24)	3.89 (0.27)	2.48 (0.26)	2.18 (0.26)	3.12 (0.26)	2.60 (0.28)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.172	0.171	0.150	0.155	0.149	0.150	0.152	0.167	0.176	0.184
Number of observations	1,696	1,688	1,676	1,663	1,649	1,635	1,621	1,607	1,593	1,579
Interbank Spread 3M										
Change in CCBS	3.03 (0.29)	5.47 (0.36)	6.17 (0.31)	3.91 (0.31)	5.82 (0.32)	3.81 (0.32)	4.35 (0.33)	2.28 (0.31)	3.22 (0.29)	3.30 (0.30)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.216	0.203	0.160	0.154	0.145	0.142	0.142	0.133	0.135	0.140
Number of observations	1,624	1,616	1,603	1,590	1,576	1,562	1,548	1,534	1,520	1,506

Footnote. This table shows regression results where the dependent variables are subsequent cumulative change in domestic financial conditions (corporate spread, sovereign spread and interbank spread 3M) over horizons from one to ten months in response to a 100-basis point shock to cross-currency basis. Controls include lag of U.S. broad dollar index, log of VIX for common variables, and CPI inflation, industrial production, exchange rate, interest rate differential between domestic rate and the world (U.S.) rate, and domestic credit growth rate and lagged dependent variables for country-specific controls. Robust standard errors are used.

Table 2. Subsequent Cumulative Change in Domestic Financial Conditions: A 100-basis point Shock to Cross-Currency Basis by Net IIP Positions

Time	1	2	3	4	5	6	7	8	9	10
<i>Corporate Spread</i>										
Net Positive IIP										
Change in CCBS	-5.39 (0.25)	-8.86 (0.31)	-7.55 (0.42)	-8.38 (0.45)	-8.82 (0.54)	-7.35 (0.60)	-6.48 (0.64)	-6.80 (0.67)	-15.09 (0.69)	-7.55 (0.68)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.252	0.247	0.281	0.291	0.278	0.283	0.246	0.219	0.226	0.261
Number of observations	607	603	598	593	588	583	578	573	568	563
Net Negative IIP										
Change in CCBS	11.25 (0.57)	17.83 (0.67)	20.27 (0.81)	27.29 (0.92)	27.54 (0.92)	29.97 (1.19)	31.43 (1.17)	35.36 (1.24)	34.43 (1.16)	31.83 (1.09)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.179	0.240	0.251	0.247	0.268	0.253	0.253	0.268	0.308	0.348
Number of observations	862	860	855	849	842	835	828	821	814	807
<i>Sovereign Spread</i>										
Net Negative IIP										
Change in CCBS	3.50 (0.26)	4.87 (0.31)	6.60 (0.36)	8.19 (0.39)	2.88 (0.39)	5.09 (0.43)	2.89 (0.43)	1.65 (0.45)	4.48 (0.44)	3.48 (0.48)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.215	0.236	0.220	0.218	0.212	0.213	0.211	0.228	0.241	0.250
Number of observations	843	841	836	830	823	816	809	802	795	788
Net Positive IIP										
Change in CCBS	-2.46 (0.12)	-1.94 (0.18)	-3.15 (0.14)	-1.64 (0.16)	-2.47 (0.15)	-2.32 (0.17)	-0.81 (0.18)	-0.28 (0.19)	-1.49 (0.19)	-0.53 (0.20)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.244	0.180	0.173	0.179	0.180	0.193	0.184	0.177	0.177	0.183
Number of observations	853	847	840	823	826	819	812	805	798	791
<i>Interbank Spread 3M</i>										
Net Negative IIP										
Change in CCBS	7.48 (0.43)	12.00 (0.50)	12.28 (0.48)	8.03 (0.47)	11.14 (0.45)	8.21 (0.44)	8.67 (0.48)	5.14 (0.47)	6.68 (0.46)	6.76 (0.47)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.301	0.291	0.244	0.233	0.216	0.210	0.202	0.180	0.179	0.187
Number of observations	819	817	811	805	798	791	784	777	770	763
Net Positive IIP										
Change in CCBS	-2.03 (0.10)	-3.74 (0.16)	-3.10 (0.15)	-3.21 (0.18)	-2.90 (0.21)	-3.33 (0.21)	-2.07 (0.24)	-1.58 (0.26)	-2.13 (0.27)	-1.10 (0.28)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.207	0.161	0.156	0.147	0.144	0.145	0.141	0.137	0.137	0.130
Number of observations	805	799	792	785	778	771	764	757	750	743

