

A SOURCE OF FINANCIAL VULNERABILITY

In the run-up to the global financial crisis, lending in US dollars by global banks headquartered outside the United States (global non-US banks), together with their reliance on short-term and volatile wholesale funding, became crucial transmission mechanisms for shocks that originated in the major funding markets for US dollars. Whereas regulation following the crisis has improved the resilience of banking sectors in many dimensions, these mechanisms remain a source of vulnerability for the global financial system. This chapter constructs three measures to gauge the degree of US dollar funding fragility of global non-US banks and describes their evolution in recent years. Empirical results show that an increase in US dollar funding costs leads to financial stress in the economies that are home to global non-US banks and to spillovers through a cutback in loans to recipient economies, those that borrow US dollars. US dollar funding fragility and the share of US dollar assets to total assets amplify these negative effects. However, some policy-related factors can mitigate them, such as swap line arrangements between central banks and international reserve holdings by home economy central banks. Furthermore, this chapter finds that emerging markets that are recipient economies are particularly susceptible to declines in US dollar cross-border lending because they have limited ability to turn to other sources of US dollar borrowing or to replace dollars with other currencies. These results highlight the importance of controlling vulnerabilities arising from the US dollar funding of non-US banks. The US dollar funding fragility measures constructed in this chapter can help improve their monitoring.

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Introduction

The US dollar historically has played a prominent role in global trade and financial flows.¹ In the run-up to the global financial crisis, European banks accumulated sizable US dollar assets, which were financed mainly in short-term wholesale funding markets such as repo, commercial paper, and certificates of deposits (McGuire and von Peter 2012). These markets became impaired in 2007–08, as heightened uncertainty led banks in the United States to hoard liquid assets and made them reluctant to lend to other financial institutions. Facing this withdrawal of US dollar funding, non-US banks were forced to finance their US dollar assets by tapping the foreign exchange swap market, where funding in other currencies can be turned into US dollar funding through the use of derivatives, further propagating financial stress through this market (Baba and Packer 2009). The freeze-up of US dollar wholesale funding markets required a global policy response and international provision of dollar liquidity via central bank swap lines, where the US Federal Reserve provided US dollars to some non-US central banks.

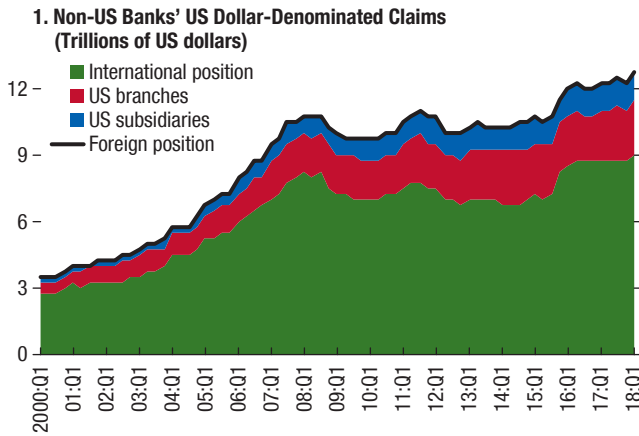
A decade later, the US dollar still plays a key role in international banking, and non-US banks, especially those from advanced economies, remain significant intermediaries of US dollar transactions in global financial markets.² Spurred by often higher returns in US dollar–denominated assets in relation to assets in other currencies, along with a preference by many corporate borrowers worldwide for financing in US dollars, non-US banks continued to expand their international US dollar lending during the past decade. US dollar–denominated assets of non-US banks amount to more than \$12 trillion, compared with \$10 trillion just before the onset of the crisis (Figure 5.1, panel 1). Among the major providers of US dollar credit, European banks were severely hit by both the global

¹See Gopinath and Stein (2018) for a theory about how a currency becomes dominant.

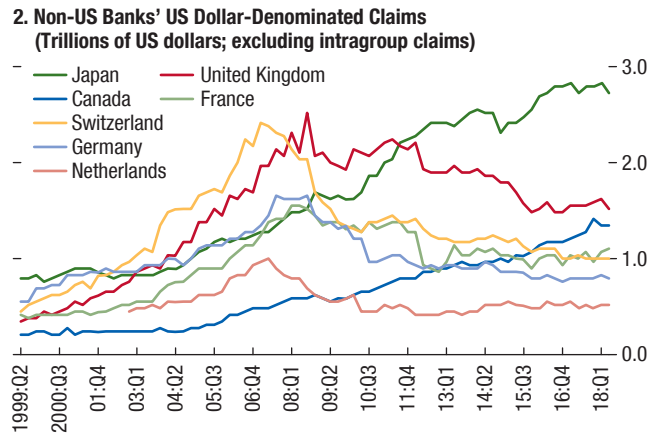
²Maturity mismatch in other currencies may also be a source of stress, but this chapter focuses on the US dollar, given its prominence in the global economy.

Figure 5.1. Trends in US Dollar Activities of Non-US Banks

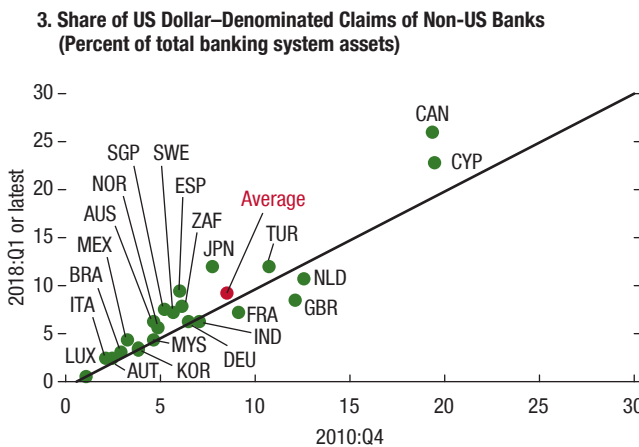
On average, non-US banks have been steadily increasing their US dollar activities, including through US branches and subsidiaries.



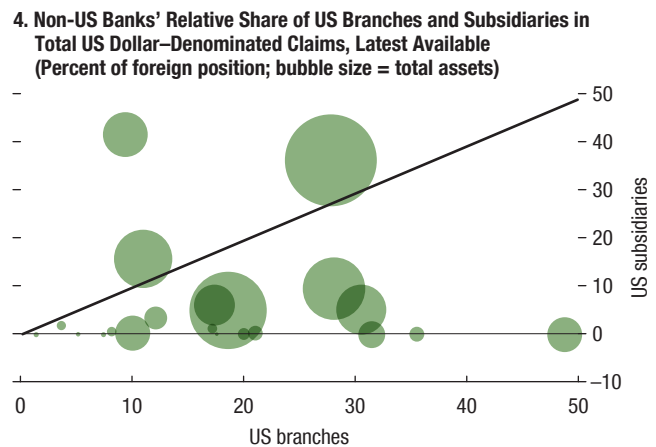
The shares of Japanese and Canadian banks in total US dollar bank intermediation have increased significantly over the past 10 years, whereas those of European banks have shrunk.



The share of US dollar activities in the total banking system balance sheet is substantial and has been increasing in many economies.



Reliance on US branches and subsidiaries varies across home economies of non-US banks.



Sources: Bank for International Settlements, locational banking statistics (nationality basis); Federal Financial Institutions Examination Council; S&P Global, Market Intelligence; and IMF staff calculations.

Note: Foreign position consists of international position as defined by the Bank for International Settlements plus the positions in US branches and subsidiaries (see Online Annex 5.3 for further clarification). The measure of US dollar-denominated claims, based on BIS data and represented in all four panels, may be larger in some cases than the trust-account-adjusted measure (see Saito, Hiyama, and Shiotani, 2018). Diagonal lines in panels 3 and 4 are 45-degree lines. Data labels in panel 3 use International Organization for Standardization (ISO) country codes.

financial crisis and the euro area crisis, and their share of US dollar assets has declined as they have reduced the level of their debt (deleveraged). At the same time, Japanese banks (which picked up some of the slack in Asia) and Canadian banks (which expanded in the United States) have greatly increased their US dollar-denominated claims (Figure 5.1, panel 2).

US dollar intermediation, whereby global non-US banks borrow and lend US dollars on a global scale, provides several benefits, including efficient allocation

of liquidity on a global scale and facilitation of financing flows to emerging markets. However, participation of non-US banks in this process is also a potential source of risk in global financial markets because their stable US dollar deposits outside the United States are insufficient to fund all their global US dollar credit. Whereas non-US banks can tap stable US dollar deposit funding through their US subsidiaries, US regulation confines the use of these funds to US activities, so they cannot be deployed at

a global level. Other sources of US dollar funding, obtained through US branches and in international markets, can be deployed outside the United States but are mostly wholesale, short term, and volatile, and are subject to sizable refinancing risk, especially in times of stress. Finally, non-US banks rely on foreign exchange swaps, which also tend to be short term and volatile. Because foreign exchange swaps are usually costlier than other sources of funding, they are the “marginal” source of US dollar funding, used to fill remaining gaps that cannot be quickly met through other sources. Analysis in Chapter 1 of the April 2018 *Global Financial Stability Report* (GFSR) identified structural liquidity mismatches associated with these institutions’ US dollar balance sheets and concluded that vulnerabilities remain, despite steps to address them.

Since the global financial crisis, some US dollar funding markets have changed significantly. Reliance on foreign exchange swaps continues, even though there is evidence that structural changes in this market have made funding more prone to instability. The role of nonbanks is also increasing. For instance, the share of major banks providing foreign exchange derivatives to Japanese financial institutions has declined, whereas nonbanks, whose commitment to stay in the market during stress periods is untested at this point, are playing a larger role (Nakaso 2017). Despite their well-documented benefits for financial resilience (see Chapter 2 of the October 2018 GFSR), some aspects of the postcrisis regulatory reforms may have had unintentional effects in US dollar funding markets. The global capital and liquidity requirements and specific regulations at the individual jurisdiction level may have tightened the supply of US dollar funding to non-US banks (Du, Tepper, and Verdelhan 2018; Iida, Kimura, and Sudo 2018). For example, the 2016 money market mutual fund reform in the United States, which aimed to reduce vulnerability in these types of vehicles, has reduced access to US dollar funding for non-US banks. This development has increased reliance on foreign exchange swaps, despite a rise in offshore US dollar deposits (Aldasoro and others 2017). Finally, supervisory and regulatory tightening may have further complicated cross-border liquidity management at global financial institutions.³

³See Online Annex 5.1.

These structural changes have resulted in higher costs across wholesale US dollar funding markets, most noticeably in the foreign exchange swap market. Although the supply of US dollars in recent years has been ample, stress in US dollar funding markets could reemerge. This would depend critically on the interest rate path differential between the United States and other regions, the process of monetary policy “normalization” at major central banks, and the fiscal outlook in the United States and associated supply of US Treasury securities.

Altogether, this suggests that the cost of US dollar funding for non-US global banks could become more volatile and perhaps more sensitive to changes in US monetary conditions and global risk appetite. These banks’ greater US dollar funding fragility—as reflected in greater liquidity and maturity mismatches between their US dollar assets and liabilities or greater reliance on volatile short-term sources of funding—could therefore be a financial vulnerability and could amplify the effects of shocks to US funding costs on banks’ financial stress and the global credit supply.

