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Global Banks' Dollar Funding: A Source of Financial Vulnerability

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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

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Monetary and Capital Markets Department

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Abstract

Leading up to the global financial crisis, US dollar activity by global banks headquartered outside the United States played a crucial role in transmitting shocks originating in funding markets. Although post-crisis regulation has improved banking systems' resilience, US dollar funding remains a global vulnerability, as evidenced by strains that reemerged in March 2020 in the midst of the COVID-19 crisis. We show that shocks to US dollar funding costs lead to financial stress in the home economies of these global non-US banks, and to spillovers to borrowers, especially emerging economies. US dollar funding vulnerability amplifies these negative effects, while some policy-related factors act as mitigators, such as swap line arrangements between central banks and international reserve holdings. Thus, these vulnerabilities should be monitored and, to the extent possible, controlled.

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Keywords: US dollar funding, financial stability risks, cross-currency basis, global banks, international liquidity

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I. INTRODUCTION

The US dollar—henceforth also referred to as USD—historically has played a prominent role in global trade and financial flows (Shin, 2012; Gopinath and Stein, 2018). In the run-up to the global financial crisis, European banks accumulated sizable USD 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). When these markets became impaired in 2007–08, non-US banks had to finance their USD assets by tapping the foreign exchange swap market, where funding in other currencies can be turned into USD funding through the use of derivatives, further propagating financial stress through this market (Baba and Packer 2009). A decade later, the USD still plays a key role in international banking, and non-US banks, especially those from advanced economies, remain significant intermediaries of USD transactions in global financial markets.

USD intermediation, whereby global non-US banks borrow and lend USD 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, it is also a potential source of risk in global financial markets since it may entail important foreign currency liquidity mismatches for non-US banks.[2] This could occur because their stable USD deposits outside the United States are typically insufficient to fund their global USD credit activities. Whereas non-US banks can tap stable USD 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 USD funding, obtained through US branches and in international markets, can be deployed outside the United States but are mostly wholesale and therefore 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.

The risks posed by the reliance of non-US banks on wholesale USD funding markets could be exacerbated by the structural changes experienced by these markets since the global financial crisis. For instance, despite the well-documented benefits of the postcrisis regulatory reforms for financial resilience (GFSR October 2018), some aspects may have had unintentional effects in USD funding markets. New leverage, capital, and liquidity requirements, at the global and jurisdiction level, as well as the 2016 money market fund reform in the United States, may have tightened the supply of USD funding to non-US banks (Du, Tepper, and Verdelhan 2018; Iida, Kimura, and Sudo 2018). While non-US banks have been able to increase offshore USD deposits (Aldasoro and others, 2017), these developments have also led them to increase their reliance on foreign exchange swap markets. These markets could be more prone to instability now because of an increasing role of nonbanks, whose commitment to stay in the market during stress periods is untested at this

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

point (Nakaso 2017). Finally, supervisory and regulatory tightening may have further complicated cross-border liquidity management at global financial institutions.

Altogether, this suggests that the cost of USD 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 USD funding fragility—as reflected in greater liquidity and maturity mismatches between their USD 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 USD funding costs on banks' financial stress and the global credit supply.

Indeed, strains in offshore USD funding re-remerged in the first quarter of 2020, particularly in the week after March 11, the date when the World Health Organization declared the COVID-19 virus to be a global pandemic. Reflecting these pressures, the cross-currency basis—a proxy for the marginal cost of USD funding outside the U.S.[3]—spiked across major currencies. In fact, for some currencies such as the Japanese yen and Canadian dollar, the widening of the basis was even greater than that experienced during the global financial crisis. Recognizing the potential global financial stability consequences of continued USD shortage, the Federal Reserve intervened forcefully—in particular, enhancing and extending swap lines to fourteen central banks in late March—and seemed to have largely arrested the strains so far. As of June, the bases for most currencies had once again reverted to their pre-2020 levels.

Against this backdrop, this paper investigates the extent to which conditions in USD funding markets could be a source of financial stress and disruption of international capital flows. The analysis relies on multiple data sources, including detailed data on the composition of cross-border as well as local positions of USD assets and liabilities for 26 advanced and emerging economy banking systems from the Bank of International Settlements, to build measures of USD funding cost and financial stress for these banking systems, and data on the composition of USD-denominated loans originated in these systems. These data are used to study how the cost of USD funding responds to different drivers identified in the literature and how USD funding conditions may generate financial stress in the home economies of non-US global banks (henceforth home economies) or lead to cutbacks in cross-border USD loans from these economies to borrowers or recipients of these flows (henceforth recipient economies). Importantly, the paper also builds a series of measures of USD funding vulnerability and tests whether the relationship between funding costs, financial stress, and cross border USD lending is magnified in more vulnerable banking systems.

Our results show that USD funding costs have become more volatile since the global financial crisis, especially for countries that rely relatively more on synthetic USD funding. They also show that increases in USD funding costs lead to financial stress in home

[3] In Section II.D. We define the cross-currency basis and examine its major trends.

economies, as measured by an increase in the probability of default of their banking system, and to reduced USD lending from these economies to recipient economies, especially emerging market ones. Using instrumental variable approaches, we show that these results are unlikely to be driven only by reverse causality. We also provide novel evidence that the adverse relationship between USD funding costs and both financial stress in the home economy and cross border lending to recipient economies is stronger for home economies with more vulnerable USD funding, that is, that rely relatively more on foreign currency derivatives, or have larger liquidity and maturity mismatches in their USD balance sheet.

This paper contributes to several strands of literature. The literature on USD funding costs for non-US banks has focused on the determinants of the difference between direct and synthetic USD funding costs, captured by the so called cross-currency basis (CCB), which also captures deviations from covered interest rate parity (CIP). This literature has documented that the CCB is related to various supply and demand factors, including term spread differentials between the US and other economies, default probabilities in foreign banking systems, the structure of foreign currency markets, global factors like the VIX and the broad USD index. and that it has responded to various regulatory reforms (Iida and others, 2018; Advjiev and others, forthcoming; Du and others, 2018; Borio and others, 2018; Brauning and Ivashina, forthcoming). This paper confirms these findings for a broader set of currencies, and also shows that the relationship between the CCB and its determinants depends on the ex-ante reliance on synthetic funding of the banking systems operating in each currency, suggesting limited ability to substitute to other forms of funding when shocks to USD funding costs take place. Furthermore, the paper provides novel evidence that shocks to USD funding costs can themselves be a source of financial stress for the banking systems of the home economies of global non-US banks.

Our work also contributes to the literature on international banking and cross border lending. This literature has demonstrated the importance of internal capital markets and risk management of global banks to reallocate funding and lending across jurisdictions (Schnabl, 2010; Cetorelli and Goldberg, 2012; Ivashina and others, 2105; Brauning and Ivashina, forthcoming). Several papers have shown that global banks reduce cross-border lending in a given currency in response to shocks to funding or liquidity in that currency (Cetorelli and Goldberg, 2012; Brauning and Ivashina, 2019; Brauning and Ivashina, forthcoming). A recent strand of this literature has emphasized the role that bilateral and multilateral exchange rates vis-à-vis the USD plays in determining the risk bearing capacity and lending behavior of global banks (Bruno and Shin, 2015; Advjiev and others, 2017; Advjiev and others, 2019). Our work complements this literature by providing novel evidence that the vulnerability of USD funding structures of global banks' balance sheets plays a material role in amplifying the negative effect of increases in USD funding costs for cross-border USD lending, and that this reduced lending also leads to financial stress in recipient economies. This evidence suggests that not only the risk bearing capacity of global banks, given by their overall balance sheet position and value-at-risk considerations, matters for their cross-border lending behavior, but also the vulnerabiity of their currency-specific funding structures plays a crucial role.

Finally, our paper contributes to the literature on dominant currencies. As shown by Gopinath and Stein (2018), the USD plays a dominant role in invoicing of international trade flows (dominant currency pricing), a role that, combined with a large international demand for safe assets, leads to a concurrent dominance of the USD for borrowing by corporates outside the U.S. (dominant currency financing). Both types of USD dominance tend to weaken the external sector's response to exchange rate fluctuations, thus making external adjustment more difficult for countries in which USD dominance is greater (Adler and others, forthcoming). In part, this weakened response is due to a cutback in USD credit by global banks to exporters when the USD appreciates (Bruno and Shin, 2019). In addition, dominant currency financing results in cross-border lending becoming more sensitive to shifts in monetary policy (Brauning and Ivashina, 2017). Our paper focuses on a key repercussion of USD dominance: the inherent liquidity mismatch on non-U.S. global banks' balance sheets. We uncover evidence of the financial stability implications of this mismatch for economies on both the lending and borrowing sides of global USD financing. The rest of the paper is structured as follows. Section II reveiws the stylized facts, describing the major trends in USD operations of non-U.S. global banks, introducing the funding vulnerability indicators, and documenting the evolution of USD funding costs. Section III analyzes the drivers of these costs as well as the effects of regulatory and other policy changes. Section IV reviews our findings on the association between USD finding costs and home economy financial stress, and Section V does so for the association between USD funding costs and recipient economy financial stress. Section VI concludes.

II. Stylized Facts

A. Data and Concepts

We rely on BIS locational banking statistics (LBS) on a nationality basis for 26 economies that are home to the major global non-US banks[4] to construct USD funding fragility measures. The nationality basis allows us to construct USD balance sheet positions at the

[4] Our sample of home economies was chosen to satisfy the following criteria: (i) existence of cross-currency swaps for the relevant currency; (ii) availability of BIS LBS data starting in 2015 at the latest; and either (iii) global importance: international USD claims of at least 50 billion; or (iv) domestic importance: share of international claims in USD of at least 5 percent of the country's total international claims plus domestic banks' local claims in local currency. The resulting sample includes seventeen advanced economies and nine emerging economies: Australia, Austria, Canada, France, Germany, India, Italy, Japan, Korea, Netherlands, Spain, Sweden, Switzerland, United Kingdom, Brazil, China, Cyprus, Hong Kong SAR, Luxembourg, Malaysia, Mexico, Norway, Russia, Singapore, South Africa, and Turkey. However, we were unable to construct one out of the three fragility measures for the latter 12 economies due to data limitations. It is also worth mentioning that, in the case of the banking systems of China, Russia, Singapore, Malaysia, Cyprus, and South Africa, BIS data only captures a portion of banks' worldwide USD positions; therefore may not provide a comprehensive picture. See Bank for International Settlements (2019) for a detailed description of the LBS.

parent level, as opposed to residency basis positions, which are at the host economy level. As **Figure 1** shows, there are several definitions of these banks' USD positions. The BIS locational banking statistics (LBS) on a nationality basis yield the first of these, the international position (IP), which encompasses cross-border claims (block A) and local USD claims of the global banks in countries other than the U.S. (block B). The local USD claims of foreign affiliates in the U.S. (block C) are made up of positions in U.S. branches, constructed from the Federal Reserve's FFIEC002 report, and in U.S. subsidiaries, which we construct from call reports (i.e. FFIEC 031/041) via the S&P Market Intelligence platform. Aggregating at the home economy level the international position with positions in branches and subsidiaries in the U.S. yields the foreign USD position (FP = A + B +C).

B. Measuring US Dollar Operations and Funding of Global Non-US Banks

The USD activities of global non-US banks grew very rapidly in the seven years leading up to the global financial crisis, and have continued to increase since, although at a much slower pace. The FP claims in USD amounted to just over $3 trillion in 2000, rose to $10 trillion before the onset of the crisis, and reached more than $12 trillion by 2018 (**Figure 2, panel 1**).[5] All three components—IP, and branches and subsidiaries in the U.S.—have contributed to the increase, and the latest figures show U.S. branches accounting for close to 19 percent of total FP assets, and US subsidiaries for about a tenth. However, the relative reliance on each varies substantially by home economy, with U.S. branches comprising as much as half or as little as one percent of the FP assets, while the share of U.S. subsidiaries can vary between zero and 45 percent (**Figure 2, panel 2**).

The distribution of the home nationality of the banks engaging in these activities has changed since the crisis. While many European banks deleveraged and contracted their USD lending activities following the crisis, Canadian and Japanese banks have compensated this decline, with a substantial and relatively uninterrupted increase in USD assets (**Figure 2, panel 3**).[6]

Overall, the relative importance of USD activities within home economy banking sectors has increased since the crisis as well. For the group of 26 economies, USD assets have increased as a share of total banking assets, and increases have occurred in all but five of the home economies analyzed. In particular, the share of USD assets increased for Canadian banks by five percentage points (pps), for Japanese banks by 7 pps, and for Swedish banks by 2 pps (**Figure 2, panel 4**).

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[5] Note that some economies enter the sample after 2000. In particular, China and Russia enter in 2015, accounting for the discrete jump USD claims observed in Figure 2.

[6] A similar figure is presented in Aldasoro, Ehlers, and Egen (2018).