Footnote. This table shows regression results where the dependent variables are subsequent cumulative change in domestic financial conditions (corporate spread, sovereign spread and interbank spread 3M) over horizons from one to ten months in response to a 100-basis point shock to cross-currency basis. For each dependent variable, the regression is run in two separate samples: net positive IIP countries and net negative IIP countries. Controls include lag of U.S. broad dollar index, log of VIX for common variables, and CPI inflation, industrial production, exchange rate, interest rate differential between domestic rate and the world (U.S.) rate, and domestic credit growth rate and lagged dependent variables for country-specific controls. For corporate spread, net positive IIP countries are Norway, Japan, Canada, South Africa and Korea and net negative IIP countries are Turkey, Brazil, Chile, Colombia, India, Indonesia, Malaysia, Philippines, Thailand. For sovereign spread and interbank spread, net positive IIP countries are Denmark, Norway, Canada, Japan, South Africa, Korea, Singapore, while net negative IIP countries are Turkey, Brazil, Chile, Colombia, India, Indonesia, Malaysia, Philippines, Thailand. Robust standard errors are used.

Table 3. Subsequent Cumulative Change in Domestic Financial Conditions: A 100-basis point Shock to Cross-Currency Basis, High-Stress vs. Low-Stress Periods

Time	1	2	3	4	5	6	7	8	9	10
<i>Corporate Spread</i>										
Change in CCBS (High Stress)	1.38 (1.17)	3.40 (1.71)	3.98 (1.90)	4.44 (2.02)	5.88 (2.18)	7.87 (3.44)	6.57 (2.89)	5.69 (2.27)	4.59 (2.11)	5.68 (2.17)
Change in CCBS (Low Stress)	0.19 (0.39)	1.17 (0.49)	0.86 (0.53)	0.81 (0.58)	1.07 (0.67)	1.29 (0.74)	1.95 (0.73)	1.98 (0.79)	1.57 (0.76)	1.65 (0.68)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.237	0.286	0.304	0.321	0.348	0.345	0.337	0.343	0.409	0.471
Number of observations	1469	1463	1453	1442	1430	1418	1406	1394	1382	1370
<i>Sovereign Spread</i>										
Change in CCBS (High Stress)	0.95 (0.24)	1.20 (0.25)	1.20 (0.26)	1.05 (0.30)	1.02 (0.27)	0.54 (0.28)	0.94 (0.34)	0.72 (0.34)	0.70 (0.37)	0.83 (0.35)
Change in CCBS (Low Stress)	0.20 (0.18)	0.22 (0.25)	0.42 (0.28)	0.50 (0.30)	0.16 (0.30)	0.32 (0.34)	0.18 (0.32)	0.13 (0.34)	0.22 (0.32)	0.18 (0.34)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.196	0.197	0.171	0.171	0.174	0.179	0.178	0.192	0.201	0.212
Number of observations	1692	1688	1676	1663	1649	1635	1621	1607	1593	1579
<i>Interbank Spread 3M</i>										
Change in CCBS (High Stress)	0.95 (0.43)	1.20 (0.62)	1.20 (0.59)	1.05 (0.59)	1.02 (0.60)	0.54 (0.54)	0.94 (0.46)	0.72 (0.44)	0.70 (0.47)	0.83 (0.41)
Change in CCBS (Low Stress)	0.00 (0.15)	0.18 (0.20)	0.42 (0.31)	0.24 (0.31)	0.37 (0.28)	0.19 (0.33)	0.04 (0.39)	-0.14 (0.36)	0.13 (0.28)	0.02 (0.32)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.305	0.293	0.237	0.211	0.209	0.212	0.207	0.194	0.191	0.190
Number of observations	1624	1616	1603	1590	1576	1562	1548	1534	1520	1506