Against this backdrop, this chapter sets out to investigate the extent to which conditions in US dollar funding markets can be a source of financial stress and disruption of international capital flows. The chapter describes the major trends in the past two decades in the size and composition of US dollar balance sheets of non-US global banks and in their costs of US dollar funding. It explores how US dollar funding fragility of these institutions can exacerbate the adverse effects of tightening funding conditions and tracks several indicators constructed to measure this fragility. It then presents econometric analysis focusing on three main issues: (1) how the cost of US dollar funding responds to different drivers of supply and demand identified in the literature, (2) how tighter US dollar funding conditions may generate financial stress in the home economies of non-US global banks (henceforth *home economies*), and (3) to what extent this tightening could also lead to cutbacks in the cross-border supply of US dollar-denominated lending from home economies to jurisdictions that receive cross-border credit flows from global non-US banks (henceforth *recipient economies*). For all three issues, the econometric analysis highlights the amplifying or mitigating role of US dollar funding fragility and macroeconomic conditions, as well as policy-related factors. The econometric approach followed is described in detail in Online Annex 5.2.

How Have US Dollar Activities and US Dollar Funding Fragility Evolved since the Global Financial Crisis?

Focusing on a sample of 26 advanced economies and emerging markets that are home to major global non-US banks, this section shows that US dollar activities of non-US banks have remained substantial since the global financial crisis, both in aggregate and as a share of the banking sectors of the home economies. The aggregate gap between US dollar assets and liabilities has expanded, although not uniformly across economies, and with some decline in more recent years. Whereas the liquidity and stable funding measures in US dollars constructed for a subset of advanced economies have increased moderately, there is evidence that in many of these economies, the liquidity in US dollars of their banking system falls well below the overall liquidity measure calculated across all currencies.

US dollar assets of global non-US banks have been trending upward since the global financial crisis, increasing from \$9.7 trillion in 2012 to \$12.4 trillion by early 2018 (Figure 5.1, panel 1).⁴ The economic composition of these claims has also changed, with some European economies reducing their share while other economies, such as Canada and Japan, have been expanding their shares noticeably (Figure 5.1, panel 2). Furthermore, the magnitude of US dollar positions relative to total banking system assets—across all currencies—is comparable to its precrisis level, and there are indications of a resurgence in activities after a postcrisis decline. In some economies, the share of US dollar claims has increased since 2010 (Figure 5.1, panel 3).

Not all of these US dollar assets constitute cross-border activities, as a significant portion is located in branches and subsidiaries in the United States. Their shares in the aggregate have remained relatively stable over time (Figure 5.1, panel 1).

⁴These 26 economies also have sufficiently long time series of the relevant data and have US dollar operations considered to be of domestic systemic importance. For the list of economies, see Online Annex 5.3. Non-US banks' US dollar balance sheet aggregates constructed for this chapter encompass several definitions. First is the "international position" as defined by the Bank for International Settlements, which includes cross-border positions plus those in branches outside the United States. Adding US-based branches results in the "international position plus branches." Adding subsidiaries in the United States yields the "foreign position" shown in Figure 5.1, panel 1. The econometric analysis in this chapter is conducted primarily using international position plus branches, with exercises using foreign position as robustness checks.

For individual home economies, positions held at US branches are often quite substantial. Their share surpasses 10 percent in 15 of the 26 economies examined and is as high as 40 to 50 percent for some economies. On the other hand, positions at US subsidiaries, which cannot be used to fund global US dollar activities, tend to be much smaller, except in a handful of cases (Figure 5.1, panel 4).

Turning to US dollar funding exposure and vulnerability, several main indicators are constructed to reflect the potential fragility of non-US banks in the face of shocks to US dollar funding sources. The first is the *cross-currency funding gap*, defined as the difference between US dollar-denominated assets and liabilities. This gap, expressed as a ratio to US dollar assets, yields the *cross-currency funding ratio*. This ratio approximates the extent to which non-US banks must resort to the foreign exchange swap market to obtain marginal funding for their US dollar positions.⁵

After falling from a mid-2008 peak of \$1 trillion (or 10 percent of US dollar assets), the cross-currency funding gap has been increasing in recent years, exceeding \$1.4 trillion; this corresponds to a cross-currency funding ratio of 13 percent of US dollar assets (Figure 5.2, panel 1). Thus, increasing US dollar activity has gone hand in hand with a widening gap between US dollar-denominated assets and liabilities, potentially making home economies more vulnerable to shocks arising in US dollar funding markets. Of the 26 economies, 17 had positive funding gaps as of the first quarter of 2018, and almost all had experienced an increase in their gap since 2012.⁶

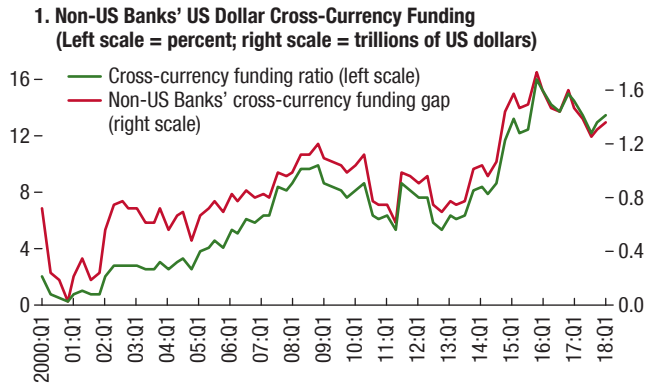
Beyond the aggregate funding gap, liquidity and maturity characteristics of both US dollar-denominated assets and liabilities shed further light on the degree of exposure and sensitivity of non-US banks to tighter funding conditions. Two additional indicators are constructed for this purpose, in the spirit

⁵This measure has previously been used as a proxy for the demand for foreign exchange swaps (Eguren-Martin, Busch, and Reinhardt 2018). Whereas the aim of the analysis is to provide measures of US dollar funding fragility that are comparable across time and economies, the trust-account-corrected cross-currency funding ratio may be smaller in some cases than the measure used here, which relies on Bank for International Settlements data (see Saito, Hiyama, and Shiotani 2018).

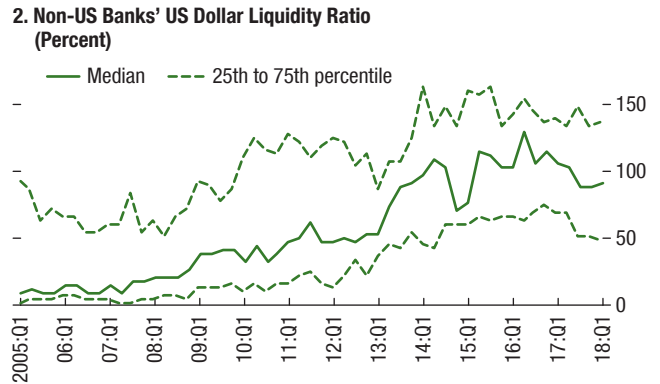
⁶In economies with positive cross-currency funding gaps, in the first quarter of 2018 the gaps totaled \$1.8 trillion—18 percent of US dollar-denominated assets. The bulk of the drop in the gap since early 2016 is attributable to Japan. Trends in non-US banks' US dollar funding have also been documented by Aldasoro and Ehlers (2018).

Figure 5.2. US Dollar Funding Fragility of Non-US Banks

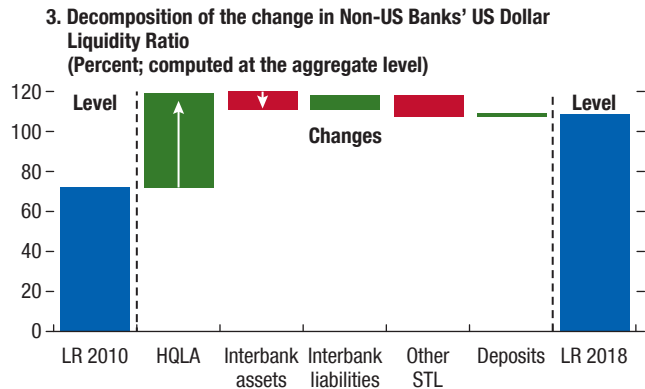
The funding gap between US dollar claims and liabilities has been expanding.



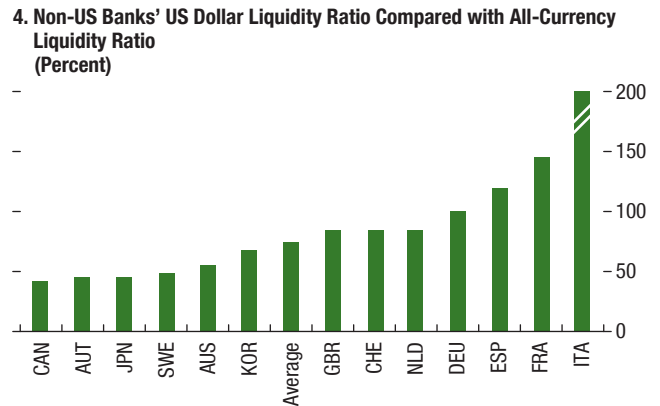
US dollar liquidity has been improving ...



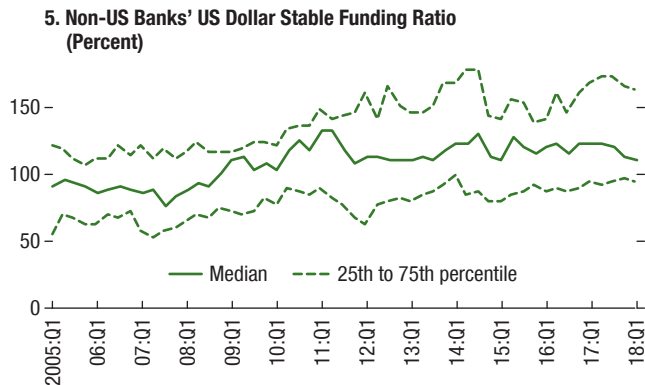
... mostly because of an increase in US dollar high-quality liquid assets ...



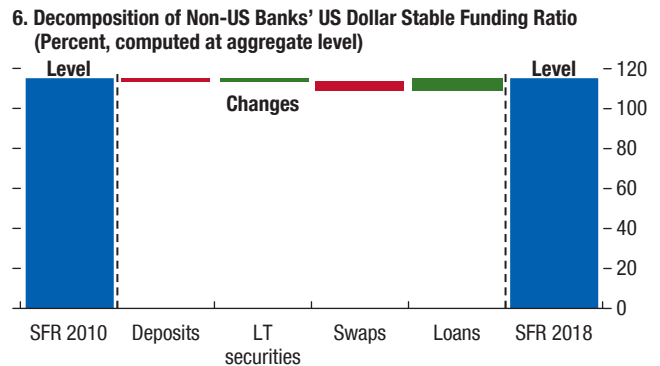
... but US dollar liquidity is well below overall liquidity levels across all currencies.



The US dollar stable funding ratio has largely remained constant ...



... with little change among components.



Sources: Bank for International Settlements, locational banking statistics (nationality basis); Federal Financial Institutions Examination Council; S&P Global, Market Intelligence; and IMF staff calculations.