C. Dollar Funding Vulnerability Indicators

As documented in the previous section, USD activities of non-US banks continue to be substantial a decade after the crisis. To quantify the degree to which these activities might be vulnerable to shocks to the cost of USD funding, we use three indicators: the cross-currency funding ratio (CCFR), the USD liquidity ratio (LR), and the USD stable funding ratio (SFR).[7]

The CCFR is defined as the difference between USD assets and USD liabilities (the cross-currency funding gap, CCFG), expressed as a ratio of USD assets. Thus, a positive value for the CCFR constitutes a net asset position in USD, meaning that some of the USD assets are not directly funded through USD liabilities. This gap is therefore either funded in other currencies and transformed into USD using derivatives—FX swaps or cross-currency swaps—or kept as a net open position in foreign currency. The latter option is probably quite limited since banks generally face regulatory pressure to limit net open foreign exchange positions and their related foreign exchange risk.[8]

To the extent that the CCFR captures the use of synthetic USD funding, a larger value will likely signal higher vulnerability to shocks to USD funding costs. If the synthetic funding is conducted through short term FX swaps, it may expose banks to liquidity risks in foreign currency. This liquidity risk may also be present in longer dated cross-currency swaps if the tenors of the swaps are shorter than that of the USD assets being funded. Furthermore, banks use synthetic USD funding when this option is relatively cheaper than directly issuing USD liabilities. For instance, non-US banks with limited access to insured retail deposits could directly access only wholesale USD funding. These relative difficulties in obtaining USD funding are likely to be exacerbated in periods of stress in USD funding markets, and put additional pressure for finding synthetic funding or reducing USD lending activity. These

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[7] The cross-currency funding gap was initially constructed in McGuire and von Peter (2009), and the LR and SFR were initially constructed in Chapter 1 of the IMF's April 2018 Global Financial Stability Report. The three vulnerability measures rely on BIS unpublished restricted data on LBS on a nationality basis. We follow a similar methodology, with some refinements. See Appendix 1 for details on the construction of the three indices. Note that all figures showing US dollar vulnerability indicators report the IP + B definition of USD activities, that is, the International Position plus branches in the U.S., but excluding U.S. subsidiaries. The presumption is that liquidity or funding of U.S. subsidiaries cannot be easily transferred to the parent, due to regulatory constraints. Robustness checks of our econometric analysis confirms this; there is no significant change in the results when moving from the IP + B to FP definition, which includes subsidiaries.

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

reactions ultimately can lead to financial stress in the home economies of the non-US banks, as well as in economies that receive financing in USD.[9]

We observe that, together with the expansion in USD activities, the CCFR has increased for many ecomomies since the crisis. Figure 3, panel 1 displays the aggregate CCFG and CCFR for a sample of 13 countries for which there is data since 2000. The CCFR increased from 9.1 percent of USD assets in 2008 to 13.8 percent in 2018. For these economies, the aggregate funding gap amounts to $1.2 trillion (More broadly, out of the 26 economies we analyzed, 17 registered a positive CCFR in 2018, and almost all experienced an increase since 2012.[10]

Although informative, the CCFR does not speak directly about the maturity or liquidity characteristics of both assets and liabilities in USD. To take account of the fact that greater liquidity of assets relative to liabilities would strengthen banks' ability to confront shortages in USD funding, we construct a USD liquidity ratio (LR) and a stable funding ratio (SFR), both in the spirit of regulatory ratios introduced in the wake of the global financial crisis: the Liquidity Coverage Ratio and Net Stable Funding Ratio. The LR is defined as the ratio of high quality liquid assets (HQLA)—those considered to be easily sold even in a stress scenario and ideally elegible as collateral for central bank lending—to a measure of likely USD net cash outflows during a one-month stress scenario.[11] The SFR is defined as the ability of banks to secure funding of their USD assets for at least one year, that is, the ratio of USD deposits, long-term-securities, and long-term swaps to USD loans.[12]

There are signs that non-US banks are less vulnerable today to USD funding shocks than immediately before the crisis, although this vulnerability still appears to be greater than in other currencies. The median LR increased from just over 70 percent in 2010 to over 110 percent in 2018, with the bulk of the increase coming from larger holdings of HQLA, which accounted for 30 pps of the increase in the LR (**Figure 3, Panel 2**). Virtually all of the 14 economies for which the LR could be constructed showed increases between 2008 and 2018, with a few European economies and Japan registering small declines since 2016. However,

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[9] Throughout the paper we use the shorthand "home economies" and "recipient economies".

[10] Trends in non-US banks' USD funding have also been documented by Aldasoro and Ehlers (2018). Note that the BIS data of Japanese banks include trust accounts (see Saito, Hiyama, and Shiotani, 2018).

[11] High quality liquid assets in USD are defined as claims on the US official sector (based on BIS consolidated positions on ultimate risk basis less the call report line items related to official positions), and the net cash outflows are obtained by assuming a certain percentage of interbank assets and liabilities will mature within 30 days, and applying runoff factors to deposits and other short-term liabilities, broadly in line with Basel guidelines. Appendix 1 also shows the sensitivity to assumptions on the runoff factors, on the order of 15 pps for the median LR.

[12] Because of lack of detailed data, assumptions must be made regarding what percentage of swaps is long-term.

we also find that, on average and for most of the economies analyzed, the USD LR lies below a corresponding LR calculated across all currencies using the same methodology (**Figure 3, panel 3).** The SR, othe other hand, has remained virtually constant since 2010, with little movement among its components (**Figure 3, panel 4**).[13]

D. Measuring the Cost of USD Funding Through The Cross-Currency Basis

We use the cross-currency basis (CCB) to measure USD funding markets conditions. The CCB is defined as the difference between the cost of funding USD directly from the cash market and the synthetic cost of funding in another currency and swapping into USD. Following Du, Tepper, and Verdelhan (2018), the CCB it is defined as:

$$CCB_{t,t+n} = y^{\$}_{t,t+n} - \left(y_{t,t+n} - \rho_{t,t+n}\right) \quad (1)$$

where $y^{\$}_{t,t+n}$ is the direct cost of funding in USD at time *t* for a term *n* (the *n*-maturity interest rate in USD), $y_{t,t+n}$ is the interest rate in the domestic currency of a non-US bank, and $\rho_{t,t+n}$ is the forward premium, defined as the difference between the forward and spot exchange rates $\left(f_{t,t+n} - s_t\right)$.[14] The term in parentheses is the cost of synthetic dollar funding that banks may achieve by borrowing in their domestic currency, exchanging the proceeds into USD at the spot exchange rate, and simultaneously entering a currency forward contract to exchange USD back into domestic currency at maturity ($t + n$).[15] Thus, a positive (negative) value for the CCB implies that direct funding in USD is more (less) costly than synthetic USD funding. Throughout this paper, we refer to a “widening of the basis” as the CCB becoming more negative, that is, the synthetic cost becoming more expensive relative to the direct cost of USD funding.

We use the CCB as a measure of conditions in USD funding markets, as it reflects the marginal cost of funding and therefore tends to detect situations when USD liquidity is strained, especially for non-US banks. A negative CCB indicates that synthetic USD funding is more expensive than direct funding, so banks with limited and relatively expensive access

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[13] One note: due to data limitations and the resulting assumptions that must be made on the maturity of assets and on the maturity and runnability of liabilities, the LR should not be interpreted in the same manner as with the LCR, namely, that a level below 100 percent denotes insufficient liquidity. Caution should also be exercised in comparing the LR and SFR across countries. In our econometric analysis, we focus on the time dimension: the financial stability implications of historically high or low levels of the LR and SFR within each country.

[14] Both rates are expressed as domestic currency units per USD. In other words, an increase in *s* or *f* corresponds to a depreciation of the domestic currency relative to the USD.

[15] Defining both *y* and $y^{\$}$ as continuously compounded rates, equation (1) and the definition of the forward premium *r* are expressed in log terms.

to direct USD funding would tend rely on synthetic funding.[16] Thus, observing a widening CCB in the data is a clear signal of tighter funding conditions in USD relative to other currencies.[17]

We construct the CCB for the 21 currencies represented in our sample according to equation (1) and using the corresponding spot and 3-month forward and LIBOR rates obtained from Bloomberg.[18] As **panel 1** in **Figure 4** illustrates, the CCB was close to zero prior to the crisis, with deviations from zero relatively small and short-lived. This behavior is consistent with the so-called covered interest parity (CIP), whereby arbitrage would ensure that direct and synthetic costs of USD funding equalize and the forward premium fully compensates for the interest differential between two currencies: $\rho_{t,t+n} = y^{\$}_{t,t+n} - y_{t+n}$. However, during the crisis, the CCB spiked for most currencies—the median of our sample widened from close to zero to -100 basis points (bps), while the 25th percentile went from about -5 to -175 bps—as interbank markets became impaired and limited arbitrage activity arose to close the gap between direct and synthetic funding costs (Baba, Packer, and Nagano, 2008).

In the decade since the crisis, the CCB has failed to revert to its pre-crisis behavior. Although there is evidence that the post-crisis introduction of swap lines between the Federal Reserve and several central banks helped to alleviate the USD shortage and therefore contributed to a narrowing of the CCB (Goldberg, Kennedy, and Miu, 2011; McGuire and von Peter, 2012), the CCB was still well below zero as of early February 2018—with the median for our sample hovering around -40 to -50 bps—suggesting that CIP is being violated.

Several explanations have been offered. Du, Tepper, and Verdelhan (2018) show that CIP violation cannot be explained by increased credit risk or transaction costs, but is likely related to the combination of two factors. First, a persistent imbalance between investment opportunities and funding supply in USD, related to our CCFR measure, and second, post-crisis regulatory changes that have imposed constraints on financial intermediaries and thereby inhibited arbitrage that would have driven the basis to zero. Iida, Kimura, and Sudo

[16] There may also be demand for cross-currency swaps if the same funding risk is priced differently across markets. In this case, borrowers could reduce their overall financing costs by raising funds in the market in which they enjoy a comparative cost advantage and swapping the proceeds.

[17] This characterization is consistent with anecdotal evidence from market participants suggesting the existence of a pecking order of USD funding sources, going from retail deposits (if available) as the most attractive source to synthetic funding as the costliest. Furthermore, analysis of CRANE data on portfolios of USD money market mutual funds from January 2012 to December 2018 shows that direct and synthetic funding costs are correlated as well; a 10-basis point widening of the CCB is associated with an increase in wholesale funding costs by one basis point in the following month. Details of this analysis are provided in Appendix 2.

[18] The currencies are: Australian dollar, Brazilian real, Canadian dollar, Swiss franc, Danish krone, euro, British pound, Hong Kong dollar, Japanese yen, South Korean won, Indian rupee, Mexican peso, Malaysian ringgit, Norwegian krone, New Zealand dollar, Philippine peso, Russian ruble, Swedish krona, Thai baht, Turkish lira, and South African rand.

(2018) focus on several factors affecting the CCB: interest rate differentials between the U.S. and other economies, USD liquidity needs of non-US banks, the wealth of U.S. arbitrageurs, and credit risk of either the non-U.S. banks requiring funding or the U.S. arbitrageurs. They also estimate the effect of regulatory reform, which has increased the direct cost of USD funding from the money market and reduced the supply of USD in the FX swap market, as well as the effect of changes in the FX swap market structure, whereby banks have reduced their role while real money investors have increased theirs. Cerutti, Obstfeld, and Zhu (2014) explore macroeconomic determinants of the CCB, such as USD strength, global risk sentiment—as captured by the U.S. VIX—and liquidity in the FX market. Finally, Ivashina, Scharfstein, and Stein (2015) construct a model in which two critical factors come into play: borrowers' credit risk and the capital constraints on arbitrageurs. When borrowers' credit risk increases, non-US banks have an incentive to switch into synthetic USD funding, which may cause a capital shortage for arbitrageurs who supply the FX swaps, thereby leading to a widening of the CCB.[19]

III. THE DRIVERS OF CHANGES IN USD FUNDING COSTS

A. The Amplifying Role of the CCFR

Based on the main insights from the above literature, we study the drivers of USD funding costs in different currencies by estimating the following equation for the CCB that includes drivers $X_{i,t}$ on both the demand and supply side:

$$CCB_{i,t} = \alpha_i + \beta' X_{i,t} + \epsilon_{i,t} \quad (2a)$$

The model is estimated at the monthly frequency in the period January 2000 – March 2018. In addition, we test whether greater USD vulnerability amplifies the effects of these drivers, including interaction terms of the CCB drivers with CCFR:[20]

$$CCB_{i,t} = \alpha_0 + \beta' X_{i,t} + \theta' CCFR_{i,t} + \gamma' CCFR_{i,t} X_{i,t} + \epsilon_{i,t} \quad (2b)$$

Where i represents the currency, t is the month, α_i are the currency fixed effects, $X_{i,t}$ are the set of drivers, which includes the VIX, the LIBOR-OIS spread, the term spread differential between the US and currency i, the bid-ask spread for the spot exchange rate between currency i and the USD, the implied volatility in foreign exchange options for currency i, the average default probability of banks with home currency i, the broad USD index (DXY), and the CCFR. $\epsilon_{i,t}$ is the error term.

[19] See also Sushko et al (2016) for related analysis of the violation of CIP.

[20] In this analysis, the CCFR for the euro area is computed as the simple average of euro area countries with available CCFR data.