Footnote. This table shows regression results where the dependent variables are subsequent cumulative change in domestic financial conditions (corporate spread, sovereign spread and interbank spread 3M) over horizons from one to ten months in response to a 100-basis point shock to cross-currency basis. High-stress period is defined as VIX taking a larger value than two standard deviations above the historical mean (about 35). Controls include lag of U.S. broad dollar index, log of VIX for common variables, and CPI inflation, industrial production, exchange rate, interest rate differential between domestic rate and the world (U.S.) rate, and domestic credit growth rate and lagged dependent variables for country-specific controls. Robust standard errors are used.

Table 4. Subsequent Cumulative Change in Domestic Financial Conditions: A 100-basis point Shock to Cross-Currency Basis, High-Stress vs. Low-Stress Periods, by Net IIP Positions

Time	1	2	3	4	5	6	7	8	9	10
<i>Corporate Spread</i>										
Net Positive IIP										
Change in CCBS (High Stress)	-0.50 (0.59)	-1.03 (0.80)	-0.83 (0.93)	-0.94 (0.80)	-1.71 (0.96)	-1.58 (0.73)	-1.34 (0.83)	-2.18 (1.14)	-4.18 (0.78)	-4.27 (0.74)
Change in CCBS (Low Stress)	0.15 (0.30)	-0.08 (0.42)	-0.18 (0.47)	-0.19 (0.42)	-0.24 (0.37)	-0.32 (0.34)	-0.31 (0.42)	-0.57 (0.46)	-0.77 (0.42)	-0.71 (0.46)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.580	0.578	0.586	0.655	0.712	0.769	0.755	0.738	0.759	0.757
Number of observations	607	603	598	593	588	583	578	573	568	563
Net Negative IIP										
Change in CCBS (High Stress)	3.39 (3.33)	6.05 (3.21)	8.74 (4.02)	13.91 (4.13)	10.32 (3.71)	12.25 (6.42)	11.51 (5.11)	11.33 (3.59)	12.35 (3.45)	10.43 (3.76)
Change in CCBS (Low Stress)	0.01 (0.59)	0.94 (0.73)	0.33 (0.74)	0.13 (0.81)	0.24 (0.96)	0.57 (1.12)	1.24 (1.11)	0.92 (1.13)	0.21 (1.12)	0.09 (1.04)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.312	0.372	0.417	0.469	0.493	0.482	0.469	0.480	0.584	0.667
Number of observations	807	860	855	849	842	835	828	821	814	
<i>Sovereign Spread</i>										
Net Positive IIP										
Change in CCBS (High Stress)	-0.87 (0.32)	-0.94 (0.38)	-0.10 (0.48)	-0.41 (0.42)	-0.60 (0.46)	-0.51 (0.56)	-0.32 (0.65)	-0.69 (0.71)	-0.88 (0.78)	-0.38 (0.76)
Change in CCBS (Low Stress)	-0.21 (0.28)	-0.46 (0.32)	-0.23 (0.37)	-0.46 (0.40)	-0.27 (0.42)	-0.51 (0.41)	-0.22 (0.43)	-0.04 (0.45)	-0.08 (0.47)	-0.29 (0.50)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.583	0.487	0.437	0.461	0.464	0.485	0.478	0.493	0.509	0.526
Number of observations	487	484	480	476	472	468	464	460	456	452
Net Negative IIP										
Change in CCBS (High Stress)	1.51 (1.19)	0.87 (0.91)	1.46 (0.87)	2.25 (1.13)	2.29 (1.16)	3.25 (1.34)	3.17 (1.45)	2.82 (1.59)	3.78 (1.87)	3.53 (1.90)
Change in CCBS (Low Stress)	0.34 (0.27)	0.54 (0.40)	0.78 (0.44)	0.87 (0.48)	0.25 (0.48)	0.45 (0.56)	0.15 (0.53)	0.06 (0.60)	-0.11 (0.56)	-0.22 (0.59)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.255	0.275	0.254	0.246	0.243	0.247	0.248	0.267	0.288	0.302
Number of observations	843	841	836	830	823	816	809	802	795	788
<i>Interbank Spread 3M</i>										
Net Positive IIP										
Change in CCBS (High Stress)	-0.10 (0.31)	-0.56 (0.40)	-0.35 (0.40)	-0.39 (0.43)	-0.11 (0.47)	-0.20 (0.53)	0.11 (0.58)	0.21 (0.60)	0.24 (0.64)	0.45 (0.68)
Change in CCBS (Low Stress)	-0.11 (0.12)	0.03 (0.12)	-0.10 (0.17)	-0.10 (0.16)	-0.06 (0.17)	-0.06 (0.18)	0.03 (0.19)	0.17 (0.20)	0.16 (0.21)	0.18 (0.23)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.278	0.252	0.262	0.257	0.260	0.267	0.276	0.277	0.280	0.273
Number of observations	805	799	792	785	778	771	764	757	750	743
Net Negative IIP										
Change in CCBS (High Stress)	2.67 (0.53)	3.85 (0.56)	2.73 (0.96)	2.18 (0.83)	3.92 (0.76)	1.27 (0.76)	2.15 (0.64)	1.43 (0.77)	1.49 (0.95)	1.32 (0.88)
Change in CCBS (Low Stress)	0.15 (0.25)	0.29 (0.31)	0.72 (0.45)	0.66 (0.44)	0.48 (0.39)	0.14 (0.47)	0.14 (0.55)	-0.24 (0.53)	0.14 (0.47)	0.01 (0.52)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R_square	0.440	0.446	0.382	0.336	0.329	0.320	0.293	0.274	0.275	0.269
Number of observations	819	817	811	805	798	791	784	777	770	763