Note: All panels correspond to the international position plus US branches of the non-US banks. Latest available calculations were as of 2018:Q1 at the time the analysis was conducted. Panel 1 shows the difference between US dollar assets and liabilities, both in trillions of dollars and as a percentage of US dollar assets. Panels 2 through 6 are based on a subset of 14 economies because of data limitations. Panels 3 and 6 were computed using the sample-wide aggregate values; the changes are in percent. Data labels in panel 4 use International Organization for Standardization (ISO) country codes. HQLA = high-quality liquid assets; LR = liquidity ratio; LT = long-term; SFR = stable funding ratio; STL = short-term liabilities.

of the regulatory liquidity ratios introduced in the wake of the global financial crisis. A *US dollar liquidity ratio* focuses on the ability of banks to withstand rapid withdrawals of US dollar funding by liquidating a portion of their US dollar assets. It is constructed analogously to the regulatory liquidity coverage ratio and looks at holdings of US dollar high-quality liquid assets—those considered highly liquid even in a stress scenario and ideally eligible as collateral for central bank lending—and US dollar net cash outflows likely during a one-month stress scenario.⁷

US dollar liquidity of non-US banks has been increasing steadily since the global financial crisis (Figure 5.2, panel 2), primarily reflecting an increase in US dollar high-quality liquid assets (Figure 5.2, panel 3). Virtually all 14 economies for which this measure is constructed registered notable increases between 2008 and 2018, with a small drop since 2016 attributable to a few European economies and Japan. However, US dollar liquidity still remains below the overall liquidity of their balance sheets as measured by an all-currencies liquidity ratio (Figure 5.2, panel 4). This has been confirmed with more detailed analysis of liquidity in the context of recent assessments under the Financial Sector Assessment Program (see Online Box 5.1).

The stability of US dollar funding has generally remained constant in recent years. A *US dollar stable funding ratio*—constructed in the spirit of the net stable funding ratio generally computed for the entire balance sheet—reflects banks’ ability to fund their US dollar assets over a longer time horizon using stable sources of funding, in part to ensure the continuity of credit and the preservation of business relationships. The US dollar stable funding ratio has improved only moderately since the global financial crisis, with little change among components (Figure 5.2, panels 5 and 6).

How Are US Dollar Funding Costs Measured and What Drives Them?

This section introduces the cross-currency basis as the measure of US dollar funding costs for non-US banks and describes how it evolved before, during, and

after the global financial crisis. Analysis of the drivers of the cross-currency basis shows that changes in macroeconomic conditions in either the United States or in home economies could lead to future stress in US dollar funding markets.

Whereas the four indicators—the cross-currency funding gap, the cross-currency funding ratio, the liquidity ratio, and the stable funding ratio—are useful indicators of the vulnerability of banks to shocks in their US dollar funding, the shocks themselves can be approximated to a large degree by changes to the US dollar cross-currency basis (see definition in the next paragraph). When non-US banks acquire dollar assets, they aim to match the currency exposure of their liability side to avoid foreign exchange risk.⁸ As the previous section explained, however, their on-balance-sheet US dollar assets often exceed their US dollar liabilities, leaving a gap in funding that the banks attempt to close through foreign exchange swaps; that is, synthetic US dollar funding. Understanding the determinants of the costs of US dollar funding is essential because such conditions affect bank profitability, capital requirements, banks’ ability to provide US dollar credit, and ultimately financial stability risks.

The *US dollar cross-currency basis* is calculated as the difference between the cost of funding US dollars directly from the cash market and the synthetic US dollar interest rate obtained when funding in a different currency and swapping that currency into US dollars.⁹ A positive (negative) currency basis implies that the direct dollar cost is higher (lower) than the synthetic one.¹⁰ Although there are different interest rate indicators that reflect US dollar funding costs for non-US banks, as explained previously, the

⁸Since the release of the Basel Committee proposal on market risks (Basel Committee on Banking Supervision 1996), the net open foreign exchange positions of banks in advanced economies have been treated as other market risks, subject to capital requirements. In addition, many emerging market economies place explicit limits on this exposure (Hofstetter, López, and Urrutia 2018).

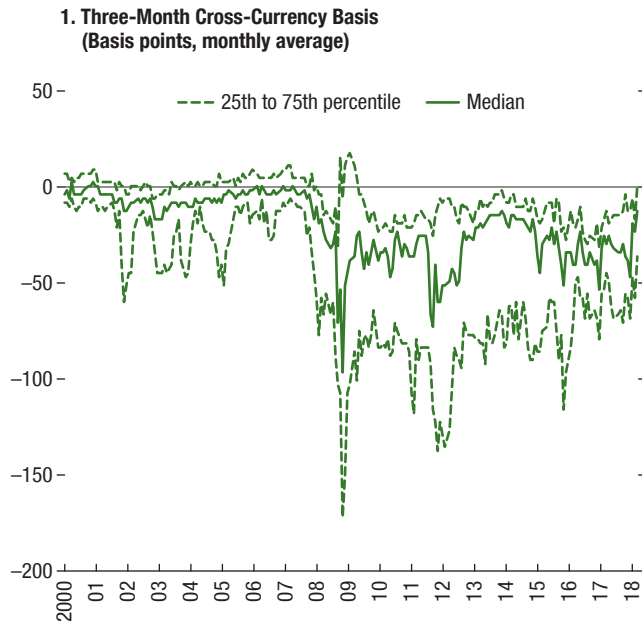
⁹Funding costs in each currency are measured using the relevant London interbank offered rate at one- and three-month “tenors,” or maturity periods.

¹⁰Throughout the chapter, reference to an “increase in US dollar funding cost” means widening of the cross-currency basis; that is, it becomes more negative. An exception is Australia, which has a persistently positive cross-currency basis.

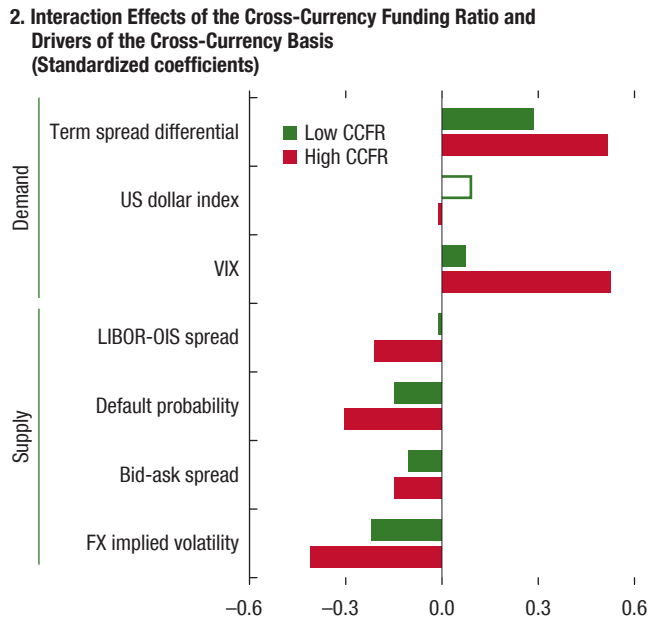
⁷The liquidity ratio should not be interpreted in strictly the same way as the liquidity coverage ratio: for example, a level below 100 percent does not necessarily represent insufficient liquidity, nor should the liquidity ratio be compared with existing data on regulatory ratios. Details of the construction are in Online Annex 5.3.

Figure 5.3. The Cross-Currency Basis

US dollar funding costs increased notably after the financial crisis, and a negative basis has persisted during the postcrisis period.



The effect of the drivers of the cross-currency basis is amplified by US dollar funding fragility.



Source: IMF staff calculations.

Note: Panel 1 shows monthly averages of the three-month LIBOR cross-currency basis, measured in selected currencies. Panel 2 reports the aggregate impact of the basis determinants with the interaction of the “low” (“high”) level of the CCFR; that is, when the CCFR is at the first (fourth) quintile. The sample period is January 1, 2000, to March 1, 2018. Currencies in the panel 2 sample are the Australian dollar, British pound, Canadian dollar, euro, Hong Kong dollar, Japanese yen, Indian rupee, Malaysian ringgit, Swiss franc, and Swedish krona. The euro area CCFR is computed as the average across the euro area economies in the sample. Solid colored bars denote significance levels at 10 percent or higher. Empty bars indicate the absence of statistical significance. Default probability is measured as the average expected default frequency of home economies’ listed banks. CCFR = cross-currency funding ratio; FX = foreign exchange; LIBOR = London interbank offered rate; OIS = overnight interest swap; VIX = Chicago Board Options Exchange Volatility Index.

cross-currency basis is a good indicator of US dollar funding conditions at the margin.¹¹

Before the global financial crisis, the cross-currency basis was close to zero across many currencies (Figure 5.3, panel 1), consistent with so-called covered interest parity whereby differences between the cost of direct and synthetic US dollar funding are very small and short-lived, as they are eventually eliminated through the action of market participants. However, since the global financial crisis, covered interest parity has failed to materialize. During the global financial

crisis and the European sovereign debt crisis, because of impaired interbank markets and limited arbitrage activity, the US dollar cross-currency bases became large and negative for many currencies. In response to the US dollar funding difficulties, swap lines were introduced between the Federal Reserve and several central banks. These arrangements lessened strains in markets and significantly diminished the dollar shortage, leading to a narrowing of the cross-currency basis (Goldberg, Kennedy, and Miu 2011; McGuire and von Peter 2012). Deviations in covered interest parity have nonetheless persisted, and the cross-currency bases have not entirely reverted to zero.¹²

The literature has shown that both demand- and supply-side factors influence changes in the

¹¹Anecdotal evidence from market participants suggests the existence of a pecking order of US dollar funding sources. In the short term, banks generally seek the least costly source of wholesale funding. Synthetic funding is usually the costliest and therefore the marginal source of US dollar funds. Consistently, analysis of detailed data on US dollar money market funding of non-US banks provides evidence that a widening of the basis is also associated with an increase in total direct funding costs. Further details of this analysis are contained in Online Annex 5.1.

¹²Several explanations of these deviations have been proposed by Avdjiev and others (2018); Baba, Packer, and Nagano (2008); Borio and others (2018); Du, Tepper, and Verdelhan (2018); Iida, Kimura, and Sudo (2018); and Sushko and others (2016).

cross-currency basis.¹³ It widens in response to supply-side-related factors such as heightened risks in interbank funding markets—the spread between the London interbank offered rate and the overnight index swap rate—and high transaction costs (bid-ask spread), as well as demand-side forces such as the risk of default of the banking sector in the home economy and the home economy interest margin relative to that in the United States. For example, a narrower home economy interest margin relative to that in the United States increases the incentive for holding US dollar–denominated investments funded in US dollars, thus adding demand pressure for synthetic US dollar funding and widening the cross-currency basis. Market sentiment in the United States also plays a role: rising risk aversion in the United States—proxied by an increase in the Chicago Board Options Exchange Volatility Index—dampens demand for risky investments denominated in US dollars, thereby alleviating pressure on the cross-currency basis.

The cross-currency funding ratio can amplify the effects of the preceding factors. That is, when needs for US dollar funding are particularly strong—the cross-currency funding ratio is large—non-US banks¹⁴ become more vulnerable to strains in the foreign exchange market and to the financial conditions of suppliers of foreign exchange swaps.¹⁵ Therefore, shocks to US dollar funding markets have a stronger impact on the cross-currency basis.¹⁶ For example, for a given increase in the implied volatility of its exchange rate, an economy with a high cross-currency funding ratio (at the fourth quintile)

will experience a larger widening (on the order of 50 percent) of its currency’s cross-currency basis relative to one with a low cross-currency funding ratio (at the first quintile) (Figure 5.3, panel 2).

Financial regulatory reforms following the global financial crisis appear also to have influenced the basis. Since January 2015, when European banks were first required to report quarter-end leverage ratios, the resulting seasonal spikes in the cost of balance sheet expansion have spilled over to global US dollar funding markets, causing jumps in the cross-currency basis around quarter ends (Figure 5.4, panel 1). Pressure to quickly adjust balance sheets to comply with regulatory capital ratios before reporting dates is stronger for the one-month than the three-month cross-currency basis, because three-month swaps appear on balance sheets at the end of the quarter regardless of when they are initiated.