Among the drivers described, the VIX captures market volatility in the U.S., and the average expected default frequency over all listed banks in the home economy measures credit risk in the home economy.[21] An increase in the VIX is expected to increase the international supply of USD by arbitrageurs, thereby narrowing the CCB, whereas an increase in home economy credit risk would induce non-U.S. banks to increase their use of synthetic funding—as in Ivashina, Scharfstein, and Stein (2015)—thus widening the CCB . Likewise, an increase in the implied volatility of the home economy currency would increase the demand for USD funding, widening the spread.[22] The term spread differential, reflecting relative monetary conditions, is defined as the difference in term spreads between the home economy and the U.S., where the term spread is the difference between the 10-year and 3-month government bond yield in each economy. An increase in the term spread differential would tend to increase the attractiveness of home currency versus USD lending, thus reducing the demand for USD funding and narrowing the CCB. A strengthening of the USD would be expected to weaken the repayment capacity of unhedged USD borrowers outside the U.S., also reducing the attractiveness of USD lending and narrowing the CCB. The bid-ask spread in FX markets reflects transactions costs, which contribute to the widening of the CCB. The LIBOR-OIS spread is included as a measure of counterparty risk in the interbank market, limiting the international supply of USD and therefore also contributing to a widening of the CCB. In addition to these common drivers, the CCFR is included as a direct measure of demand for synthetic USD funding—expected to widen the CCB—and interacting with each of the drivers, to test whether it plays an amplifying role.[23]

As **Table 1** shows, the estimated relationships between the CCB and its various drivers have the expected sign. The baseline specification in Column 1 shows effects on the CCB that are in the expected direction and statistically significant. In particular, the CCFR is positively associated with a widening of the basis; as USD assets exceed USD liabilities, the demand for synthetic USD funding exerts pressure on the CCB. Columns (2)-(6) report the results for alternative CCB measures based on different tenors and/or benchmark rates, and corroborate the results in the baseline specification.

Table 2 also shows that CCFR amplifies the effects of the CCB drivers. According to the analysis, the impact of a given driver on the CCB is greater in banking systems where the gap between assets and liabilities in USD is greater. This is illustrated further by **Table 3** and **panel 2** in **Figure 4**, which compare the effect of each driver on the CCB depending on whether the CCFR is low (at the first quintile of the historical distribution for each economy) or high (at the fourth quintile). For some divers, such as the VIX or the LIBOR-OIS spread,

[21] The expected default frequency (EDF) is a measure of the probability that a bank will default over a given period. We take the EDF estimation for a one-year horizon from Moody's Analytics.

[22] We use the implied volatility from FX options.

[23] Note that we standardize all regressors with respect to the sample-wide distribution.

the amplification effect can be quite large. These results indicate that shocks to the various drivers of the CCB have an outsized effect on it when banking systems that are already relying relatively more on synthetic funding.

B. Robustness Checks

The previous estimation treated the CCFR as an exogenous driver of the CCB, whereas it is reasonable to think of reverse causality, whereby the cost of synthetic USD funding could affect the banks' decision on how large of a USD asset position they would be willing to hold in excess of the direct funding they obtain. Recognizing this possibility, we ran regressions in which the CCFR was lagged, with similar results. We also estimated an unrestricted panel VAR that treats all variables as jointly endogenous. The corresponding orthogonalized impulse response functions (IRFs) are reported in **Figure A.1**. Similarly, we run Granger causality tests on a panel VAR with two equations including only CCFR and CCB, and find that CCFR Granger causes CCB. Overall, the results corroborate the finding that the CCB responds to shocks to the CCFR.

C. Effects of Regulation

As several studies have pointed out the role of regulatory factors in the post-crisis violation of CIP, we used a variant of Equation (2) as a test of whether the relationship between the CCB and CCFR experienced discrete jumps coinciding with the introduction of major regulatory reforms

$$CCB_{i,t} = \alpha_0 + \beta X_{i,t} + \theta CCFR_{i,t} + \sum_{k=1}^{4} \lambda_r CCFR_{i,t} REG_{r,t} + \epsilon_{i,t} \tag{2c}$$

Where $REG_{r,t}$ refers to four separate dummy variables (indexed by r) that take the value one when t surrounds the date of one of the following regulatory reforms: stress-VaR (January – December 2013), supplementary leverage ratio (January – December 2014), liquidity coverage ratio (January – December 2015), and money market mutual fund (MMMF) reform (January – December 2016). **Table 4** shows the regression results for equation (2c), estimated for the CCB on one- and three-month tenor swaps involving the USD and each of the seven currencies affected by these reforms.[24] The introduction of the liquidity coverage ratio and the money market mutual fund reform appear to be associated with heightened sensitivity of the basis to the demand for synthetic USD funding, as proxied by the CCFR. In fact, the highest sensitivity arises in the period surrounding the MMMF reform in 2016, when funding drained out of prime institutional money market funds, who were important lenders in the wholesale dollar funding market. This led foreign banks to resort to using synthetic dollar funding, leading to a significant widening of the basis.

[24] The currencies included are the Australian dollar, British pound, Canadian dollar, euro, Japanese yen, Swedish krona, and Swiss franc.

IV. USD FUNDING COSTS AND HOME ECONOMY FINANCIAL STRESS

A. Baseline Regression

Our first exercise estimates a relationship between banking sector stability in the home economy and USD funding costs. The baseline specification is as follows:

$$\Delta Y_{i,t} = \alpha_i + \beta \Delta Cost_{i,t} + \gamma Controls_{i,t} + \epsilon_{i,t} \tag{3}$$

Where $Y_{i,t}$ is either the logarithm of the one-year ahead probability of default for all publicly listed banks in the home country (PD).[25] The parameter α_i is a fixed effect for economy i and $Cost_{i,t}$ is (minus) the CCB, for ease of interpretation: an increase in costs corresponds to a widening of the CCB. The vector of $Controls_{i,t}$ includes several macroeconomic variables, as in Avdjiev, Du, Koch, and Shin (2019): interest rate differentials between the home country and the U.S.; home economy inflation; the logarithm of the USD nominal effective exchange rate, the level and volatility of the logarithm of the VIX; and home economy real GDP growth. Home economy banking sector controls are also included, as in Samaniego-Medina and others (2016): ratios of capital, deposits, and net loans to assets, and the cost-to-income ratio. These as well as the macro controls expressed as moving averages from quarter t-4 to t-1.

Table 5 reports the results of the baseline regression, which show that β is positive statistically significant for both the probability of default (Column 1). Thus, increases in the USD funding costs are associated with greater financial stress in the home economy. Furthermore, there is evidence of nonlinearity for the PD, indicating that the association strengthens for larger increases in costs (Column 2). Finally the table shows that during two periods, the global financial crisis (2007-09) and the European debt crisis (2011-12) stand out as having a particularly strong relationship between USD funding costs and home economy financial stress (Column 3), thus suggesting that the relationship is nonlinear, arising primarily when changes in funding costs are particularly sizable.[26]

The previous regressions could be subject to reverse causality, whereby home economy financial stress is expected to exert an upward pressure on the cross-currency basis, due to

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[25] Banking sector probability of default is constructed by the Risk Management Institute using a forward intensity function whose inputs include the state of the economy (four macro-financial risk factors) and the vulnerability of individual banks (twelve bank-specific attributes). For each economy, a quarterly average across listed banks is obtained as the probability of default measure. It includes dead banks, which helps to reduce survivorship bias. Alternatively, bank CDS spreads could be used to measure home economy financial stress, but this would cut the sample of economies by half.

[26] We also conducted the analysis of financial stress using the Financial Conditions Index (FCI) of the home country as the dependent variable, with similar, albeit somewhat weaker results than obtained for the PD. For methodology and variables included in the FCI, refer to Annex 3.2 of the October 2017 Global Financial Stability Report.

increased difficulties or cost of banks in obtaining direct USD financing. To address this concern, we undertake a two-stage least-squares regression in which we use US monetary policy shocks as an instrument for the CCB. In the first stage, we generate the fitted values of CCB changes explained by monetary policy shocks. In the second stage, these fittted values are included as an explanatory variable in our benchmark model for home country financial stress. Two different definitions of policy shocks are tested, following Nakamura and Steinsson (2018): a Federal Funds rates shock and policy news shocks. As the results from the second stage regression in **Table 6** show, the main positive relationship between the instrumented basis and the measures of home economy financial stress remains statistically significant.

B. Amplifying Effect of Home Economy Funding Conditions

We use a variant of equation (3) to test whether conditions in the home country, including funding vulnerability, can serve to amplify the relationship between USD funding costs and financial stress. We include an indicator for these conditions, *AMP*, and interact it with funding costs. The USD asset share as well as the three vulnerability measures are used: the CCFR, the LR, and SFR, all of which are expressed as quintiles of their within-country distribution, and enter the regression as their lagged average between quarters *t-4* and *t-1*. Thus, if funding conditions amplify the effect of funding costs, we should have $\beta_2 > 0$. Additionally, we also tested whether β_2 is different when banks are likely to have a positive net demand for synthetic funding, as reflected in a positive CCFR, by adding another interaction term:

$$\Delta Y_{i,t} = \alpha_i + \beta_1 \Delta Cost_{i,t} + \beta_2 AMP_{i,t} \Delta Cost_{i,t} + \beta_3 AMP_{i,t} + \gamma Controls_{i,t} + \epsilon_{i,t} \quad (4)$$

Table 7 shows evidence of an amplification effect of the size of USD activity and, in particular, USD funding fragility. The CCFR amplifies the relationship between USD funding costs and the probability of default, as one would expect, only when the funding gap is positive (**Table 7, Column 3**). Other vulnerability indicators play a role as well as amplifiers; when global banks are experiencing low liquidity in USD or with less access to stable funding, the transmission of an increase in USD funding to the banking system probability of default in their home economy is likely to be strengthened (**Table 7, Columns 4 and 5**).

As an illustration of the size of the amplification effect, for an economy with a "low" CCFR,[27] a 50 basis-point increase in the CCB—similar to the average quarterly increase observed during the global financial crisis—has a negligible effect on the probability of default. In contrast, the increase is statistically significant when the CCFR is "high" and is

[27]"Throughout the paper, "low" refers to the first quintile of the distribution, while "high" refers to the fourth quintile.

equal to 0.41 standard deviations, or a 14 percent increase.[28] Given that the average quarterly increase for the probability of default at the height of the crisis was 34 percent, this amplification effect could account for about two-fifths of the increase in financial stress. Similarily, the amplification effects are not economically significant when either LR or SFR are high—at the fourth quintile of their economy's historical distribution—but rise to 0.3 – 0.4 standard deviations when either ratio is low.

The key results reported in **Table 7** are based on a difference-in-difference identification strategy, where we compare the relationship between changes in the cost of USD funding and financial stress across periods and countries with different degrees of USD funding vulnerability. Thus, they should be less affected by the potential reverse causality between USD funding costs and economy-specific financial stress. Nonetheless, to further ease concerns, we also estimate the regressions in the subsample of Euro area countries, which share a currency—and therefore a basis—but differ in their measures of financial stress and levels of USD funding vulnerability. Although the sample shrinks substantially, to eight economies, the results of **Table 7** continue to hold: an increase in the basis is associated with increased financial stress in the home economy. The results still hold when we restricted the sample further, by excluding the two largest Euro area countries—Germany and France—who may exert a large influence on the measures of financial stress in the area (**Table A.2**).

C. Amplifying of Mitigating Effects of Other Factors

Analogously to our analysis of USD funding vulnerability, we test whether other conditions or policies not directly related to USD activities also could affect the relationship between USD funding costs and home economy financial stress, by introducing these variables into equation (4) as *AMP*.

The introduction of swap lines between the US Federal Reserve and other central banks became prominent during the global financial crisis, starting with the European Central Bank and the Swiss National Bank in December 2007. The number of central banks engaging in temporary USD 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.

The results in **Table 8** show that these swap lines appear to have played a mitigating role in the international transmission of shocks to USD funding costs. Whenever they were

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[28] This result is obtained as follows: the 20th and 80th percentiles of positive CCFRs are 0.18 and 0.83 respectively. Using the Table 7, Column (3) coefficients of the cross-currency basis (-0.066) and of its interaction with CCFR (0.401), one obtains the impact of a one-standard deviation increase in the cross-currency basis (32.49) on home country financial stress: 0.0065 = -0.066 + 0.401x0.18 for the 20th percentile of CCFR, and 0.267 = -0.066 + 0.401x0.83 for the 80th percentile. Multiplying by 50/32.49 yields the impact of a 50 bp increase in the cross-currency basis, equal to 0.01 for the 20th percentile, and 0.41 for the 80th percentile. Since the impact is measured as a multiple of the standard deviation of the probability of default (0.337), it translates into an increase of 0.41x0.337=13.8 percent.

announced in a given economy, the relationship between USD funding costs and home economy financial stress is weak and statistically insignificant (Columns 1 and 3). The same is true for when the swap line was in effect (Columns 2 and 4).

Stronger home economy banking sector fundamentals could be more resilient to shocks to USD funding costs. **Table 9** shows supporting evidence; when bank capital buffers are larger (higher capital-asset ratio), profitability (return on assets) is greater, and/or liquidity (cash-asset ratio) is greater, the relationship between USD funding costs and home economy financial stress weakens, both in terms of default probability and financial conditions. The magnitude of these effects is also economically significant. A 50 basis-point increase in USD funding costs is associated with a 0.40 standard deviation (14 peps) increase in the probability of default when the capital ratio of the banking system is low by historical standards. However, the increase is only 0.25 standard deviations (8 peps) when the capital ratio is high.