Footnote. This table shows regression results where the dependent variables are subsequent cumulative change in domestic financial conditions (corporate spread, sovereign spread and interbank spread 3M) over horizons from one to ten months in response to a 100-basis point shock to cross-currency basis. The regressions are run separately for net positive IIP countries and net negative IIP countries. High-stress period is defined as VIX taking a larger value than two standard deviations above the historical mean (about 35). Controls include lag of U.S. broad dollar index, log of VIX for common variables, and CPI inflation, industrial production, exchange rate, interest rate differential between domestic rate and the world (U.S.) rate, and domestic credit growth rate and lagged dependent variables for country-specific controls. Robust standard errors are used.

Annex. A Simple Model of FX Hedging Demand

In this annex, we present a simple model of a non-U.S. bank's demand for foreign exchange (FX) swaps to understand the implications of a higher basis and FX hedging costs on domestic financial conditions. The model is based on Ivashina et al. (2015) and Iida et al. (2018), which describes global bank's demand for FX swaps.

We consider the following two scenarios that could affect bank's demand for FX swaps: (1) an exogenous widening of the cross-currency basis; and (2) an increase in the interest rate differential. We assume that an increase in local currency (LCU)-denominated assets would lead to an easing of domestic financial conditions, while the opposite would lead to a tightening of domestic financial conditions.

A non-U.S. bank invests in two types of assets: USD-denominated assets (loans and bonds, etc.) that are issued by borrowers in the United States (L^{US}), and local currency (LCU)-denominated assets (L^D) that are issued by borrowers in domestic market. The expected gross return of loans will be $g_L(\cdot)$ and $g_{US}(\cdot)$, respectively, which are concave functions of the amount of loans.

The bank faces an overall capital constraint on lending, where the aggregate lending cannot exceed capital: $L^{US} + L^D \leq K$. The constraint is more likely to bind with a tighter regulatory capital regime or higher external equity financing cost, in which case the bank would prefer to hold on to its capital instead of lending. As in Ivashina et al. (2015), the bank has a default probability of p and the size of the default is denoted by α .

On the liability side, the bank has three possible sources of funding: LCU-denominated funding (such as deposits) (D^L), USD-denominated funding (D^{US}), and FX swaps (S). Following Iida et al. (2017), the cost of domestic funding is determined by $c_L(D^L)$, comprising of two parts: the interest payment that the bank pays on its deposits and the convex cost of expanding the retail deposits. The interest rate paid to its depositors is the domestic risk-free rate, r , assuming that deposits are fully guaranteed by the government. The latter part assumes that the more the bank expands its retail deposits, the higher the cost it incurs. The cost of U.S. dollar funding is determined by $c_{US}(D^{US})$, defined in a similar way as $c_L(D^L)$, except that the default probability of the bank is taken into consideration (Figure 9).