Other key regulatory changes appear to have coincided with a strengthening of the relationship between the cross-currency funding ratio and the basis. Among these changes, the 2016 US money market mutual fund reform seems to be associated with the sharpest widening observed (Figure 5.4, panel 2). The draining of funds out of prime institutional money market funds, which were important lenders in the wholesale dollar funding market,¹⁷ led non-US banks to increase their use of synthetic dollar funding, resulting in a significant strengthening of the relationship. The introduction of the liquidity coverage ratio had a similar effect, because of the constraints on US banks to supply foreign exchange swaps.¹⁸

Changes in macroeconomic conditions in the United States and worldwide could contribute to a wider basis in the home economies of non-US banks. Increased fiscal pressure and/or an eventual widening of the interest rate gap between the United States and other major economies could tilt the term spread differential toward greater demand for US dollar–denominated assets, thereby widening the basis. US dollar appreciation, by weakening

¹³The distinction between supply and demand factors is based on Ivashina, Scharfstein, and Stein (2015).

¹⁴Although nonbank institutions also drive demand for foreign exchange hedging, because of data constraints this chapter focuses on the banking sector.

¹⁵Whereas the analysis treats the cross-country funding ratio mainly as an independent driver of the basis, there could be some degree of interdependence between these variables. By using an unrestricted panel vector autoregression framework that treats the variables as endogenous and interdependent, impulse response functions were estimated, and they corroborate the finding that the basis responds to shocks to the cross-country funding ratio.

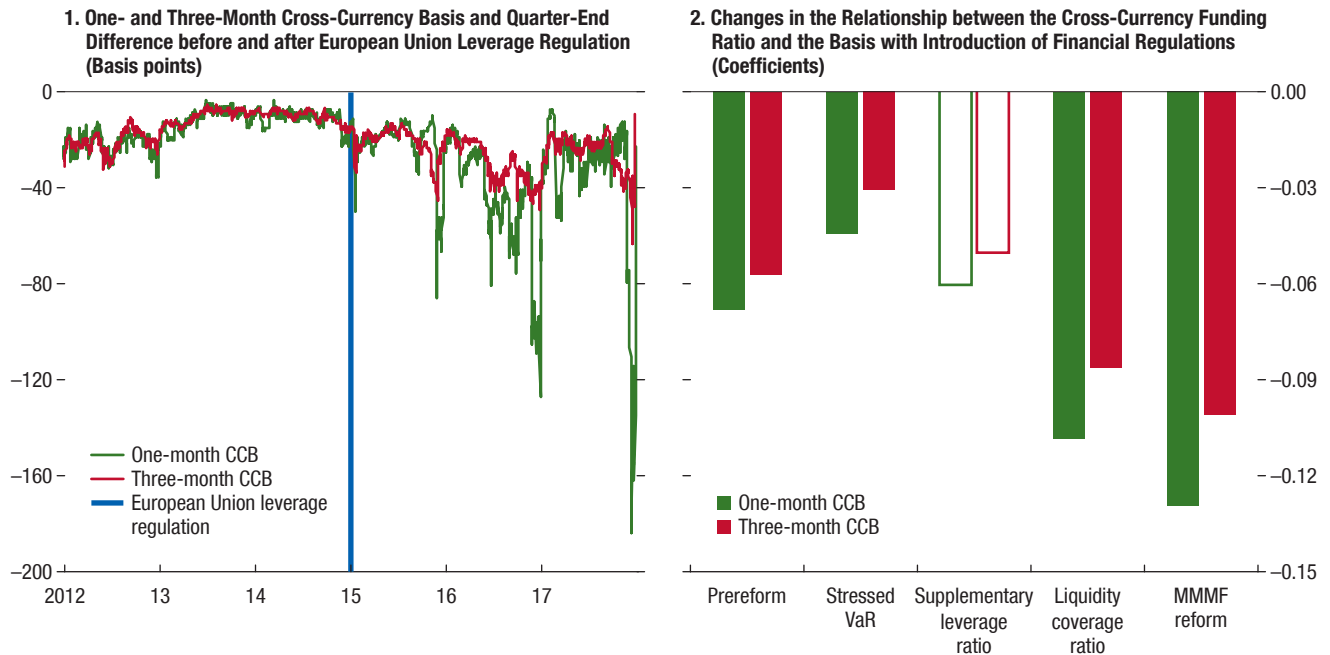
¹⁶Cerutti, Obstfeld, and Zhou (2019) point out that there is considerable heterogeneity in the determinants of the cross-currency basis across economies and time. The analysis in this chapter takes a more general perspective on drivers of the cross-currency basis and focuses on one source of heterogeneity: the cross-currency funding gap.

¹⁷It is possible that the effect of the globally important systemic bank capital surcharge and resolution funding requirements, both phased in since 2016, is also captured here. Resolution funding requirements have required subsidiaries to hold their own liquidity to meet resolution funding requirements without recourse to the governments in a situation of near failure.

¹⁸See Du, Tepper, and Verdelhan (2018).

Figure 5.4. Financial Regulations and the Cross-Currency Basis

The cross-currency basis widens, particularly at the end of quarters after the introduction of European leverage regulation.



Source: IMF staff calculations.

Note: Panel 1 depicts the average one-month and three-month cross-currency basis and indicates the introduction of the European Union leverage regulation on January 1, 2015. Panel 2 depicts the change in the association between the cross-currency funding ratio and the cross-currency basis following the introduction of various financial regulations in the United States: stressed VaR (2013), supplementary leverage ratio (2014), liquidity coverage ratio (2015), and money market mutual fund reform (2016). Currencies in the sample are the Australian dollar, British pound, Canadian dollar, euro, Japanese yen, Swedish krona, and Swiss franc. In panel 2, solid colored bars denote statistical significance at the 10 percent level or higher. Empty bars denote absence of statistical significance at the 10 percent level. CCB = cross-currency basis; MMMF = money market mutual fund; VaR = value at risk.

balance sheets of net US dollars borrowers, could indirectly increase credit risk of the global non-US banks, adding pressure to their currency bases.¹⁹ In addition, an expected increase in the supply of US Treasuries could put pressure on the spread between the London interbank offered rate and the overnight index swap, further straining US dollar funding conditions. Increased global uncertainty, reflected in elevated implied foreign exchange volatility in home economies, could widen the basis as well. Finally, sluggishness in domestic real activity could have repercussions on banking system health, exerting additional pressure on the basis.

¹⁹See also Avdjiev and others (forthcoming); and Bruno and Shin (2015).

What Are the Implications of Tightening US Dollar Funding Conditions on Financial Stress and Cross-Border Lending?

This section analyzes whether rising US dollar funding costs may hurt profitability of global non-US banks, resulting in financial stress in the home economy via increased probability of banking system default or tighter domestic financial conditions. Non-US banks may also be forced to shrink their balance sheets by cutting back on US dollar cross-border lending, thus generating spillovers beyond the home economy. The ability of these recipient economies—many of which are emerging markets—to substitute for the cutback is also investigated. Finally, an additional spillover is explored: increases in US dollar funding costs could ultimately induce financial stress on recipient economy banking systems.

A tightening of US dollar funding conditions is associated with greater financial stress in home economies of non-US banks engaging in global US dollar intermediation. Regression analysis shows that the probability of banking sector default increases when US dollar funding costs rise, as proxied by the widening of the cross-currency basis.^{20,21} Starting from stable US dollar funding conditions, a 50 basis point increase—equivalent to the average quarterly change in the cross-currency basis at the onset of the global financial crisis—is associated with a 0.22 standard deviation increase (equivalent to a 7½ percent increase) in the probability of banking sector default and an additional tightening by 0.29 standard deviation in domestic financial conditions (Figure 5.5, panel 1).²² Furthermore, the relationship appears to be nonlinear; that is, it is much stronger for large increases in the basis and is most prominent during two stressful episodes: the global financial crisis and the 2011 US money market fund run on European banks, as suggested by Ivashina, Scharfstein, and Stein (2015) and Du, Tepper, and Verdelhan (2018).

Increases in US dollar funding costs for lenders can also spill over and cause financial stress in recipient economies—those that receive cross-border

²⁰The “probability of default” of the banking sector is defined as the logarithm of the one-year-ahead probability of default for all publicly listed banks, which is compiled by the Risk Management Institute. It also includes dead firms, which helps reduce survivorship bias.

²¹These results could be affected by reverse causality, whereby the estimated impact of widening of the basis on home economy default probability is driven by the reverse relationship, from probability of default to the basis. Nonetheless, additional evidence suggests that the relationship documented in this section is not driven entirely by this reverse phenomenon. For further details, see Online Annex 5.2. Furthermore, this chapter focuses on the amplification or mitigation effects that arise through US dollar funding fragility or other factors, reported in the next section. These effects are unlikely to be affected by reverse causality.

²²The econometric specifications for home economy risk analyze the relationship between the quarterly change in the probability of default of the banking sector (or the financial conditions index) and the quarterly change in US dollar funding costs. To keep the language simple, henceforth the chapter uses the term “increase” rather than term “increase in the quarterly change” when summarizing the findings. In addition, to facilitate the comparison and interpretation of the size of the coefficients, both the quarterly change in the probability of default and the financial conditions index are standardized to unit variance with sample-average standard deviation. (For the quarterly change in the probability of default, an increase by one standard deviation is equivalent to an increase by 33 percent.)

credit flows from global non-US banks. Regression analysis shows that the probability of default of the recipient’s banking sector is adversely affected by shocks to US dollar funding costs. For instance, a 50 basis point increase in the funding costs of a recipient economy’s main lenders results in a 0.1 standard deviation increase in the probability of default of its banking sector (a 3.3 percent increase) (Figure 5.5, panel 2). This spillover is quantitatively stronger and is statistically significant for economies that borrow US dollars more heavily: that is, the top 10 US dollar cross-border recipients.²³

Beyond financial stress spillovers, cross-border lending is the main channel through which an increase in US dollar funding costs is transmitted from lenders to recipient economies. A 50 basis point annual cumulative increase in US dollar funding costs is associated with a reduction in US dollar cross-border lending by 5.3 percent (Figure 5.6, panel 1). This reduction is larger when the lender is an emerging market, amounting to a 7.1 percent decrease for all recipients and a 9.3 percent decrease in lending to other emerging markets. Emerging market recipients are more susceptible in general to cutbacks in cross-border lending when US dollar funding conditions tighten. An increase in US dollar funding costs by 50 basis points affects US dollar lending to emerging market recipients by about –6.6 percent, twice the effect on advanced economy recipients.