International reserve holdings by the home economy central bank may play a similar mitigating role to that of the swap line arrangements, by signaling the potential availability of USD during times of market stress. We explore the role of international reserves by testing for whether they counteract the amplification effect exerted by USD funding vulnerability, using the following specification:

$$\Delta Y_{i,t} = \alpha_i + \beta_1 \Delta Cost_{i,t} + \beta_{21} AMP_{i,t} \Delta Cost_{i,t} + \beta_{22} AMP_{i,t} RES_{i,t} \Delta Cost_{i,t} + \beta_3 AMP_{i,t} + \\ + \beta_4 RES_{i,t} + \gamma Controls_{i,t} + \epsilon_{i,t} \quad (5)$$

If US international reserve holdings do play this mitigating role, then we would expect $\beta_{21} > 0$ and $\beta_{22} < 0$. **Table 10** shows that this is the case; lower liquidity and stable funding both amplify the relationship between USD funding and financial stress, while greater reserve holdings weaken this amplification.

Regarding further robustness checks, note that the results reported for this section include home economy fixed effects along with time-varying and macro and banking sector variables to control for economy-specific trends. However, we also ran a separate set of regressions which included time fixed effects to control for global trends. The key result continues to hold: conditional on USD funding fragility, tightening of USD funding conditions will be transmitted to financial stress in the home economy of non-US global banks.

V. USD FUNDING COSTS AND RECIPIENT ECONOMY FINANCIAL STRESS

Global non-US banks facing difficulties in obtaining USD funding and experiencing financial stress may react by cutting back on their USD claims. This reaction may transmit financial stress to those countries that receive the USD funding from them, the recipient economies. This section uses loan level data to test for the presence of these spillovers.

A. USD Funding Costs and USD Claims

Our first exercise consists of examining the direct effect: how tightness in USD funding could lead to cutbacks in USD lending. The baseline specification is:

$$\log\left(L_{i,j,t+1,t+4}^{USD}\right) \times 100 = \alpha_{j,t} + \rho_{i,j} + \beta\Delta_4 Cost_{i,t} + \gamma Controls_{i,t} + \epsilon_{i,j,t+4} \quad (6)$$

Where $L_{i,j,t+1,t+4}^{USD}$ is the stock of USD claims, or lending[29] from home economy i to recipient country j, averaged over quarters $t+1$ to $t+4$,[30] $\alpha_{j,t}$ is a fixed effect that picks up the trend in credit growth in the recipient economy, $\rho_{i,j}$ is a fixed effect capturing average cross-border USD credit from i to j, and $\Delta_4 Cost_{i,t}$ is the one-year cumulative change in USD funding costs (the negative of the CCB).[31] The home economy vector of *Controls* includes macroeconomic variables (domestic credit growth to GDP, real GDP growth rate, and the log of the nominal exchange rate) and banking sector ratios (log of total banking sector assets, the equity asset-ratio, cash-asset ratio, and ROA). The main test is for $\beta < 0$, which would indicate that an increase in USD funding costs is associated with a cutback in USD lending across all recipients.

Table 11 shows the results obtained for this baseline regression, which confirm that increases in USD funding costs are followed by a significant cutback in USD lending (Column 1). A 50 bps increase in USD funding costs in associated with a 5 percent decline in USD lending. We also test for whether this effect differs for EMs, either as home (lending) or recipient (borrowing) economies. We find that indeed, the estimated cutbacks in USD lending are stronger if the home economy is an EM (Column 2) or the recipient economy is an EM (Column 3). We also find evidence of two types nonlinearities in the relationship: (i) allowing for a quadratic term in the USD funding cost variable (Column 4), and (ii) interacting with the initial level of USD funding costs (Column 5). Columns 6 and 7 use Seemingly Unrelated Regression Estimator methods for the baseline specification and for EM recipients, respectively, with similar results to those from fixed-effects regressions in Colunms 1 and 3.

B. Degree of Substitutability of USD Lending

Recipient economies—and EMs in particular—that experience a cutback in lending from global non-US banks that, in turn, face an increase in funding costs might be able to

[29] USD claims include both cross-border as well as local position USD flows, for example, USD lending by a Japanese bank's subsidiary in Thailand to Thai corporates. Claims include loans, debt securities, and others, and we refer to these collectively as "lending".

[30] In the regressions the log is multiplied by 100, to express it in percentage points.

[31] Since the regressions include recipient economy time fixed effects, these reductions can be interpreted as being deviations from the recipient economy-specific trend.

substitute this lost funding, either through additional USD loans from other countries and/or currencies, or through additional USD financing from the domestic financial system. If this were the case, the aggregate consequences of spillovers to recipient countries could be significantly mitigated. To test for this possibility, we estimate the parameters of the following equation:

$$\log\left(L^{USD}_{-i,j,t+1,t+4}\right) \times 100 = \alpha_{j,t} + \rho_{i,j} + \beta_1 \Delta_4 Cost_{i,t} + \beta_2 \sum_{-i} S_{-i,j,t} \Delta_4 Cost_{-i,t} + \\ + \gamma Controls_{i,t} + \epsilon_{i.t} \quad (7)$$

Where $L^{USD}_{-i,j,t+1,t+4}$ is the average amount of USD claims to recipent economy j coming from all global non-US banks except those from economy i, denoted by the symbol $-i$.[32] The summation term captures the (weighted) increase in USD funding costs to the non-i home economies, with $S_{-i,j,t}$ the share of economy j's borrowing coming from each (non-i) lender.

The coefficient β_1 captures the relationship between USD lending from non-i economies and increases in the cost of funding in country i, capturing the degree of substitution or complementarity in USD lending. To measure the degree of substitution, we combine the results of equations (6) and (7) into a sustitution coefficient $\theta = -(\beta_1/\beta) \times 25$ that captures whether the total increase in lending from non-i economies (β_1 times 25, the number of non-i economies) compensates for the decline in lending from economy i, given by β.[33] If θ=1, then there is full substitution; an increase by all other 25 lenders fully offsets the cutback by i. For values of less than one, there is partial substitution only, and a value of zero would indicate no substitution at all.

We use two variants of equation (7) to test for broader substitutability from cross-border to domestic USD loans, and from USD to other currencies:

$$\frac{\Delta L^{USDALL}_{j,t+4}}{L^{USDALL}_{j,t}} = \alpha_j + \beta_1 \sum_i S_{i,j,t} \Delta_4 Cost_{i,t} + \gamma Controls_{i,t} + \epsilon_{i.t} \quad (7a)$$

$$\frac{\Delta L^{Cross}_{j,t+4}}{L^{Cross}_{j,t}} = \alpha_j + \beta_1 \sum_i S_{i,j,t} \Delta_4 Cost_{i,t} + \gamma Controls_{i,t} + \epsilon_{i.t} \quad (7b)$$

Equation (7a) allows us to estimate how growth in total USD borrowing by economy j ($L^{USDALL}_{j,t}$), including from both cross-border and domestic sources, responds to an increase in USD funding costs across all of j's lenders. On the other hand, equation (7b) explores how total cross-border loans to j in *all currencies* ($L^{Cross}_{j,t}$) respond to increases in USD funding

[32] In this section, the home economies of global non-US banks are also referred to as cross-border "lenders", while the recipient economies of these cross-border USD loans are also referred to as "borrowers".

[33] Note that we multiply the ratio by 25 since there are 26 lending countries in the sample and β_1 estimates the reaction by one representative lending country.

costs for all lenders. In both cases, if $\beta_1 < 0$ then there is imperfect substitution, and if $\beta_1 = 0$ there is perfect substitution, as total borrowing is unaffected by increases in USD funding costs.

In both cases, we constructed a similar substitution index by regression on different dependent variables. In the case of equation (7a), running the regression for USD loans only, and then for domestic USD loans only, would yield two separate estimates for β_1: β_1^{USDCB} and β_1^{USDDOM}. The substitution index is then defined as $= -\frac{\beta_1^{USDDOM}}{\beta_1^{USDCB}}$, indicating the degree to which domestic USD loans compensate for a loss in cross-border USD loans. For equation (7b) regressions we also a ran a regression for cross-border loans in non-USD currencies, yielding the estimated coefficient: $\beta_1^{NON-USDCB}$. The substitution index is equal to $\theta = -\frac{\beta_1^{NON-USDCB}}{\beta_1^{USDCB}}$, measuring the degree to which cross-border borrowing in other currencies compensates for a cutback in USD cross-border loans.

The results for equation (7) and its variants, reported in **Table 12**, show that there are possibilities for substituting some of the lost cross-border USD financing. The estimate for β_1 is positive and significant for USD cross-border lending (Column 1). If a lender cuts back USD loans to a recipient because of an increase in USD funding costs, the recipient can make up for part of this decline by borrowing more in USD from other lenders. However, the estimated coefficients indicate that this substitution is only partial, reaching about half of the lost financing.[34] Likewise, when USD funding costs increase for all cross-border lenders, the recipent cannot fully make up the loss by borrowing more in USD domestically. Column (3) shows that total USD lending from both cross-border lenders and domestic lenders is reduced by 2.8 percent after a broad based funding shock. However, when limiting the analysis to the EM sample of recipient economies, we see that substitution possibilities are more limited, with an estimated degree of substitution across USD cross-border lenders θ of only 46.6 percent (from Column 2).[35]

The ability of recipients to subsitute across currencies is noticeably greater, but primarily for AEs. The estimate for β_1 is negative but not significant for substitution across currencies (Column 5), meaning that when USD funding costs lead USD cross-border lending to fall, cross-border lending in other currencies appears to react to fully compensate the loss in USD cross-border lending, whereas this compensation does not occur for EM borrowers (Column 6).

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[34] To compute the number, $\theta = -\frac{\beta_1 \times 25}{\beta} = -\frac{0.113 \times 25}{5.31} \approx 51.8\%$.

[35] Likewise, $\theta = -\frac{\beta_1 \times 25}{\beta} = -\frac{(0.132 - 0.033) \times 25}{5.31} \approx 46.6\%$.

C. Amplifying Effect of Home Economy Funding Vulnerability

Having presented evidence that increases in USD funding costs lead to a net reduction in USD lending, we explore whether USD funding vulnerability in the home economy magnifies this relationship. To this end, we expand equation (6) to include interactions between USD funding costs and our alternative measures of USD funding vulnerability, *AMP*, the (within-country quintiles of) CCFR, LR, SFR, and the ratio of USD HQLA to USD assets:

$$\log\left(L^{USD}_{i,j,t+1,t+4}\right) = \alpha_{j,t} + \rho_{i,j} + \beta_1 \Delta_4 Cost_{i,t} + \beta_2 \Delta_4 Cost_{i,t} AMP_{i,t} + \beta_3 AMP_{i,t} + \\ + \gamma Controls_{i,t} + \epsilon_{i,j,t} \qquad (8)$$

As shown in **Table 13**, Columns 1-3, we find all three measures of vulnerability to amplify the cutback in USD lending associated with an increase in USD funding costs in the home economy. The magnitudes are also important; for example, the financing cutback from a 50 basis-point increase in USD funding costs is statistically insignificant when the CCFR is low (first quintile), but increases to 5.82 percent (and statistically significant) if the CCFR is high (fourth quintile).

D. Amplifying or Mitigating Effects of Other Factors

By mitigating financial stress in the home economy, bank fundamentals, swap lines, and international reserves, could also mitigate the consequences of USD funding cost increases for cross-border lending. The regressions reported in **Table 14** explore this possibility. Regressions in columns 1 and 2 focus on bank fundamentals, while Column 3 includes the existence of swap line agreements between the home economy central bank and the US Federal Reserve, and Column 4 analyzes the role of reserve holdings by the home economy central bank. In addition, Columns 5-8 control for USD funding vulnerability by including CCFR and its interaction with the shock in USD funding cost. The results in the last 4 columns address whether these economy-specific characteristics mitigate the adverse impact trasnmitted through USD funding fragility. We find all to be effective mitigators in the transmission from USD funding costs to lending. For example, following a 50 basis-point increase in USD funding costs, a high liquidity banking sector would not cut back its USD lending, but a low liquidity one it will do so by about 3 percent. Global non-US banks from a home economy with a swap line arrangement with the US federal reserve are not likely to cut back their USD lending, whereas those lacking such arrangements are estimated to do so by 5.6 percent on average. Finally, the estimated cutback is mitigated by 2.9 percentage points if domestical central bank's holdings of international reserves is higher by 10 percentage points of GDP.

E. USD Funding Costs and Recipient Economy Financial Stress

Since the domestic financial system is often a large recipient of USD lending—consistent with the result above on the amplification effect of recipient economy banking sector risk—

these cutbacks in financing could have repercussions on financial stress indicators in the recipient economy. To test for this possibility, we link increases in USD funding costs for global non-US banks to the measures of financial stress in recipent economies using an empirical specification that relates these measures to the weighted average of the changes in USD funding costs over lending economies:

$$\Delta Y_{j,t} = \alpha_i + \beta \sum_i S_{i,j,t} \Delta Cost_{i,t} + \gamma \sum_i S_{i,j,t} Controls_{i,t} + \epsilon_{i,t} \quad (9)$$

where $Y_{j,t}$ is the recipient country PD or FCI, and, as before, $S_{i,j,t}$ denotes the share of lending economy *i* in the USD lending received by economy *j* in quarter *t*. The results in **Table 15** show that there is indeed an adverse effect of USD funding costs on recipient economy financial stress, be it the banking probability of default or financial conditions. Furthermore, we find this effect to be concentrated in the top ten recipients of USD cross-border lending.