If the bank's loans in USD exceeds the liabilities in USD, the bank raises USD-funding from the FX swap market, as the bank does not take FX risks. The mismatch between assets and liabilities (U.S. dollar funding gap) determines the bank's hedging demand, i.e., demand for FX swap. The funding cost for FX swaps is determined as $(r^{US} - r - \Delta)$, where Δ is the cross-currency basis. When CIP holds, Δ is zero. Finally, we assume that the minimum size of liquidity needs is exogenous given and denoted by V .

As a result, the bank's profit is determined by the following functions:

$$g_L(L^L) = (1 + q)L^L - \frac{\tau^L}{2}(L^L)^2$$

$$\begin{aligned}
g_{US}(L^{US}) &= (1 + q^{US})L^{US} - \frac{\tau^{US}}{2}(L^{US})^2 \\
c_L(D^L) &= (1+r)D^L + \frac{\eta^L}{2} \max(D^L)^2 \\
c_{US}(D^{US}) &= (1+r^{US} + p\alpha)D^{US} + \frac{\eta^{US}}{2}(D^{US})^2
\end{aligned}$$

Here, τ^L and τ^{US} are costs associated with the loans denominated in local-currency and U.S. dollar, respectively. η^L and η^{US} are the costs associated with changing the size of a bank's balance sheets.

The objective of the bank is to maximize its profits, π , which is the sum of the following: (1) return on L^L , (2) return on L^{US} , (3) cost of D^L , (4) cost of D^{US} and (5) cost of FX swaps. The bank's maximization problem is as follows:

$$\max_{L^L, L^{US}, D^L, D^{US}, S} \{g_L(L^L) + g_{US}(L^{US}) - c_L(D^L) - c_{US}(D^{US}) - (r^{US} - r - \Delta)S\}$$

subject to

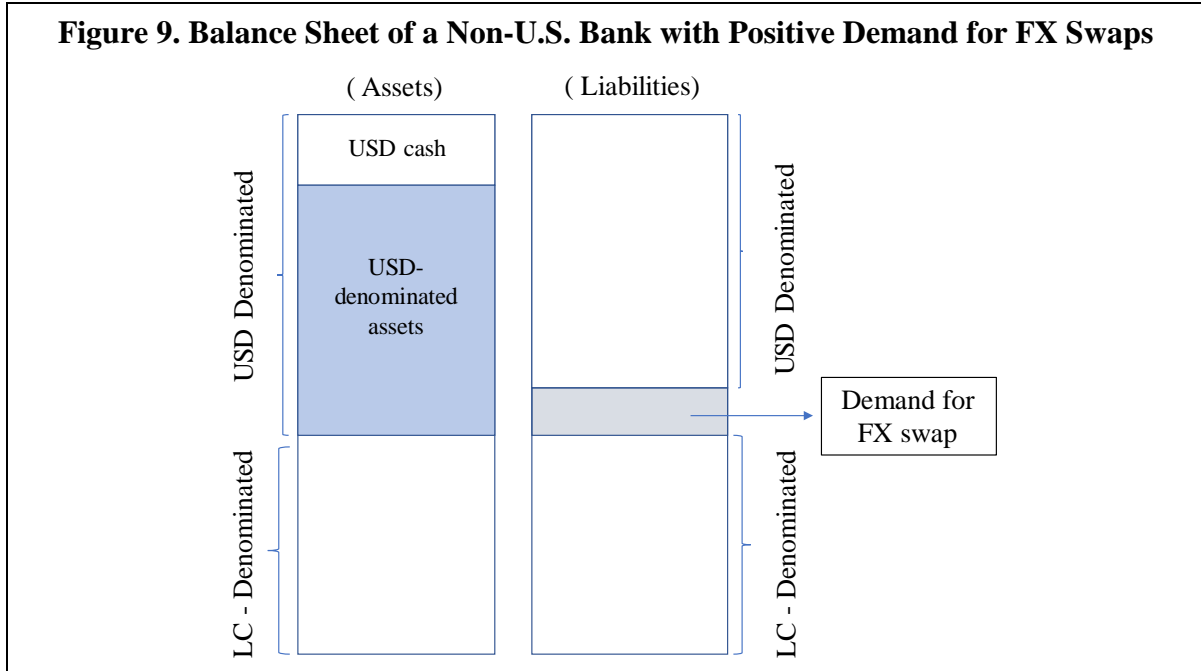
$$\begin{aligned}
M &\geq V \\
L^L &= D^L - S \\
L^{US} + M &= D^{US} + S
\end{aligned}$$