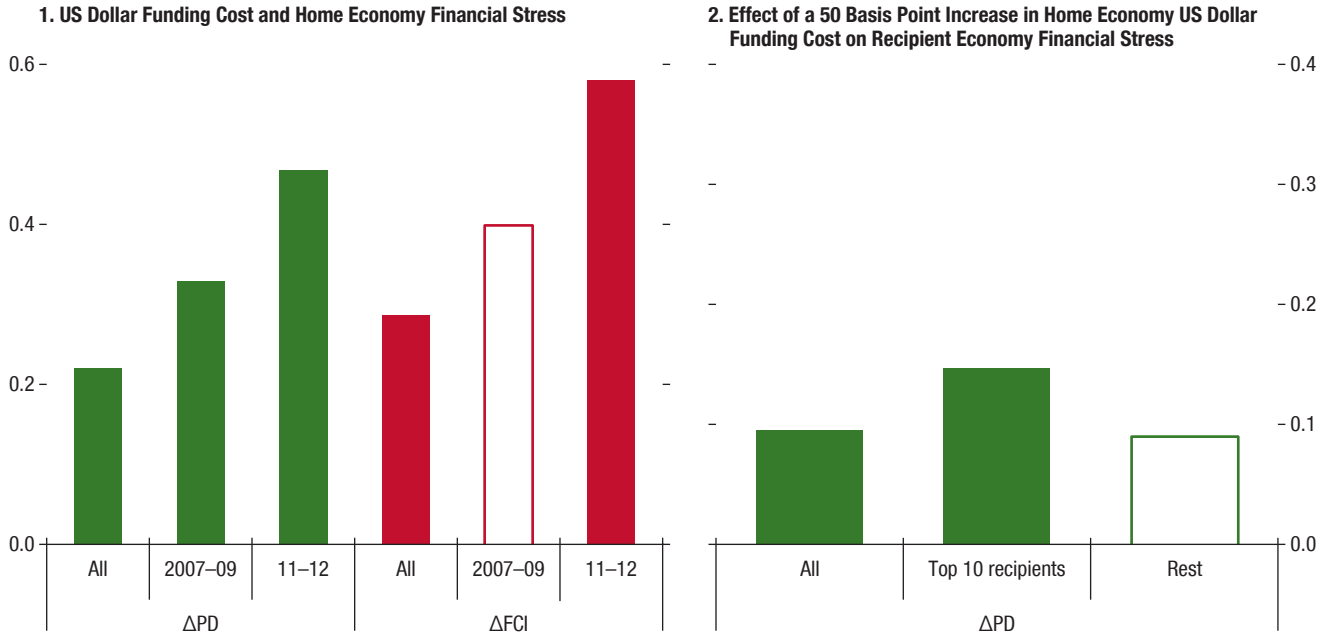
Recipient economies seem to have limited ability to turn to other sources of US dollar borrowing or replace dollars with other currencies when facing cutbacks from one or more of their main US dollar lenders. As discussed previously, when a lender economy faces an increase in US dollar funding costs, its cross-border US dollar lending to all recipient economies is reduced. Additional results show that an average recipient can compensate for only about half of this cutback by increasing its US dollar borrowing from other lenders (Figure 5.6, panel 2). Such substitution is much weaker for emerging market recipients, with only one-quarter of the loss being compensated (Figure 5.6, panel 3). Furthermore, when US dollar

²³The list of top cross-border borrowers is determined by the share of US dollar cross-border lending of a recipient economy’s banking sector relative to total bank credit to the recipient economy’s private sector in the full sample period.

Figure 5.5. US Dollar Funding and Financial Stress
(Standard deviation of the financial stress measure)

The association between financial stress in the home economy and US dollar funding costs was most prominent during the global financial crisis and the European sovereign debt crisis episode.

Tightening US dollar funding conditions for lenders can spill over into recipient economy financial stress, especially for the lenders' main borrowers.



Source: IMF staff calculations.

Note: Panel 1 shows the association of the change in the probability of default (ΔPD) or financial conditions (ΔFCI) of the home economy banking sector with a contemporaneous increase in the change of the US dollar funding cost by 50 basis points, comparing this association for the entire sample period and by different subperiods (2007-09, 2011-12). Panel 2 shows the association between a 50 basis point increase in the funding costs of a recipient economy's main lenders and increases in the probability of default of its banking sector. We compare this association across all recipients economies, top 10 main recipients economies, and the rest (all recipient economies excluding top 10 main recipient economies). Solid colored bars indicate that the associations are statistically significant at the 10 percent level or higher. Empty bars indicate the absence of statistical significance. Standard errors are clustered at the economy level in all regressions.

funding conditions tighten across a recipient economy's foreign lending partners, the economy cannot make up for the resulting decline in US dollar loans by borrowing more US dollars domestically: an increase in the weighted average of cross-border lenders' US dollar funding costs leads to a compensation of only 20 percent of US dollar credit by local banks. Neither is it possible to compensate for the decline with increased cross-border borrowing in other currencies; in fact, rather than compensate for the initial cutback, borrowing in other currencies falls as well, by one-third of the initial cutback. These same calculations for emerging market recipients show even less ability to compensate for declines in US dollar cross-border lending by resorting to other foreign lenders in US dollars, local US dollar credit, or cross-border credit in other currencies (Figure 5.6, panel 3).

US Dollar Activities and Funding Fragility May Act as Amplifiers of Shocks to US Dollar Funding Costs

This section explores the role played by the home economy's exposure to US dollar activities and associated US dollar funding fragility in amplifying the relationship between increases in US dollar funding costs and financial stress in home economies and cross-border lending.

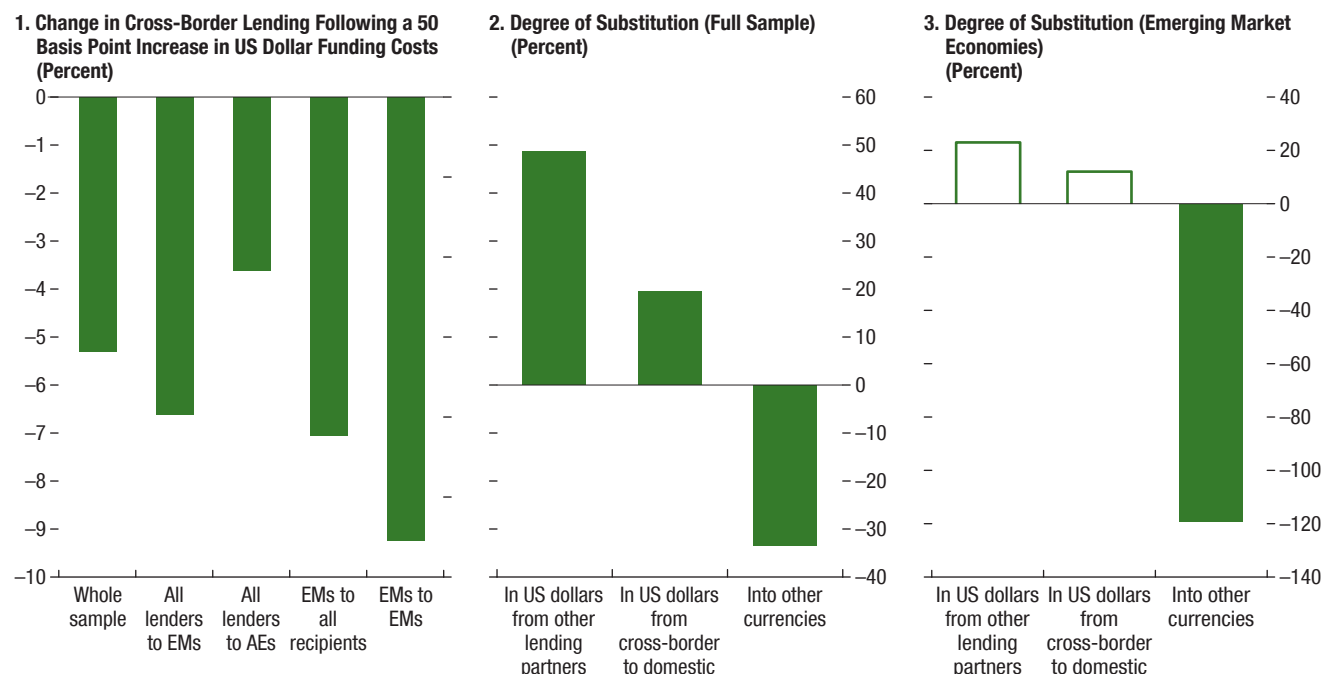
An increase in US dollar funding costs has a greater adverse impact on financial stress in economies where the importance of banks' US dollar activities (as captured by the share of US dollar assets to total assets) is greater. For instance, when this share is historically low (at the first quintile), the impact of a 50 basis point increase in US dollar funding costs on the probability of default of the banking sector in the home economy

Figure 5.6. Spillovers from US Dollar Funding Costs in Home Economies to Recipients of Cross-Border US Dollar Lending

US dollar funding shocks lead to a cutback in US dollar cross-border lending, particularly for emerging market lenders and recipients.

For the full sample of recipient economies, there are substitution possibilities for US dollar lending, but not into other currencies ...

... and negligible substitution possibilities for emerging market recipients.



Source: IMF staff calculations.

Note: Panel 1 shows the cutback of cross-border US dollar lending associated with a 50 basis point increase in US dollar funding costs, for different subgroups of lenders and recipients. Panels 2 (whole sample) and 3 (emerging markets) show the degree of substitution into other lending partners, from cross-border to domestic US dollar credit, and into other currencies. The degree of substitution is defined as the ratio of the increase in lending from either (1) other lending partners, (2) domestic US dollar credit, or (3) other currency cross-border credit, to the cutback in US dollar cross-border borrowing following a year-on-year shock to one lending partner's US dollar funding costs for (1), or to a weighted average of all lending partners' US dollar funding costs for (2) and (3). Dark solid colored bars indicate the associations are statistically significant at the 10 percent level or higher. Empty bars indicate that the coefficient used to compute the degree of substitution is not significant at the 10 percent level. Standard errors are clustered at the economy level in all regressions. AEs = advanced economies; EMs = emerging market economies.

is negligible and statistically insignificant, whereas the impact increases to 0.32 standard deviations (an 11 percent increase) when the asset share is high (at the fourth quintile) (Figure 5.7, panel 1). Qualitatively similar results are found for domestic financial conditions.

The fragility of US dollar funding also amplifies the effect of shocks to US dollar funding costs on domestic financial stress. In particular, the amplification arises only when the cross-currency funding gap is positive—reflecting positive demand for foreign exchange swaps to cover US dollar funding needs. The impact of a 50 basis point increase in US dollar funding costs on the probability of default of the banking sector in the home economy is statistically insignificant if the cross-currency funding gap ratio is low (at the first

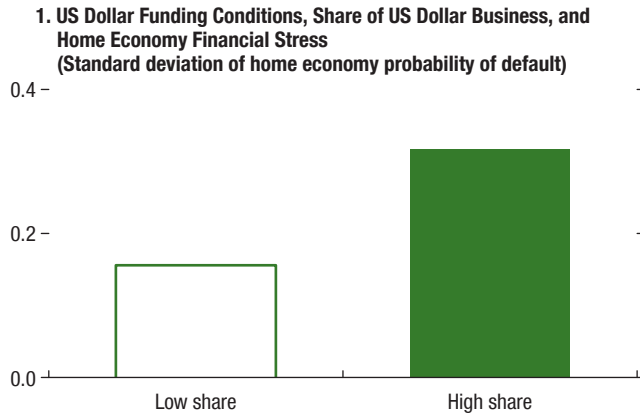
quintile) but increases to 0.41 standard deviations (a 14 percent increase) if the cross-currency funding gap ratio is high (at the fourth quintile) (Figure 5.7, panel 2).²⁴

Other measures of US dollar funding fragility (such as indicators of weaknesses in liquid assets and stability of funding) also amplify the impact of a change in

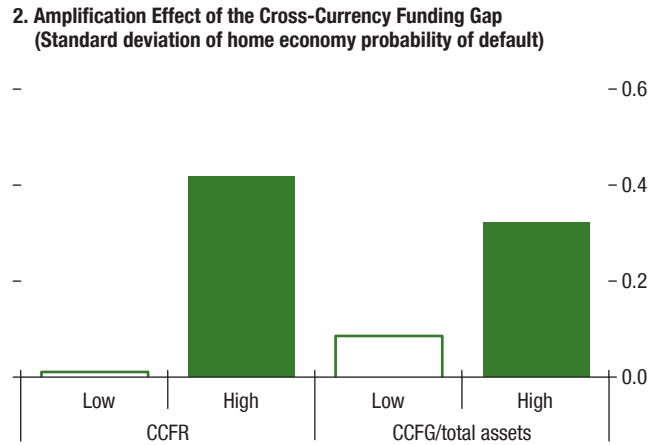
²⁴The average quarterly increase in the probability of default of the banking sector for this sample of economies was 34 percent at the peak of the global financial crisis. The amplification effect of the cross-currency funding ratio, at 14 percent, is therefore equivalent to about two-fifths of this increase, an economically significant amount. The econometric results also hold if the cross-currency funding gap is scaled by total assets, which combines the extent of US dollar liquidity needs with the share of US dollar activities on the balance sheet, albeit only when using the probability of default as a measure of financial stress.