VI. Conclusion

This paper has produced a novel set of indicators of USD funding vulnerability for 26 banking systems that are home to global non-US banks to document some key stylized facts on the trends followed by USD operations of these banks. USD operations of global non-US banks have been increasing steadily post-crisis, including operations that are cross-border, in branches outside the U.S., and in branches and subsidiaries in the U.S.. For some economies, these operations are also increasing as a share of their domestic banking system's assets. Furthermore, for many economies, the gap between USD assets and liabilities (CCFR) has widened since the GFC, and, while both USD liquidity and stable funding ratios have been improving, there are many economies in which these fall well below the levels calculated across all currencies. Post-crisis, the cross-currency basis (CCB), a measure of the marginal cost of USD funding, has not reverted to its low pre-crisis levels due to pressure on the demand and supply side—the latter of which include global regulatory changes. The CCFR acts as an amplifier of several these market pressures.

For economies that are home to the global non-US banks, our results show that increases in USD funding costs produce stress in the domestic financial system, an effect which is amplified with a larger CCFR and mitigated when USD liquidity or stable funding is more robust, and when domestic banking system health is stronger. Furthermore, the evidence indicates that increases in USD funding costs are also associated with negative spillovers to recipients of cross-border lending by the non-US banks. EM borrowing countries are particularly susceptible to these spillovers, as they have limited ability to substitute into either other sources of USD financing or into other currencies. The analysis also suggests that swap line arrangements between central banks, and the holding of international reserves by home economy central banks, can mitigate some of the above adverse effects of increases in USD funding costs.

These results are consistent with the segmentation of liquidity in different currencies during periods of financial stress, even for currencies with the deepest and most liquid spot and derivatives markets. Global non-US banks experience financial stress and cut back USD lending when USD funding costs suddenly rise because they cannot smoothly convert liquidity in their own currency, for which they have easier and cheaper access, into USD liquidity. This phenomenon is probably stronger for the home economies of less liquid currencies, which is backed up by our findings of transmission of financial stress through cross-border lending.

These findings have important consequences for our thinking about the functioning of the global banking system. Current liquidity regulation for global banks, as reflected for instance on the LCR, that pools together liquid assets and liabilities in different currencies implicitly assumes that liquidity can be easily transformed across currencies when necessary. Our results show that this might not always be the case and that it is important to have adequate access to liquidity in the key currencies in which a bank operates.

From a policy perspective, our results suggest that regulators should monitor the USD 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 USD liquidity conditions.

The analysis points to the benefits of access to USD liquidity during periods of stress, both for the economies that are home to banks that intermediate USD 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 USD 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.

The broad country coverage of this paper comes at the cost of conducting the analysis at a banking sector level. Testing for the relevance of the mechanism documented here at a granular, bank level is an important area of further research.

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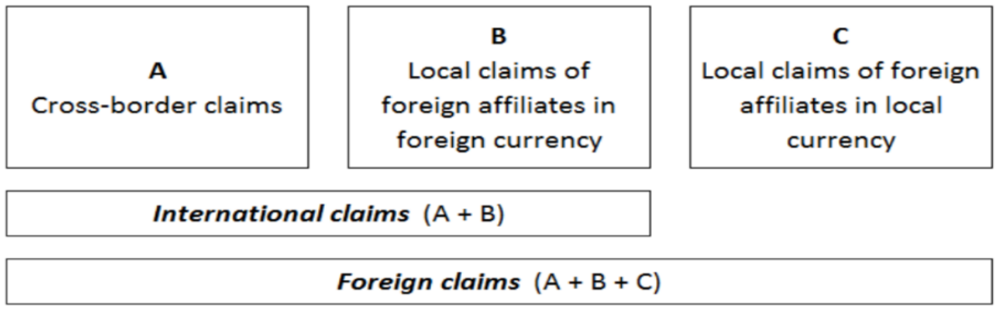
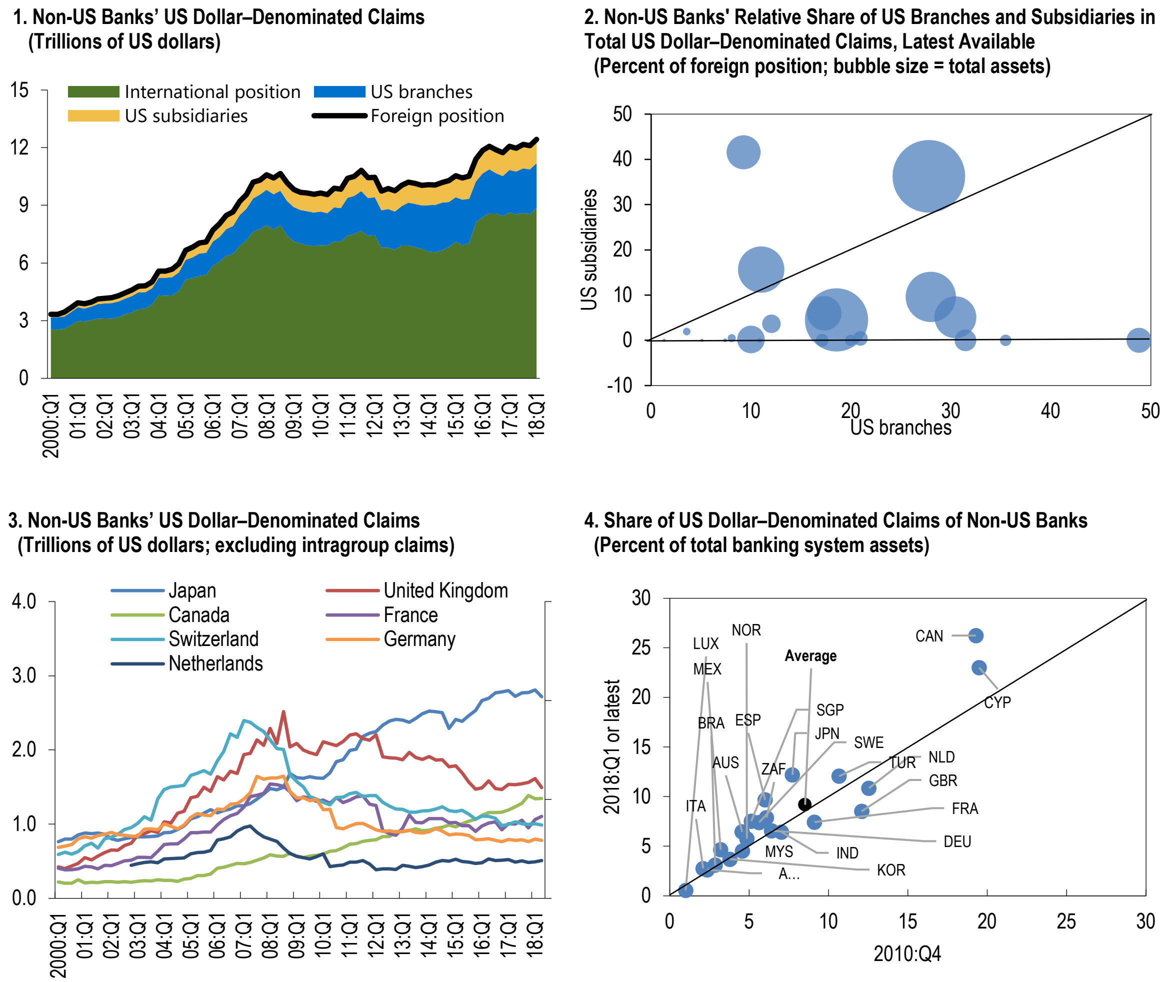
FIGURES

Figure 1. International Position vs. Foreign Position



Source: Cerutti, Claessens, and McGuire (2012).
Notes: In our analysis A corresponds to U.S. dollar cross-border claims; B refers to U.S. dollar local positions outside the U.S. (hence U.S. dollar is the foreign currency of the jurisdiction); C refers to the local positions in the U.S (i.e. non-U.S. banks' branches and subsidiaries in the U.S.) - due to data limitations, this component, (C) is sourced from FFIEC002 filings for non-US banks' U.S. branches and from call reports (i.e. FFIEC 031/041) for non-US banks' U.S. subsidiaries when the balance sheets are constructed.

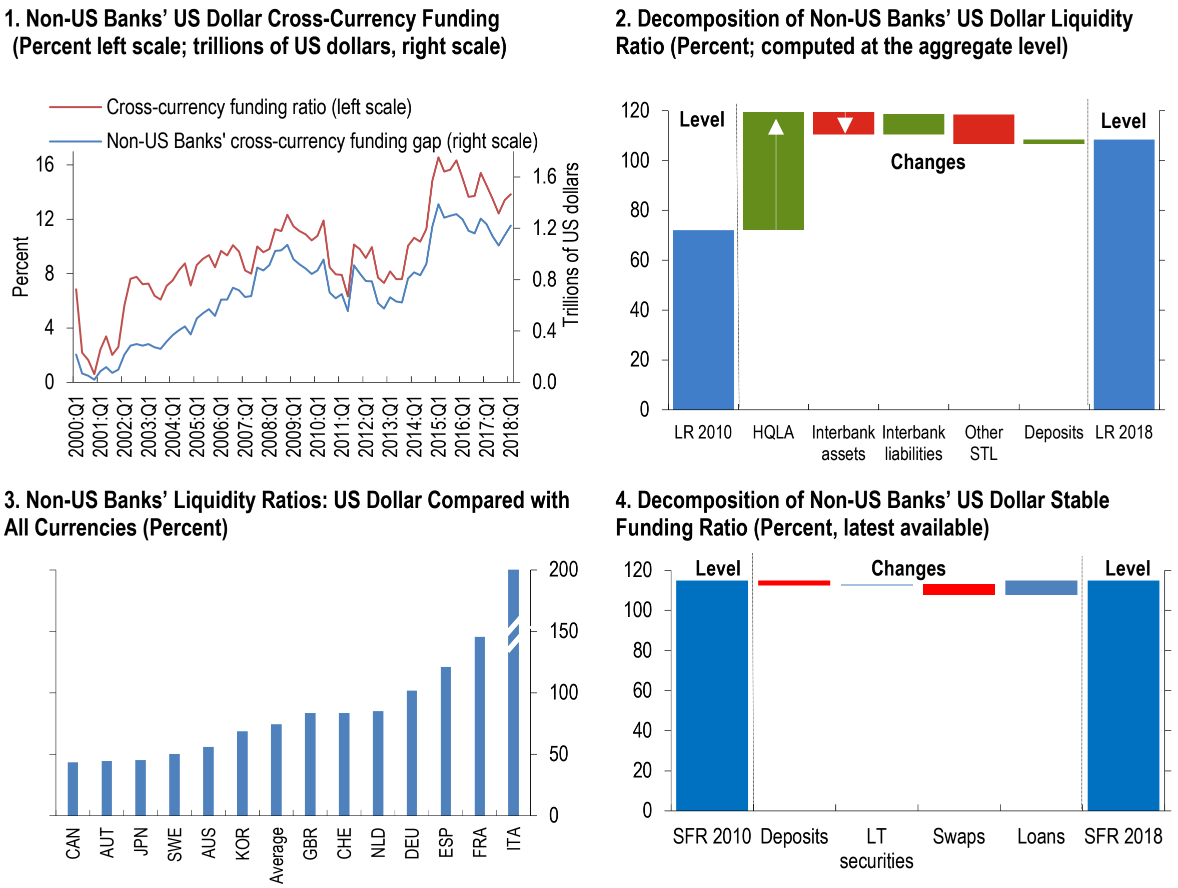
Figure 2. Trends in US Dollar Activities of Non-US Banks



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

Notes: Foreign position consists of international position as defined by the Bank for International Settlements plus the positions in US branches and subsidiaries. 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). In panel 1, some economies enter the sample after 2000. For example, China and Russia enter in 2015 and therefore account for a discrete jump in the series. Diagonal lines in panels 2 and 4 are 45-degree lines. Data labels in panel 4 use International Organization for Standardization (ISO) country codes.

Figure 3. US Dollar Funding Fragility of Non-US Banks

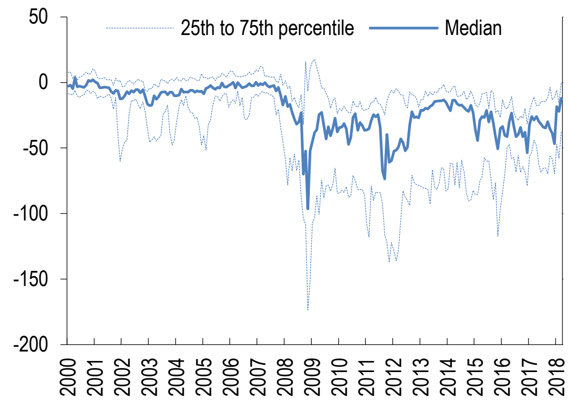


Sources: Bank for International Settlements, locational banking statistics (nationality basis); Federal Financial Institutions Examination Council; S&P Global, Market Intelligence; and IMF staff calculations.