Taking the first-order condition of the bank's optimization problem and assuming that costs related to both increasing loans and balance sheets are the same for different currencies, i.e., $\tau^L = \tau^{US}$ and $\eta^L = \eta^{US}$, the optimal amount of USD-denominated assets held by a non-U.S. banks are given as follows:

$$L^{US} = \frac{1}{\tau + \eta} \left\{ \left(1 + \frac{\eta}{2\tau}\right) (q^{US} - r^{US}) - \frac{\eta}{2\tau} (q - r) - \frac{\tau + \eta}{2\tau} \Delta - \frac{p}{2} \alpha - \frac{\eta}{2} V \right\} \quad (1)$$

Similarly, the optimal amount of local-currency denominated assets held by a non-U.S. banks are derived as follows:

$$L^L = \frac{1}{\tau + \eta} \left\{ \left(1 - \frac{\eta}{2\tau}\right) (q - r) - \frac{\eta}{2\tau} (q^{US} - r^{US}) + \frac{\tau + \eta}{2\tau} \Delta - \frac{p}{2} \alpha - \frac{\eta}{2} V \right\} \quad (2)$$



We consider the following two scenarios that could affect the bank's demand for FX swaps: (i) an exogenous widening of cross-currency basis; and (ii) an exogenous increase in interest rate differential. From equations (1) and (2), we find that

- *An increase in cross-currency basis* (Δ) will lead banks to *increase* their assets in local currency, and a *decrease* in U.S. dollar-denominated assets. This is consistent with the findings in Ivashina et al. (2017).
- *An increase in the U.S. policy rates* (q^{US} or $q^{US} - r^{US}$). If the Federal Reserve increases policy rate, driving the interest rate differentials to widen, ceteris paribus, this will lead banks to invest more in U.S. dollar-denominated assets and less in local-currency denominated assets.

Net liabilities position vis-à-vis the U.S. dollar. So far, we have implicitly assumed that the cost of domestic financing is relatively low, to ensure that the dollar gap exists and the demand for FX swaps takes a positive value. Let's now consider a bank with net liabilities position vis-à-vis the U.S. dollar. This is relevant for banks in countries with net negative IIP position, such as emerging economies, where the cost of raising funding domestically may be high or limited. In the model, suppose the cost of raising funding (η^L) is very high. Ceteris paribus, this implies an inevitably high reliance on U.S. dollar funding (D^{US}), as the equilibrium level of domestic funding (D^L) is low. For this case, an increase in cross-currency basis (Δ) reduces the funding from FX swaps (S), but domestic financing cannot be raised to compensate for this reduction in funding. With higher costs of the U.S. dollar funding, overseas borrowing cannot be expanded either. The reduction in total liabilities leads the bank to reduce its overall assets, which will tighten domestic financial conditions.

Finally, an interesting case to consider, which we do not explore in the empirical section, is the case when both factors increase at the same time. For instance, the U.S. rate and the cross-currency basis may rise at the same time, as implicitly suggested by Avdjiev et al. 2017. Suppose the U.S. monetary policy continues its normalization path. It often involves strengthening of the U.S. dollar against other currencies. According to Avdjiev et al. 2017, strong U.S. dollar is correlated with negative cross-currency basis. In such case, the bank's decision for more offshore investment is not straightforward – despite a higher U.S rate, higher FX hedging costs will lower hedge-adjusted returns in USD-denominated assets. The net effects of these two forces would depend on the parameter values.