Figure 5.7. Amplification Effects of US Dollar Activities and US Dollar Funding Fragility

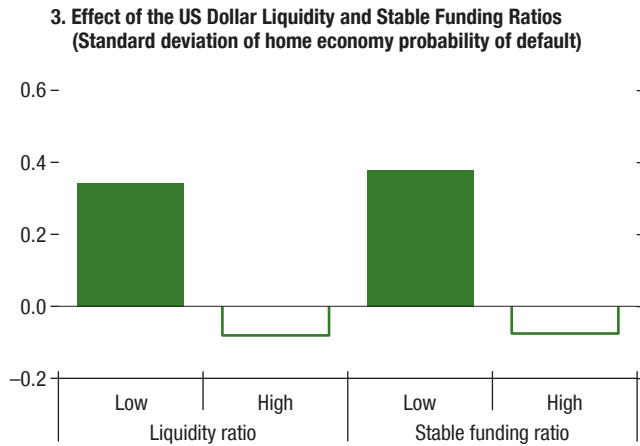
Increases in US dollar funding costs affect home economy financial stress only if the share of US dollar activity is large.



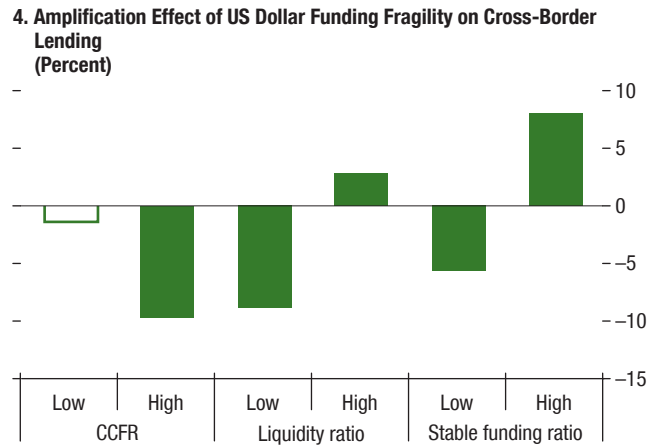
The cross-currency funding gap amplifies shocks in US dollar funding costs.



Shortages in US dollar liquidity and stable funding also amplify the relationship between US dollar funding costs and home economy financial stress.



When US dollar funding conditions tighten, greater US dollar funding fragility in the home economy results in sharper cutbacks in cross-border lending.



Source: IMF staff calculations.

Note: This figure shows the association between a 50 basis point increase in US dollar funding costs and the change in the probability of default of the home economy banking sector, and with US dollar cross-border lending. Panel 1 compares the effect on probability of default when the share of US dollar business in quarter $t-1$ to quarter $t-4$ is low vs. high relative to the full-sample distribution of US dollar assets to total assets. Panel 2 compares this effect when the cross-currency funding ratio (CCFR) or the ratio of cross-currency funding gap (CCFG) to US dollar assets in quarter $t-1$ to quarter $t-4$ is low vs. high relative to the distribution when the CCFG is positive. Panel 3 compares the effect when the US dollar liquidity ratio, or US dollar stable funding ratio in quarter $t-1$ to quarter $t-4$ is low vs. high relative to the historical distribution for each economy. Panel 4 compares the association between US dollar funding cost shocks on cross-border US dollar lending between economy-quarter observations whose US dollar funding fragility measures are high and low by historical standards within an economy. In all panels, high levels are defined as being at the top quintile, and low levels are defined as being in the bottom quintile. The dark bars indicate significance at the 10 percent level. The empty bars indicate the absence of statistical significance at the 10 percent level. Standard errors are clustered at the economy level in all regressions.

US dollar funding costs on domestic financial stress. As with the cross-currency funding ratio, the impact from US dollar funding conditions does not arise unless either US dollar liquid assets or stable funding is relatively low by historical standards.²⁵ In particular, a 50 basis point increase in US dollar funding conditions raises the probability of default of the banking sector in the home economy by 0.33 standard deviations (a 10 percent increase) if the US dollar liquidity ratio is low (at the first quintile), whereas the impact becomes statistically insignificant if the US dollar liquidity ratio of the home economy's banking sector is high (at the fourth quintile) (Figure 5.7, panel 3). Furthermore, effects are similar for the US dollar stable funding ratio. Additional analysis finds that the impact on domestic financial conditions is qualitatively similar, and the magnitude is slightly larger.

US dollar funding fragility also amplifies the effect of a shock to US dollar funding costs on cross-border lending. The analysis shows that the adverse impact of funding costs on cross-border lending is greater when the cross-currency funding ratio is larger. Likewise, when liquidity is weaker or funding less stable by historical standards—the liquidity ratio and stable funding ratio are smaller—the adverse impact is amplified (Figure 5.7, panel 4).²⁶ With an additional 50 basis point increase in the one-quarter-ahead US dollar funding cost, economies experiencing more fragile US dollar funding relative to their own historical levels tend to cut back their cross-border lending by a greater amount.

There is evidence that the mix between subsidiaries and branches in the United States makes a difference in the transmission of stress from heightened US dollar funding costs to the home economy. Subsidiaries tend to be locally capitalized, deposit funded, and supervised, whereas branches have no local capital, rely on uninsured wholesale funding, and are supervised primarily by their home regulators. Results confirm that dollar liquidity held at US subsidiaries cannot be easily transferred to the parent, therefore playing little role in mitigating stress induced by tightening US dollar funding conditions. Indeed, having a high

US dollar liquidity ratio in US subsidiaries does not significantly mitigate the effect of an increase in US dollar funding costs on home economy financial stress (Figure 5.8, panel 1).

Similarly, the subsidiary-branch mix of foreign banks in the home economy plays a role as well. Results show that a high share of foreign subsidiaries residing in the home economy does not have a significant amplification effect because their behavior is not appreciably different from that of domestic banks (Figure 5.8, panel 2). In contrast, foreign branches tend to exacerbate stresses. Home economies with substantial foreign branch presence are estimated to experience a large (0.64 standard deviations, or 21 percent) and statistically significant increase in financial system stress in response to tightening US dollar funding (Figure 5.8, panel 2). This observation, which might be a motivating factor for the de facto tightening of branch supervision across many economies, is consistent with the literature on shock transmission through the bank channel and banks' legal entity architecture (see Chapter 1 of the April 2018 GFSR; Cetorelli and Goldberg 2012; Fiechter and others 2011; Fillat, Garetto, and Smith 2018; Hoggarth, Hooley, and Korniyenko 2013).

Other Factors, Some Policy Related, May Play a Mitigating Role

Just as US dollar funding fragility can amplify the transmission of US dollar funding strains, a number of other factors can play a mitigating role. These include the health of the home economy banking sector and other factors, related to policy, such as the existence of swap lines or central banks' international reserve holdings. This section explores these effects, as well as possible direct effects of swap lines on the cross-currency basis.

The condition of the domestic banking sector can mitigate the association between US dollar funding costs and home economy financial stress. Larger capital buffers, stronger overall liquidity, and higher profitability (return on assets) of banking systems in home jurisdictions are all associated with weaker transmission of shocks in US dollar funding costs to financial stability. For instance, the impact of an increase in US dollar funding conditions by 50 basis points on the probability of default of the banking sector in the home economy is 0.40 standard deviations (14 percentage

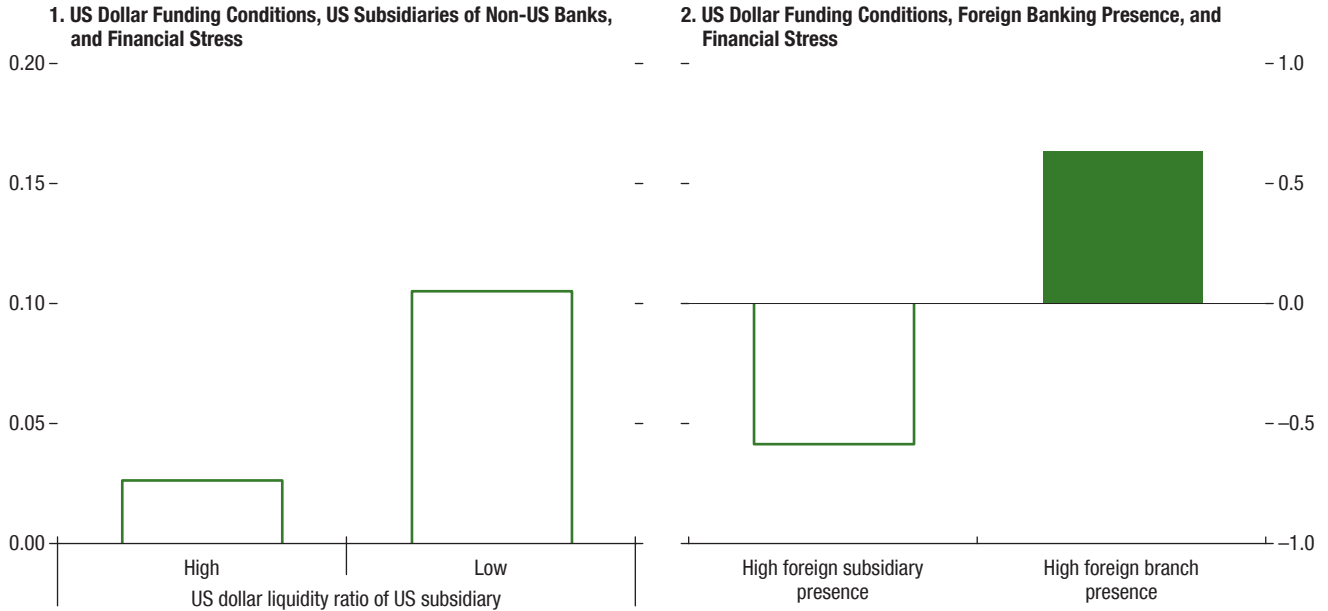
²⁵Throughout the analysis, the percentiles of the US dollar liquidity ratio, the stable funding ratio, and a simple version of the liquidity ratio—the ratio of US dollar high-quality liquid assets to US dollar assets—are constructed within each economy.

²⁶When the analysis is repeated with foreign position measures of funding fragilities, the results are unchanged.

Figure 5.8. US Dollar Funding Conditions, Home Economy Financial Stress, and the Subsidiary-Branch Mix
(Standard deviation of change in home economy probability of default)

In a situation of tightening US dollar funding conditions, US dollar liquidity in US subsidiaries of non-US banks does not significantly relieve home economy financial stress.