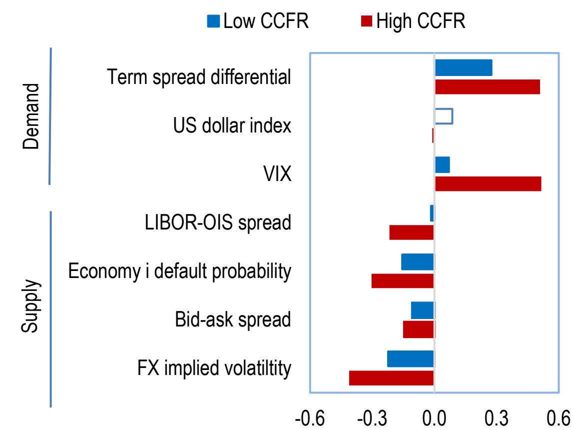
Notes: All panels correspond to the international position plus US branches of the non-US banks. Latest available calculations were as of 2018:Q1 at the time the analysis was conducted. Panel 1 shows the difference between US dollar assets and liabilities (both in trillions of dollars and as a percentage of US dollar assets) for a balanced sample of 13 economies. Panels 2 through 4 are based on a set of 14 economies that permit the calculation of the liquidity and stable funding ratios. Panels 2 and 4 are computed using the sample-wide aggregate values; the changes are in percentage points.

Figure 4. Interaction Effects of the Cross-Currency Funding Ratio and Drivers of the Cross-Currency Basis

1. Three-Month Cross-Currency Basis (CCB)
(Basis points, monthly average)



2. Interaction Effects of the Cross-Currency Funding Ratio and Drivers of the Cross-Currency Basis
(Standardized coefficients)



Source: IMF staff calculations.

Notes: 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 "low" ("high") level of CCFR, i.e. when CCFR is at the 25th (75th percentile) CCFR. The sample period is from 1/1/2000 to 03/01/2018. Panel 2 sample: AUD, CAD, CHF, EUR, GBP, HKD, JPY, MYR, SEK. Colored bars denote significance levels at 10 percent or lower.

TABLES

Table 1. The Drivers of the Cross-Currency Basis (CCB)

	Baseline	Robustness				
VARIABLES	3m CCB (LIBOR)	1m CCB (LIBOR)	1y CCB (LIBOR)	1m CCB (OIS)	3m CCB (OIS)	1y CCB (OIS)
	(1)	(2)	(3)	(4)	(5)	(6)
Cross-Currency Funding Ratio (CCFR)	-0.096***	-0.252***	0.015	-0.307***	-0.126***	0.017
LIBOR-OIS spread	-0.131***	-0.149***	-0.058***	-0.046	0.036	-0.034***
Term spread differential	0.195***	0.196***	0.014***	0.257***	0.246***	0.019***
Bid-ask spread	-0.100***	-0.195***	-0.004	-0.251***	-0.151***	-0.033
FX implied volatility	-0.169***	-0.098***	-0.062***	-0.120***	-0.161***	-0.069***
Economy i default probability	-0.080*	-0.064	-0.073***	0.031	-0.010	-0.055***
US dollar index	-0.028**	-0.050***	-0.009**	-0.030*	-0.025*	-0.050***
VIX	0.100***	0.102***	0.029***	0.047*	-0.018	-0.037***
Constant	-0.150***	-0.124***	-0.074***	-0.119***	-0.145***	-0.135***
Observations	1,776	1,621	1,418	1,557	1,717	1,377
R-squared	0.882	0.857	0.633	0.832	0.828	0.506
Currency FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the association of the cross-currency basis (CBB) and its main drivers, which include: the VIX, US dollar index, home country default probability, FX implied volatility, Bid-Ask spread, Term-Spread differential, Libor-OIS spread, and cross-currency funding gap ratio (CCFR). The term spread differential is defined as the difference between the term spread in the home country and the term spread in US, where the term spread is calculated as the difference between the 10-year and 3-month government bond yield. Home country default probability is measured with the expected-default frequency over 1-year time. Column (1) shows the estimates for the baseline model using the 3-month CCB based on LIBOR rates. As a robustness check, columns (2)-(3) show the results for alternative tenors of the basis, and Columns (4)-(6) show the results using overnight index swap rates rather than the LIBOR to construct the basis. The coefficients are standardized to depict the impact of a one standard deviation increase in the level of the drivers on the cross-currency basis. Robust standard errors are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2. Interaction Effects of the Cross-Currency Funding Ratio (CCFR) and the Drivers of CCB

	Baseline	Robustness				
VARIABLES	3m CCB (LIBOR)	1m CCB (LIBOR)	1y CCB (LIBOR)	1m CCB (OIS)	3m CCB (OIS)	1y CCB (OIS)
	(1)	(2)	(3)	(4)	(5)	(6)
LIBOR-OIS spread x CCFR	-0.124***	-0.072*	-0.056***	-0.090*	-0.120***	-0.065***
Term spread differential x CCFR	0.174***	0.252***	-0.005	0.280***	0.212***	0.021***
Bid-ask spread x CCFR	-0.040**	-0.105*	0.021**	-0.027	-0.025	-0.008
FX implied volatility x CCFR	-0.137***	-0.045	-0.146***	-0.002	-0.095**	-0.179***
Economy i default probability x CCFR	-0.098*	-0.134	-0.070***	-0.005	0.022	-0.003
US dollar index x CCFR	-0.213*	-0.256	-0.318***	-0.159	-0.279*	-0.327***
VIX x CCFR	0.308***	0.284***	0.107***	0.217***	0.288***	0.164***
Observations	1,820	1,827	1,813	1,599	1,763	1,400
R-squared	0.888	0.866	0.626	0.845	0.844	0.540
CCB Controls	Yes	Yes	Yes	Yes	Yes	Yes
Currency FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the amplification effects of the cross-currency funding ratio (CCFR) on the drivers of the cross-currency basis, which include the VIX, US dollar index, home country default probability, FX implied volatility, Bid-Ask spread, Term-Spread differential, and Libor-OIS spread. The term spread differential is defined as the difference between the term spread in the home country and the term spread in US, and the term spread is calculated as the difference between the 10-year and 3-month government bond yield. Home country default probability is measured with the expected-default frequency over 1-year time. Colum (1) shows the estimates of the interaction terms for the baseline model using the 3-month CCB based on LIBOR rates. As a robustness check, columns (2)-(3) show the results for alternative tenors of the basis, and Columns (4)-(6) the results using overnight index swap rates rather than the LIBOR to construct the basis. Estimates of the coefficients of the levels of the variables are not shown. The coefficients are standardized to depict the impact of a one standard deviation increase in the level of the interaction terms on the cross-currency basis. Robust standard errors are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Comparison of the Effects of CCB Drivers for Low and High Values of CCFR

VARIABLES	Low CCFR	High CCFR
Term spread differential	0.275	0.510
US dollar index	0.086	-0.010
VIX	0.069	0.515
LIBOR-OIS spread	-0.016	-0.217
Economy i default probability	-0.156	-0.303
Bid-ask spread	-0.106	-0.145
FX implied volatility	-0.224	-0.411

Table 4. Changes in the Relationship Between the Cross-Currency Funding Ratio and the Basis with Introduction of Financial Regulations

	Baseline	Robustness				
VARIABLES	3m CCB (LIBOR)	1m CCB (LIBOR)	1y CCB (LIBOR)	1m CCB (OIS)	3m CCB (OIS)	1y CCB (OIS)
	(1)	(2)	(3)	(4)	(5)	(6)
CCFR (Pre-reform)	-0.059***	-0.070***	-0.138***	-0.070***	-0.060***	-0.152***
CCFR x 1{Stress VaR}	0.027***	0.025***	0.032***	0.025***	0.029***	0.044***
CCFR x 1{Supplementary leverage ratio}	0.008	0.008	0.021***	0.009	0.010	0.030***
CCFR x 1{Liquidity coverage ratio}	-0.029***	-0.033***	-0.023***	-0.034***	-0.031***	-0.030***
CCFR x 1{MMMF reform}	-0.042***	-0.051***	-0.034***	-0.051***	-0.044***	-0.045***
Observations	420	420	420	420	420	420
R-squared	0.610	0.610	0.763	0.737	0.791	0.734
Reform Dates Controls	Yes	Yes	Yes	Yes	Yes	Yes
CCB Controls	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the changes in the CCFR surrounding the dates of 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). Pre-Reform period corresponds to 2012. The model is estimated at monthly frequency, and controls for the set of CCB drivers, which include the VIX, US dollar index, home country default probability, FX implied volatility, Bid-Ask spread, Term-Spread differential, Libor-OIS spread and cross-currency funding ratio (CCFR). The term spread differential is defined as the difference between the term spread in the home country and the term spread in US, where the term spread is calculated as the difference between the 10-year and 3-month government bond yield. Home country default probability is measured with the expected-default frequency over 1-year time. Colum (1) shows the estimates of the interaction terms for the baseline model using the 3-monts CCB based on LIBOR rates. As a robustness, columns (2)-(3) show the results for alternative tenors of the basis, and Columns (4)-(6) the results using overnight index swap rates rather than the LIBOR to construct the basis. Estimates of the coefficients of the levels of the variables are not shown. The coefficients are standardized to depict the impact of a one standard deviation increase in the level of CCFR on the cross-currency basis. Robust standard errors are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5. US Dollar Funding Costs and Home Economy Financial Stress

VARIABLES	ΔlogPD		
	(1)	(2)	(3)
ΔFunding Cost	0.142**	0.133**	
	(0.063)	(0.059)	
$\Delta\text{Funding Cost}^2$		0.018*	
		(0.010)	
ΔFunding Cost X 1[if 2007<=Year<=2009]			0.213**
			(0.099)
ΔFunding Cost X 1[if 2011>=Year<=2012]			0.302***
			(0.075)
ΔFunding Cost X 1[if Year=rest]			-0.006
			(0.063)
Observations	1,080	1,080	1,080
R-squared	0.102	0.108	0.115
Country FE	Yes	Yes	Yes
Macro Control	Yes	Yes	Yes
Bank Control	Yes	Yes	Yes

Notes: This table shows the association of the change in the log probability of default (ΔlogPD) of the home economy banking sector with a contemporaneous increase in the change of the US dollar funding cost (the negative of the CCB). ΔlogPD is standardized by the standard deviation in the whole sample. ΔDollar Funding cost is standardized by standard deviation in the whole sample. All regressions control for macro variables, as in Avdjiev and others (2019), and banking sector control variables, as in Samaniego-Medina and others (2016). Macro controls include interest rate differentials, inflation, logarithm of nominal effective exchange rate (NEER), logarithm of VIX, volatility of logarithm of VIX, and real GDP growth, and bank controls include bank capital to asset ratios, cash to assets ratio return to assets ratio, deposit to assets ratio, net loan to assets ratio, and cost to income ratio. All controls are moving averages from quarter t-4 to t-1. The coefficient estimates of the two period dummies are not reported. Results in Column (1) correspond to baseline specification. Results in Column (2) correspond to the specification with quadric term to capture the non-linearity. Results in Column (3) correspond to the specification with interaction between change in dollar funding cost and time dummy. Standard errors are clustered at the economy level in all regressions. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 6. Robustness Analysis to Control for Endogeneity of CCB Using US Monetary Policy Shocks

VARIABLES	ΔlogPD (1)	ΔlogPD (2)
ΔFunding Cost (instrumented with Fed funds rate shock)	4.525	
	(2.631)	
ΔFunding Cost (instrumented with Policy News Shock)		7.128**
		(2.815)
Observations	724	724
R-squared	0.220	0.220
Macro Controls	Yes	Yes
Bank Controls	Yes	Yes
Country FE	Yes	Yes

Notes: This table shows the second stage regression of the change in the log probability of default (ΔlogPD) of the home economy banking sector on the fitted values of the change in US dollar funding costs (the negative of the CCB) from the first stage regression. In the first stage, the change in US dollar funding costs is instrumented with US monetary policy shocks, defined in two alternative ways, following Nakamura and Steinsson (2018): a Federal Funds rate shock and policy news shock. The Federal Funds rate shock amounts to the change in the expected federal funds rate at the time of the next scheduled FOMC meeting. The policy news shock is constructed formally as a principal component of the change in five different rates (i.e. changes in the federal funds rate shock, changes in the market expectations of the federal funds rate over the remainder of the month after the policy announcement, and changes in the price of three euro-dollar futures at the time of the FOMC announcements ΔlogPD is standardized by the standard deviation in the whole sample. ΔDollar Funding cost is standardized by standard deviation in the whole sample. All regressions control for macro variables, as in Avdjiev and others (2019), and banking sector control variables, as in Samaniego-Medina and others (2016). Macro controls include interest rate differentials, inflation, logarithm of nominal effective exchange rate (NEER), logarithm of VIX, volatility of logarithm of VIX, and real GDP growth, and bank controls include bank capital to asset ratios, cash to assets ratio return to assets ratio, deposit to assets ratio, net loan to assets ratio, and cost to income ratio. All controls are moving averages from quarter t-4 to t-1. The coefficient estimates of the two period dummies are not reported. Standard errors are clustered at the economy level in all regressions. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 7. Amplification Effect of US Dollar Funding Vulnerability on the Relationship between Funding Costs and Home Economy PD