Foreign bank presence in the home economy through subsidiaries has little effect, but through branches it exacerbates the effect of funding cost increases on financial stress.



Source: IMF staff calculations.

Note: This figure shows the impact of a 50 basis point increase in the quarterly change in US dollar funding conditions on the probability of default in the home economies of non-US banks. Panel 1 compares the effect when the US dollar liquidity ratio of US subsidiaries of non-US banks is high (at the fourth quintile) vs. low (at the first quintile). Panel 2 shows the effect when foreign subsidiary presence is high (at the fourth quintile) or when foreign branch presence is high (at the fourth quintile). The solid bar indicates that the association is statistically significant at the 10 percent level or higher. Empty bars indicate the absence of statistical significance at the 10 percent level. Standard errors are clustered at the economy level in all regressions.

points) if the capital ratio is low by historical standards (at the first quintile), but decreases to 0.25 standard deviations (an 8 percent increase) if the capital ratio is high (at the fourth quintile) (Figure 5.9, panel 1). Greater overall liquidity (measured by the ratio of cash to assets)²⁷ and profitability (higher return on assets) show similar benefits. Qualitatively similar effects are found with respect to the impact on domestic financial conditions. Having large capital buffers and/or high profitability can somewhat offset the adverse effect of US dollar funding fragility.²⁸

²⁷The results may give the impression that overall liquidity management, as reflected in high liquidity ratios across all currencies, could substitute for US dollar liquidity management. However, more detailed analysis in recent Financial Sector Assessment Programs has concluded that currency-specific liquidity management is also crucial (see Online Box 5.1).

²⁸High capital (at the fourth quintile) can partially offset the amplification effects of low liquidity ratios (at the first quintile)

Strong bank health also mitigates the effect of US dollar funding shocks on cross-border lending. For instance, following a 50 basis point increase in funding costs, economies whose banking system average capital ratio is at the lowest quintile of its historical level cut their US dollar cross-border lending by 4.7 percent more than those whose capital is at the fourth quintile (Figure 5.9, panel 2).

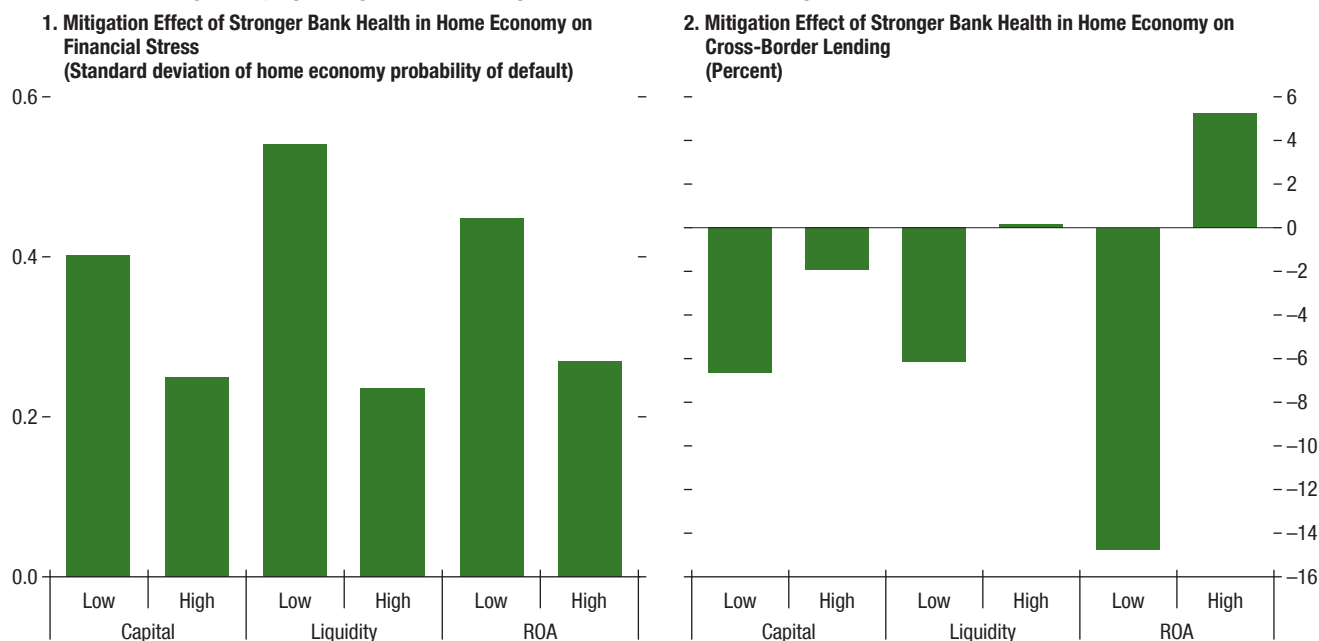
Central bank swap arrangements with the Federal Reserve can play an important role in alleviating US dollar funding pressures. Because these arrangements limit the deviation from covered interest parity by offering an alternative source of US dollar funding, they tend to curb funding risk. These swap arrangements became prominent during the global financial crisis, starting with the European

for the probability of default. Similar results were obtained for the comparison between return on assets and liquidity ratios.

Figure 5.9. The Mitigating Effect of Home Economy Bank Health

The health of the home economy banking system can help mitigate the financial stress brought on by tightening US dollar funding conditions ...

... and it can help cushion the induced cutback in US dollar cross-border lending.



Source: IMF staff calculations.

Note: This figure shows the association between a 50 basis point increase in the change in US dollar funding costs and the change in the probability of default (panel 1) and on US dollar cross-border lending (panel 2). The figure compares these associations when the capital asset ratio (capital), cash assets ratio (liquidity), and ROA in quarter $t-1$ to quarter $t-4$ is at the bottom (low) and the top (high) quintiles of the full-sample distribution. The colored bars indicate significance at the 10 percent level. Standard errors are clustered at the economy level in all regressions. ROA = return on assets.

Central Bank and the Swiss National Bank, which first established temporary US dollar liquidity swap arrangements with the US Federal Reserve in December 2007. The number of central banks engaging in temporary US dollar liquidity swap arrangements peaked at 14 in October 2008, before stabilizing to five major advanced economy central banks in May 2010 with full allotment: that is, without a prespecified limit.

Evidence of the impact of swap lines is given by an event study surrounding the Federal Reserve's unexpected announcement on November 30, 2011, that it would lower the swap line rate by 0.5 percent (Bahaj and Reis 2019). After the announcement, daily cross-currency bases narrowed noticeably, but primarily for currencies with swap arrangements (Figure 5.10, panel 1). For currencies with swap lines, the basis became less negative on average, and the most negative

values disappeared, whereas for currencies without swap lines the changes in the basis were much less pronounced.

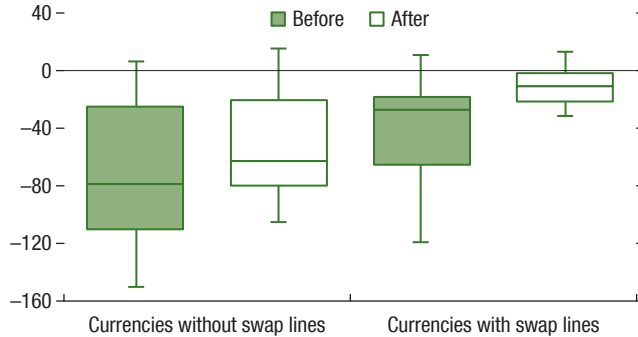
Swap line arrangements with the Federal Reserve also mitigate the consequences of increases in US dollar funding costs. Regression analysis finds that in economies with these arrangements there was no statistically significant association between the change in US dollar funding conditions and a change in domestic financial stress. However, without the swap line arrangement, the association was statistically significant (Figure 5.10, panel 2). The results for both the probability of default of the banking sector and domestic financial conditions are qualitatively similar.

Central banks' international reserve holdings can also play a mitigating role when non-US banks face US dollar liquidity tightening, for two main

Figure 5.10. Mitigating Effects of US Dollar Swap Lines and International Reserve Holdings by Home Economy Central Banks

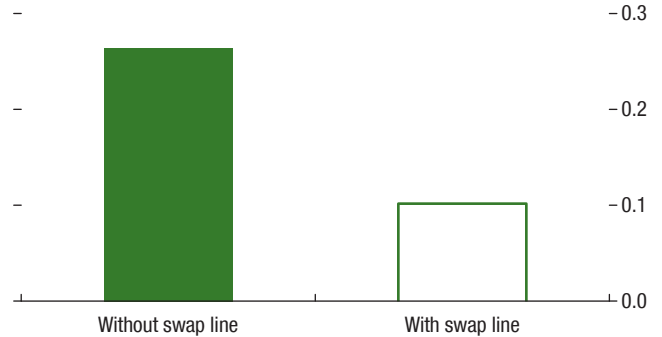
The change in the swap line rate resulted in narrower CCBs, but primarily for currencies with swap lines.

1. Three-Month Cross-Currency Basis Distribution after Swap Line Rate Ceiling Change
(Basis points, showing tick marks for minimum and maximum values, horizontal lines for the median, and boxes encompassing the 25th to the 75th percentiles)



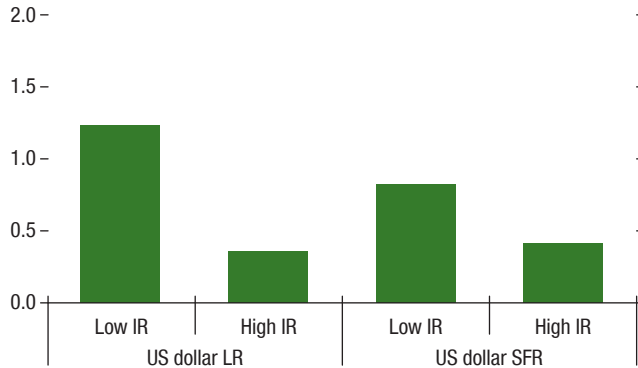
US dollar swap arrangements mitigate the impact of increases in US dollar funding costs on home economy financial stress ...

2. Mitigation Effect of Central Bank Swap Line Arrangements on Home Economy Financial Stress
(Standard deviation of home economy probability of default)



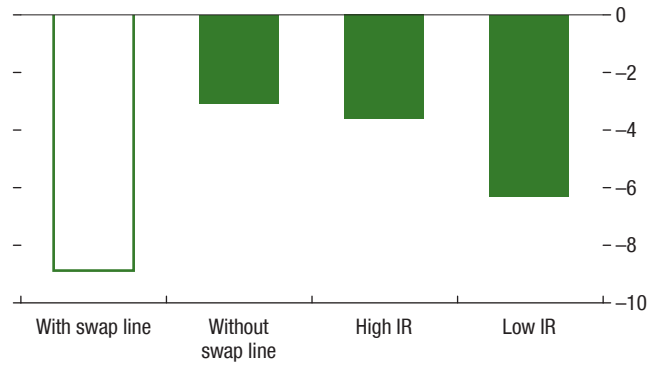
... as do non-US central banks' international reserve holdings.

3. Mitigation Effect of International Reserve Holdings by Non-US Central Banks through US Dollar Funding Fragility on Home Economy Financial Stress
(Standard deviation of home economy probability of default)



US dollar swap line arrangements and international reserve holdings also help cushion cutbacks in cross-border lending.

4. Mitigation Effect of Central Bank Swap Arrangements and International Reserve Holdings on Cross-Border Lending
(Percent)



Source: IMF staff calculations.