ΔlogPD	USD Asset Share	CCFR		LCR	SFR
	(1)	(2)	(3)	(4)	(5)
ΔFunding Cost	0.041	0.122**		-0.142	-0.148
	(0.100)	(0.054)		(0.154)	(0.090)
USD Assets/Total Assets, lag annual average	0.208				
	(0.157)				
ΔFunding Cost X (USD Assets/Total Assets, lag annual average)	0.091				
	(0.058)				
USD Funding Gap/USD Assets, lag annual average		-0.054			
		(0.075)			
ΔFunding Cost X (CCFR, lag annual average)		0.071			
		(0.080)			
1.[CCFR, lag annual average>=0]			0.204		
			(0.194)		
ΔFunding Cost X 0.[CCFR, lag annual average>=0]			0.264***		
			(0.087)		
ΔFunding Cost X 1.[CCFR, lag annual average>=0]			-0.066		
			(0.085)		
CCFR, lag annual average X 0.[CCFR, lag annual average>=0]			-0.032		
			(0.063)		
CCFR, lag annual average X 1.[CCFR, lag annual average>=0]			-0.395		
			(0.319)		
ΔFunding Cost X CCFR, lag annual average X 0.[CCFR, lag annual average>=0]			0.155		
			(0.156)		
ΔFunding Cost X CCFR, lag annual average X 1.[CCFR lag annual average>=0]			0.401***		
			(0.130)		
Quintile LCR, lag annual average				0.006	
				(0.036)	
ΔFunding Cost X Quintile LCR, lag annual average				0.090**	
				(0.035)	
Quintile SFR, lag annual average					0.032
					(0.035)
ΔFunding Cost X Quintile SFR, lag annual average					0.099***
					(0.026)
Observations	1,080	1,080	1,080	587	587
R-squared	0.107	0.108	0.115	0.118	0.129
Country FE	Yes	Yes	Yes	Yes	Yes
Macro Control	Yes	Yes	Yes	Yes	Yes
Bank Control	Yes	Yes	Yes	Yes	Yes

Notes: This table shows that the impact of increases in US dollar funding costs on changes in the log probability of default (ΔlogPD) of the home economy banking sector is amplified by higher USD funding fragility. ΔlogPD, ΔDollar Funding cost, US dollar asset share and US dollar funding ratio (CCFR) are all standardized by the respective standard deviations in the whole sample, whereas the USD liquidity ratio and the USD stable funding ratio are expressed as economy-specific quintiles ordered from highest to lowest, that is, higher values denote lower liquidity or stable funding. All regressions control for macro variables, as in Avdjiev and others (2019), and banking sector control variables, as in Samaniego-Medina and others (2016). Macro controls include interest rate differentials, inflation, logarithm of nominal effective exchange rate (NEER), logarithm of VIX, volatility of logarithm of VIX, and real GDP growth, and bank controls include bank capital to asset ratios, cash to assets ratio return to assets ratio, deposit to assets ratio, net loan to assets ratio, and cost to income ratio. All regressors are expressed as moving averages from quarter t-4 to t-1. Results in Column (1) correspond to specification with US dollar asset share. Results in Column (2) correspond to the specifications with US dollar funding gap/US dollar assets (CCFR). Results in Column (3) correspond to the specifications with sign dummy of US dollar funding gap/US dollar assets (CCFR). Results in Column (4) correspond to the specification with USD liquidity ratio (LCR). Results in Column (5) correspond to the specification with USD stable funding ratio (SFR). Standard errors are clustered at the economy level in all regressions. *** p<0.01, ** p<0.05, * p<0.1.

Table 8. The Effect of Swap Lines with the US Federal Reserve

VARIABLES	ΔlogPD			
	(1)	(2)	(3)	(4)
SWAP Announcement Dummy	-0.089		-0.098	
	(0.073)		(0.075)	
ΔFunding Cost X 0.(SWAP Announcement Dummy)	0.174***		0.154***	
	(0.043)		(0.033)	
ΔFunding Cost X 1.(SWAP Announcement Dummy)	0.003		-0.015	
	(0.103)		(0.107)	
SWAP Dummy		0.003		0.001
		(0.134)		(0.133)
ΔFunding Cost X 0.(SWAP Dummy)		0.171***		0.152***
		(0.048)		(0.034)
ΔFunding Cost X 1.(SWAP Dummy)		0.066		0.054
		(0.114)		(0.116)
CCFR, lag annual average			-0.058	-0.056
			(0.073)	(0.075)
Delta Cost X (CCFR, lag annual average)			0.069	0.062
			(0.076)	(0.078)
Observations	1,080	1,080	1,080	1,080
R-squared	0.106	0.104	0.108	0.105
Country FE	Yes	Yes	Yes	Yes
Macro Control	Yes	Yes	Yes	Yes
Bank Control	Yes	Yes	Yes	Yes

Notes: This table tests whether the impacts of increases in USD funding costs on changes in the log probability of default (ΔlogPD) of the home economy banking sector is mitigated by swap lines with the US Federal Reserve. ΔlogPD, and ΔDollar Funding cost are standardized across the entire economy-time sample. The information of swap line and announcement of swap line is from Federal Reserve Board. All regressions control for macro variables, as in Avdjiev and others (2019), and banking sector control variables, as in Samaniego-Medina and others (2016). Macro controls include interest rate differentials, inflation, logarithm of nominal effective exchange rate (NEER), logarithm of VIX, volatility of logarithm of VIX, and real GDP growth, and bank controls include bank capital to asset ratios, cash to assets ratio return to assets ratio, deposit to assets ratio, net loan to assets ratio, and cost to income ratio. All controls are expressed as moving averages from quarter t-4 to t-1. Results in Columns (1) and (3) correspond to specifications with swap announcement dummy. Results in Columns (2) and (4) correspond to the specifications with swap line arrangement dummy. CCFR corresponds to the USD funding gap/USD assets ratio. Standard errors are clustered at the economy level in all regressions. *** p<0.01, ** p<0.05, * p<0.1.

Table 9. The Mitigating Effect of Domestic Bank Health

VARIABLES	ΔlogPD					
	(1)	(2)	(3)	(4)	(5)	(6)
Bank Capital/Asset, lag annual average	0.048	0.051	0.054	0.074	0.079	0.080
	(0.127)	(0.123)	(0.123)	(0.143)	(0.139)	(0.138)
Bank Cash/Asset, lag annual average	-0.060	-0.060	-0.059	-0.054	-0.058	-0.055
	(0.063)	(0.063)	(0.063)	(0.061)	(0.061)	(0.061)
Bank ROA, lag annual average	0.239***	0.229***	0.230***	0.228***	0.213***	0.219***
	(0.064)	(0.066)	(0.063)	(0.066)	(0.066)	(0.065)
ΔFunding Cost	0.406***	0.404***	0.325***	0.386***	0.397***	0.304***
	(0.044)	(0.075)	(0.053)	(0.048)	(0.073)	(0.047)
ΔFunding Cost X Bank Capital/Asset, lag annual average	-0.082***			-0.080***		
	(0.012)			(0.013)		
ΔFunding Cost X Bank Cash/Asset, lag annual average		-0.131***			-0.144***	
		(0.043)			(0.040)	
ΔFunding Cost X Bank ROA, lag annual average			-0.083***			-0.082***
			(0.020)			(0.021)
CCFR, lag annual average				-0.054	-0.050	-0.051
				(0.074)	(0.074)	(0.073)
Delta Cost X (CCFR, lag annual average)				0.053	0.120*	0.063
				(0.072)	(0.058)	(0.076)
Observations	1,080	1,080	1,080	1,080	1,080	1,080
R-squared	0.114	0.114	0.112	0.116	0.118	0.113
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Macro Control	Yes	Yes	Yes	Yes	Yes	Yes
Bank Control	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table tests whether the impacts of increases in USD funding costs on changes in the log probability of default (ΔlogPD) of the home economy banking sector is mitigated by strong bank fundamentals. ΔlogPD, and ΔDollar Funding cost are standardized by the respective standard deviation in the whole sample. All regressions control for macro variables, as in Avdjiev and others (forthcoming), and banking sector control variables, as in Samaniego-Medina and others (2016). Macro controls include interest rate differentials, inflation, logarithm of nominal effective exchange rate (NEER), logarithm of VIX, volatility of logarithm of VIX, and real GDP growth, and bank controls include bank capital to asset ratios, cash to assets ratio return to assets ratio, deposit to assets ratio, net loan to assets ratio, and cost to income ratio. All controls and bank fundamentals are expressed as moving averages from quarter t-4 to t-1. The first (second) panel is using ΔlogPD as dependent variable. Results in Columns (1) and (4) correspond to specifications with bank capital ratio. Results in Columns (2) and (5) correspond to the specifications with bank cash ratio. Results in Columns (3) and (6) correspond to the specifications with bank funding cost ratio. CCFR corresponds to the USD funding gap/USD assets ratio. Standard errors are clustered at the economy level in all regressions. *** p<0.01, ** p<0.05, * p<0.1.

Table 10. The Effect of International Reserve Holdings by Home Economy Central Banks

VARIABLES	ΔlogPD			
	LCR	SFR	LCR	SFR
	(1)	(2)	(3)	(4)
ΔFunding Cost	-0.917**	-0.488**	-0.958**	-0.494**
	(0.316)	(0.223)	(0.323)	(0.217)
International Reserve/GDP, lag annual average	-0.059	-0.201**	-0.061	-0.206**
	(0.067)	(0.080)	(0.072)	(0.086)
Quintile USD Fragility Ratio, lag annual average	0.017	-0.017	0.021	-0.019
	(0.041)	(0.032)	(0.053)	(0.034)
ΔFunding Cost X International Reserve/GDP, lag annual average	0.599***	0.278*	0.604***	0.273*
	(0.169)	(0.141)	(0.177)	(0.143)
ΔFunding Cost X Quintile USD Fragility Ratio, lag annual average	0.311***	0.207***	0.314***	0.202***
	(0.090)	(0.061)	(0.086)	(0.058)
International Reserve/GDP, lag annual average X Quintile USD Fragility Ratio, lag annual average	-0.007	0.063***	-0.007	0.064**
	(0.013)	(0.019)	(0.014)	(0.022)
ΔFunding Cost X International Reserve/GDP, lag annual average X USD Fragility Ratio, lag annual average	-0.175***	-0.088**	-0.181***	-0.090**
	(0.053)	(0.038)	(0.052)	(0.036)
CCFR, lag annual average			0.014	-0.040
			(0.158)	(0.117)
Delta Cost X (CCFR, lag annual average)			0.167**	0.119
			(0.076)	(0.074)
Observations	587	587	587	587
R-squared	0.133	0.138	0.136	0.139
Country FE	Yes	Yes	Yes	Yes
Macro Control	Yes	Yes	Yes	Yes
Bank Control	Yes	Yes	Yes	Yes

Notes: This table tests whether international reserve holdings mitigate the amplification effect of USD funding fragility on the log probability of default (ΔlogPD) of the home economy banking sector. Both ΔlogPD and ΔFunding Cost are standardized by the respective standard deviations in the whole sample. USD liquidity ratio and USD stable funding ratio are expressed as economy-specific quintiles ordered from highest to lowest, that is, higher values denote lower liquidity or stable funding. All regressions control for macro variables, as in Avdjiev and others (2019), and banking sector control variables, as in Samaniego-Medina and others (2016). Macro controls include interest rate differentials, inflation, logarithm of nominal effective exchange rate (NEER), logarithm of VIX, volatility of logarithm of VIX, and real GDP growth, and bank controls include bank capital to asset ratios, cash to assets ratio return to assets ratio, deposit to assets ratio, net loan to assets ratio, and cost to income ratio. All controls and international reserves are expressed as moving averages from quarter t-4 to t-1. Results in Columns (1) and (3) correspond to specifications with USD liquidity ratio (LCR). Results in Columns (2) and (4) correspond to the specifications with USD stable funding ratio (SFR). CCFR corresponds to the cross-currency funding ratio. Standard errors are clustered at the economy level in all regressions. *** p<0.01, ** p<0.05, * p<0.1.