Note: Panel 1 shows the box-and-whisker plots of daily three-month CCBs before and after the implementation of lower swap line rates for currencies with and without access to swap lines. The presample and postsample periods are from November 1, 2011, to November 30, 2011, and January 1, 2012, to January 31, 2012, respectively. Currencies with swap lines include the British pound, Canadian dollar, euro, Japanese yen, and Swiss franc. Currencies without access to swap lines include the Australian dollar, Danish krone, Norwegian krone, and Swedish krona. Panel 2 shows the association between a 50 basis point increase in US dollar funding costs and the change in the home economy probability of default, comparing the presence and absence of a swap line arrangement. Panel 3 shows the transmission effect of US dollar funding fragility—the LR or SFR evaluated at their median—on the change in the probability of default when the home central bank's international reserve holdings are low (at the bottom quintile) vs. high (at the top quintile) by historical standards. Standard errors are clustered at the economy level in all regressions. Panel 4 shows the association of a 50 basis point increase in US dollar funding cost shocks with cross-border US dollar lending for economies with vs. without swap line arrangements and for economies with high vs. low central bank international reserve holdings. Economies that have high international reserves are those whose international reserves-to-GDP ratio is higher than the top quintile of historical levels. The solid green and red bars indicate that the association is statistically significant at the 10 percent level or higher. Empty bars indicate the absence of statistical significance at the 10 percent level. CCB = cross-currency basis; IR = international reserves; LR = liquidity ratio; SFR = stable funding ratio.

reasons.²⁹ First, non-US central banks can use international reserves (largely denominated in US dollars) to provide contingent US dollar liquidity to the domestic financial system. Second, external providers of US dollar liquidity might be more willing to provide liquidity to an economy that is backed by a central bank with deep pockets. Although previous analysis showed that lack of liquidity in US dollars held by banks—reflected by a low US dollar liquidity ratio—can amplify the impact of funding costs on financial stress, this amplification is appreciably smaller in an economy with high holdings of international reserves. With US dollar liquidity at its historical median, a 50 basis point increase in US dollar funding costs results in a 0.38 standard deviation increase in an economy with high reserve holdings (at the fourth quintile), compared with a 1.22 standard deviation increase when reserve holdings are low (at the first quintile) (Figure 5.10, panel 3). Additional analysis finds that this difference also holds for domestic financial conditions, though the magnitude is slightly larger.

Swap lines and US dollar reserve holdings play a similar role in mitigating the impact on cross-border lending. Facing similar funding cost increases, economies with a swap line arrangement do not reduce lending significantly, whereas those without a swap line arrangement with the Federal Reserve provide about 3.2 percent less cross-border US dollar lending. In economies with high international reserves (top quintile in the entire sample), cutbacks in lending are about 40 percent less than in those with low (bottom quintile) reserve holdings (Figure 5.10, panel 4).

²⁹Several IMF country reports obtain similar results from analysis of systemic foreign currency liquidity. For instance, Sweden's central bank, the Riksbank, boosted international reserves by about one-third in 2013 to ensure ready access, and the Sweden 2013 Article IV consultations with the IMF—during which IMF staff teams assess the macroeconomic and financial sector outlook and discuss policies in these areas with the relevant officials in the country—recommended sharing some of the fiscal costs with the banks to create proper incentives to manage these risks at the bank level. The Mauritius 2015 Article IV consultations and Financial Sector Assessment Program suggested that the reserve adequacy metric should take into account the deposits of the so-called global business companies held in domestic banks and the liquid foreign currency assets of domestic banks (IMF 2016).

Policy Implications

As in recent decades, the US dollar will likely maintain a predominant role in global trade and finance in the coming years, and non-US banks will continue to be key providers of US dollar intermediation. This chapter focuses on the liquidity risk that this activity entails and finds that, despite postcrisis regulatory reforms, US dollar liquidity conditions remain a source of vulnerability for non-US banks in terms of both financial stress in the economies that are home to these institutions and potential spillovers to those that are recipients of cross-border US dollar loans.

The findings have a number of policy implications:

- Despite the benefits of reducing the vulnerability of the financial system, some postcrisis regulatory reforms may have had unintended consequences in global US dollar funding markets. This is not to suggest that the regulatory reforms should be rolled back. In fact, this chapter shows that having healthy capital buffers and overall liquidity in home economy banking systems can mitigate the destabilizing effects of increased US dollar exposure and funding fragility. However, the findings of the chapter suggest that trade-offs should be considered between risk abatement and reduction in financial intermediation activity, as well as between public provision of liquidity buffers and ex ante incentives to take excessive risk (moral hazard).
- Regulators should monitor the US dollar funding fragility of local banks and develop or enhance as needed currency-specific liquidity risk frameworks, including stress tests, emergency funding strategies, and resolution planning. The cross-currency funding ratio, liquidity ratio, and stable funding ratio measures used in this chapter could be useful monitoring tools. This is particularly true for economies exposed to or borrowing from non-US global banks, given possible spillovers from tighter US dollar liquidity conditions.
- The analysis points to the benefits of access to US dollar liquidity during periods of stress, both for the economies that are home to banks that intermediate US dollars globally and for recipient economies. International reserves can play a stabilizing role in the event of stress in US funding markets. This is a dimension that should be considered in assessing reserve adequacy. Furthermore, access to US dollar liquidity through swap lines at times of strain can contribute to stability, including through a signaling effect. Finally, there is a case for a stronger global financial safety net, including through adequate IMF resources, such as those provided through flexible credit lines.

References

- Aldasoro, Iñaki, Torsten Ehlens, Egemen Eren, and Robert N. McCauley. 2017. "Non-US Banks' Global Dollar Funding Grows Despite US Money Market Reform." *BIS Quarterly Review* (March): 22–23.
- Aldasoro, Iñaki, and Torsten Ehlens. 2018. "The Geography of Dollar Funding of Non-US Banks." *BIS Quarterly Review* (December): 15–26.
- Avdjiev, Stefan, Valentina Bruno, Catherine Koch, and Hyun Song Shin. 2018. "The Dollar Exchange Rate as a Global Risk Factor: Evidence from Investment." BIS Working Paper 695, Bank for International Settlements, Basel.
- Avdjiev, Stefan, Wenxin Du, Catherine Koch, and Hyun Song Shin. Forthcoming. "The Dollar, Bank Leverage and the Deviation from Covered Interest Parity." *American Economic Review: Insights*.
- Baba, Naohiko, and Frank Packer. 2009. "Interpreting Deviations from Covered Interest Parity during the Financial Market Turmoil of 2007–08." *Journal of Banking & Finance* 33 (11): 1953–62.
- , and Teppei Nagano. 2008. "The Spillover of Money Market Turbulence to FX Swap and Cross-Currency Swap Markets." *BIS Quarterly Review* (March).
- Bahaj, Saleem, and Ricardo Reis. 2019. "Central Bank Swap Lines: Evidence on the Effects of the Lender of Last Resort." IMES Discussion Paper Series 19-E-09, Institute for Monetary and Economic Studies, Bank of Japan, Tokyo.
- Basel Committee on Banking Supervision. 1996. "Amendment to the Capital Accord to Incorporate Market Risks." Bank for International Settlements, Basel.
- Borio, Claudio E. V., Mubeen Iqbal, Robert N. McCauley, Patrick McGuire, and Vladyslav Sushko. 2018. "The Failure of Covered Interest Parity: FX Hedging Demand and Costly Balance Sheets." BIS Working Paper 590, Bank for International Settlements, Basel.
- Bruno, Valentina, and Hyun Song Shin. 2015. "Cross-Border Banking and Global Liquidity." *Review of Economic Studies* 82 (2): 535–64.
- Cerutti, Eugenio M., Maurice Obstfeld, and Haonan Zhou. 2019. "Covered Interest Parity Deviations—Macroeconomic Determinants." IMF Working Paper 19/14, International Monetary Fund, Washington, DC.
- Cetorelli, Nicola, and Linda Goldberg. 2012. "Follow the Money: Quantifying Domestic Effects of Foreign Bank Shocks in the Great Recession." Staff Report 545, Federal Reserve Bank of New York.
- Du, Wenxin, Alexander Tepper, and Adrien Verdelhan. 2018. "Deviations from Covered Interest Rate Parity." *Journal of Finance* 73 (3): 915–57.
- Eguren-Martin, Fernando, Matias Ossandon Busch, and Dennis Reinhardt. 2018. "FX Funding Shocks and Cross-Border Lending: Fragmentation Matters." Bank of England Working Paper 762, Bank of England, London.
- Fiechter, Jonnathan, Inci Ötoker, Anna Ilyina, Michael Hsu, Andre Santos, and Jay Surti. 2011. "Subsidiaries or Branches—Does One Size Fit All?" IMF Staff Discussion Note, International Monetary Fund, Washington, DC.
- Fillat, Jose, Stefania Garetto, and Arthur Smith. 2018. "What Are the Consequences of Global Banking for the International Transmission of Shocks? A Quantitative Analysis." CEPR Discussion Paper 13274, Centre for Economic Policy Research, London.
- Goldberg, Linda S., Craig Kennedy, and Jason Miu. 2011. "Central Bank Dollar Swap Lines and Overseas Dollar Funding Costs." *Economic Policy Review* 17 (1).
- Gopinath, Gita, and Jeremy C. Stein. 2018. "Banking, Trade, and the Making of a Dominant Currency." NBER Working Paper 4485, National Bureau of Economic Research, Cambridge, MA.
- Hofstetter, Marc, José Ignacio López, and Miguel Urrutia. 2018. "Limits to Foreign Exchange Net Open Positions and Capital Requirements in Emerging Economies." Documentos CEDE 2018–10, Universidad de los Andes, Bogotá.
- Hoggarth, Glenn, John Hooley, and Yevgeniya Korniyenko. 2013. "Which Way Do Foreign Branches Sway? Evidence from the Recent UK Domestic Credit Cycle." Bank of England Financial Stability Paper 22, Bank of England, London.
- Iida, Tomoyuki, Takeshi Kimura, and Nao Sudo. 2018. "Deviations from Covered Interest Rate Parity and the Dollar Funding of Global Banks." *International Journal of Central Banking* 14 (4): 275–325.
- International Monetary Fund (IMF). 2016. "Mauritius: Staff Report for the 2015 Article IV Consultation." IMF Country Report 16/89, Washington, DC.
- Ivashina, Victoria, David S. Scharfstein, and Jeremy C. Stein. 2015. "Dollar Funding and the Lending Behavior of Global Banks." *Quarterly Journal of Economics* 130 (3): 1241–81.
- McGuire, Patrick, and Goetz von Peter. 2012. "The Dollar Shortage in Global Banking and the International Policy Response." *International Finance* 15 (2): 155–78.
- Nakaso, Hiroshi. 2017. "Monetary Policy Divergence and Global Financial Stability: From the Perspective of Demand and Supply of Safe Assets." Speech at a meeting hosted by the International Bankers Association of Japan, Bank of Japan, January 20.
- Saito, Kaori, Kazunori Hiyama, and Kyosuke Shiotani. 2018. "International Comparison of the BIS International Banking Statistics: Estimates of the Positions Excluding Trustee Business." Bank of Japan report 18-E-2, Tokyo.
- Sushko, Vladyslav, Claudio E. V. Borio, Robert N. McCauley, and Patrick McGuire. 2016. "The Failure of Covered Interest Parity: FX Hedging Demand and Costly Balance Sheets." BIS Working Paper 59, Bank for International Settlements, Basel.