Table 11. Impact of US Dollar Funding Shocks on Cross-border US Dollar Lending

VARIABLES	Baseline (1)	EM Lenders (2)	EM Recipients (3)	Quadratic (4)	Initial Cost (5)
ΔCredit/GDP	-0.184	-0.059	-0.176	-0.209	-0.190
	(0.308)	(0.277)	(0.308)	(0.128)	(0.308)
Real GDP Growth	-1.088	-1.214	-1.084	-0.977	-1.019
	(1.843)	(1.887)	(1.846)	(0.817)	(1.546)
log(FX)	1.977	8.455	1.487	0.964	1.562
	(24.222)	(24.639)	(24.073)	(8.802)	(25.392)
log(Assets)	-6.946	-4.086	-6.479	-6.641	-8.481
	(30.698)	(32.199)	(30.500)	(6.595)	(32.892)
Deposit/Assets	-0.081	-0.145	-0.022	-0.201	-0.100
	(0.888)	(0.949)	(0.873)	(0.318)	(0.954)
Equity/Assets	-2.865**	-3.279***	-2.823**	-3.037***	-2.366**
	(1.091)	(1.131)	(1.089)	(0.722)	(1.011)
Cash/Assets	-1.101	-0.902	-1.108	-1.095***	-0.954
	(0.871)	(0.863)	(0.871)	(0.262)	(0.924)
Return on Assets	5.839	6.216	5.933	4.978*	8.191
	(6.124)	(6.035)	(6.159)	(2.871)	(6.334)
ΔFunding Cost	-5.311***	6.890	-3.073	-3.920***	-2.725**
	(1.683)	(6.180)	(2.067)	(0.745)	(1.299)
ΔFunding Cost x EM		-13.039*	-3.919*		
		(6.547)	(2.198)		
ΔFunding Cost^2				-0.271***	
				(0.101)	
Initial Cost					-1.081
					(1.550)
ΔFunding Cost x Initial Cost					-0.436**
					(0.186)
Observations	23,154	23,154	23,154	23,154	23,154
R-squared	0.953	0.953	0.953	0.953	0.953
Recipient-Year FE	Yes	Yes	Yes	Yes	Yes
Lender-Recipient FE	Yes	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes	Yes
Banking Sector Controls	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the association between change in the US dollar funding cost and bilateral cross-border US dollar lending. The funding cost shock is in 50 bps per annum and the log of the dependent variable is multiplied by 100 so that the impact on cross-border USD lending is in percentage points. The control variables include home economy macro controls (domestic credit growth to GDP, real GDP growth rate, and the log of FX, the nominal exchange rate) and banking sector controls (log of total banking sector assets, the equity asset-ratio, cash-asset ratio, and ROA). Results in Column (1) shows the overall impact of US dollar funding shocks. Results in Column (2) and (3) report the amplified impact on cross-border lending from EM lenders and towards EM recipients. Column (4) and (5) correspond to the non-linearity tests with a quadratic term of the US dollar funding shock and an initial level of US dollar funding cost. Standard errors are clustered at both lending economy levels and recipient economy levels. Robust standard errors are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 12. Substitution Across Cross-Border USD Lenders, Between Cross-Border and Domestic USD Lenders, and Across Cross-Border All Currency Lenders

VARIABLES	Cross-Border USD Lenders (1)	Cross-Border USD Lenders (EM) (2)	Cross-Border and Domestic USD Lenders (3)	Cross-Border and Domestic USD Lenders (EM) (4)	Cross-Border All Currency Lenders (5)	Cross-Border All Currency Lenders (EM) (6)
ΔFunding cost of lender *i*	0.113***	0.132***				
	(0.039)	(0.044)				
ΔFunding cost of other lenders (*-i)*	3.156*	7.826***				
	(1.583)	(0.474)				
ΔFunding cost of *i* x EM dummy		-0.033				
		(0.059)				
ΔFunding cost of others x EM Dummy		-6.842***				
		(1.471)				
ΔFunding cost of all lenders			-2.800***	-3.097***	-0.769	0.105
			(0.614)	(0.630)	(0.991)	(0.656)
ΔFunding cost of all lenders x EM dummy				0.999		-2.883*
				(1.764)		(1.457)
Observations	22,802	22,802	347	347	361	361
R-squared	1.000	1.000	0.169	0.169	0.320	0.325
Recipient-Year FE	Yes	Yes	No	No	No	No
Lender-Recipient FE	Yes	Yes	No	No	No	No
Recipient FE	No	No	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes	Yes	Yes
Banking Sector Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the degree of substitution over cross-border USD Lenders, between cross-border and domestic (local position in the home economy) USD Lenders, and over cross-border lending in all currencies. In columns (1) and (2), the dependent variable is total cross-border USD lending from all other countries except for *i*, whereas the regressors are the change in USD funding costs in *i* and a weighted average of changes in USD funding costs in all other countries. In columns (3) and (4), the dependent variable is total cross-border and domestic USD lending to a recipient country *j*, whereas the explanatory variable is a weighted average of changes in all lending partners' USD funding costs. In columns (5) and (6), the dependent variable is cross-border lending in all currencies to country *j*. change in funding costs is expressed in 50 bps per annum, and the log of the dependent variable is multiplied by 100 so that the impact on cross-border USD lending is in percentage points. The control variables include home (lending) economy macro controls (domestic credit growth to GDP, real GDP growth rate, and the log of nominal exchange rate) and banking sector controls (log of total banking sector assets, the equity asset-ratio, cash-asset ratio, and ROA). Standard errors are clustered at both lending economy levels and recipient economy levels in Columns (1)-(2), and at recipient economy levels in Columns (3)-(6). Robust standard errors are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 13. The Amplification Effect of US Dollar Funding Vulnerability on the Transmission from US Dollar Funding Costs to Cross-border US Dollar Lending

VARIABLES	CCFR	LCR	SFR
	(1)	(2)	(3)
∆Funding Cost	0.617	-3.882***	-2.169***
	(1.047)	(1.225)	(0.548)
CCFR	2.489		
	(3.071)		
∆Funding Cost x CCFR	-0.758*		
	(0.411)		
LCR		0.010	
		(1.739)	
∆Funding Cost x LCR		1.195**	
		(0.416)	
SFR			-0.598
			(1.758)
∆Funding Cost x SFR			0.874**
			(0.339)
Observations	23,840	17,216	17,216
R-squared	0.916	0.931	0.931
Recipient-Year FE	Yes	Yes	Yes
Lender-Recipient FE	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes
Banking Sector Controls	Yes	Yes	Yes

Notes: This table reports the amplification effect of US dollar funding vulnerability on the relationship between the change in US dollar funding costs in the lender (home) economy *i* and bilateral cross-border US dollar lending from *i* to a recipient economy *j*. The four home economy US dollar funding vulnerability measures are the cross-currency funding ratio (CCFR), liquidity coverage ratio (LCR), stable funding ratio (SFR), and the ratio of US dollar HQLA to US dollar assets. All four measures are expressed in quintiles, with higher quintiles indicating a higher ratio. The funding cost shock is in 50 bps per annum and log of the dependent variable is multiplied by 100 so that the impact on cross-border USD lending is in percentage point. The control variables include home economy macro controls (domestic credit growth to GDP, real GDP growth rate, and the log of nominal exchange rate) and banking sector controls (log of total banking sector assets, the equity asset-ratio, cash-asset ratio, and ROA). Column (1)-(3) report the amplification effects of each individual vulnerability measure. Standard errors are clustered at both lending economy levels and recipient economy levels. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 14. The Mitigation Effects of Banking Sector Health, Swap Line Arrangements with the Federal Reserve, and International Reserve Holdings on the Transmission of US Dollar Funding Costs to Cross-border US Dollar Lending

VARIABLES	(1) Liquidity Ratio	(2) ROA	(3) Swap Lines	(4) Int'l Reserves	(5) Liquidity Ratio	(6) ROA	(7) Swap Lines	(8) Int'l Reserves
□Funding Cost	-6.615***	-4.014***	-5.653***	-12.049***	-7.378***	-1.603	-5.583***	-12.726**
	(0.908)	(1.185)	(0.553)	(1.912)	(2.083)	(1.665)	(2.083)	(4.856)
Bank Liquidity Ratio	-0.845				-0.879			
	(1.020)				(1.061)			
□Funding Cost x Bank Liquidity Ratio	1.951***				2.128***			
	(0.283)				(0.373)			
Bank Return on Assets (ROA)		1.089				0.790		
		(0.789)				(0.846)		
□Funding Cost x Bank Return on Assets (ROA)		0.934**				0.779**		
		(0.354)				(0.356)		
□Funding Cost x Swap line			7.544**				9.404***	
			(3.150)				(3.272)	
Int'l Reserves				0.218				0.236
				(0.353)				(0.353)
□Funding Cost x Int'l Reserves				0.313***				0.292***
				(0.062)				(0.074)
CCFR					2.212	2.149	0.347	0.887
					(2.028)	(2.095)	(0.711)	(1.760)
□Funding Cost x CCFR					0.039	-1.022**	-0.553	0.039
					(0.489)	(0.452)	(0.659)	(1.143)
Observations	21,175	21,175	23,154	23,154	20,356	20,356	22,253	22,253
R-squared	0.922	0.922	0.953	0.953	0.923	0.922	0.951	0.952
Recipient-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lender-Recipient FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Banking Sector Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the mitigation effect of home economy *i*'s banking sector health, swap lines with the U.S. Federal Reserve, and central bank international reserve holdings on the transmission of US dollar funding costs to bilateral cross-border US dollar lending to a recipient economy *j*. The two banking sector health measures are liquidity: the cash to assets ratio, and return on assets (ROA), and are expressed in quintiles, with higher quintiles indicating higher ratios. The funding cost shock is in 50 bps per annum and the dependent variable is expressed in logs and multiplied by 100 so that the impact on cross-border USD lending is in percentage points. The control variables include home economy macro controls (domestic credit growth to GDP, real GDP growth rate, and the log of the nominal exchange rate) and home economy banking sector controls (log of total banking sector assets, the equity to asset ratio, cash to asset ratio, and ROA). Columns (1), (2), (5) and (6) report the mitigation effect of each banking sector health measure. Column (4), (5), (7) and (8) show the mitigation effect of the swap line arrangement with the Fed and central bank international reserves as a ratio to GDP. Standard errors are clustered at both lending economy levels and recipient economy levels. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

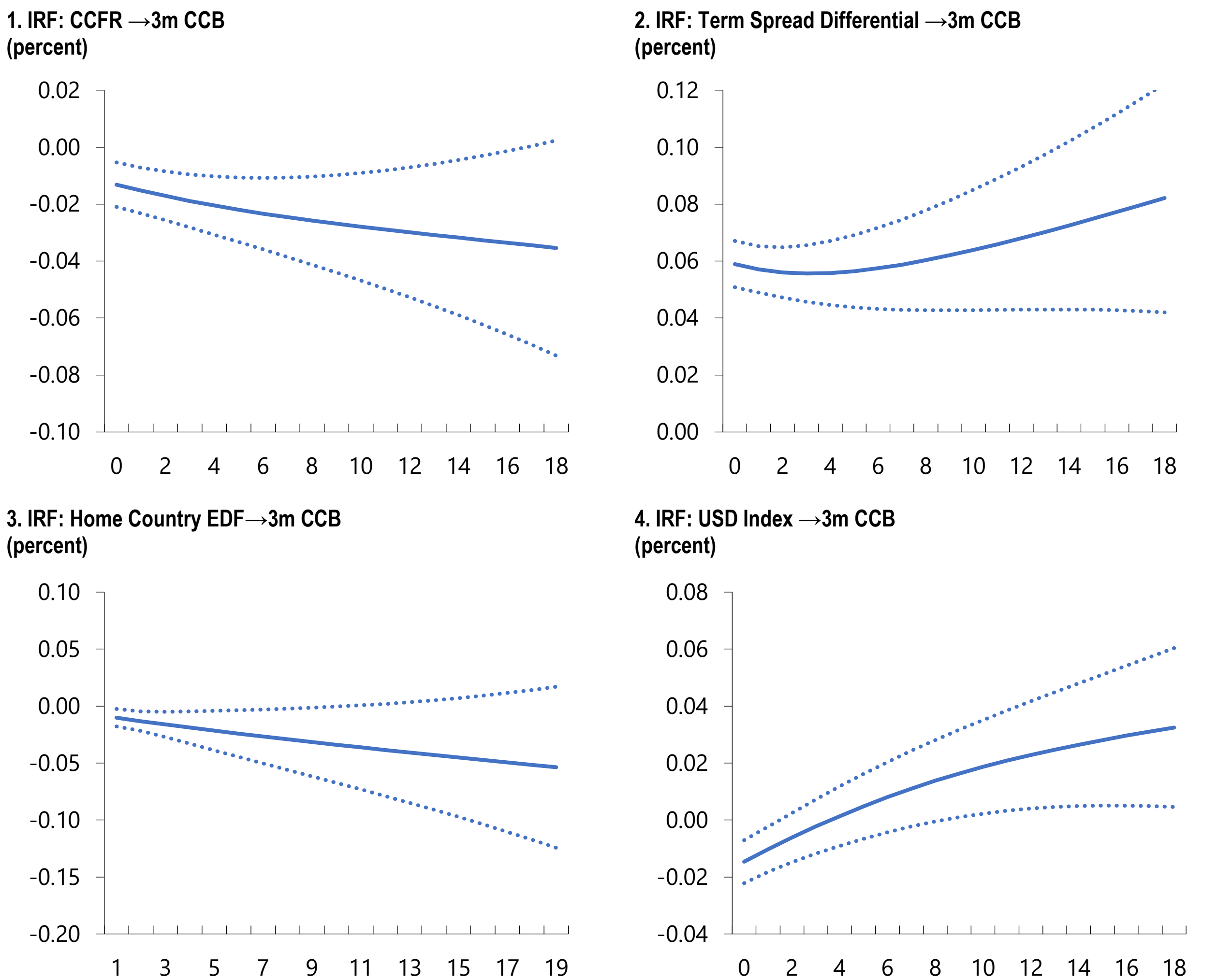
Table 15. US Dollar Funding Costs of Home Economies (Lenders) and Recipient Economy (Borrowers) Financial Stress

VARIABLES	ΔlogPD		
	All	Top 10 recipients	Rest
	(1)	(2)	(3)
ΔFunding Cost	0.095*	0.146*	0.091
(Weighted Average)	(0.051)	(0.066)	(0.055)
Observations	874	230	644
R-squared	0.031	0.037	0.029
Country FE	Yes	Yes	Yes
Macro Control	Yes	Yes	Yes
Bank Control	Yes	Yes	Yes

Notes: This table shows the association of the change in the log probability of default (ΔlogPD) of the recipient economy banking sector with a contemporaneous increase in the change of the weighted average US dollar funding cost in the lending economies. ΔlogPD, and ΔDollar Funding cost are standardized over the whole sample. All regressions control for macro variables, as in Avdjiev and others (2019), and banking sector control variables, as in Samaniego-Medina and others (2016). Macro controls include interest rate differentials, inflation, the logarithm of the nominal effective exchange rate (NEER), the logarithm of VIX, volatility of logarithm of VIX, and real GDP growth. Bank controls include ratios to assets of bank capital, cash, return, deposits, net loans, and the cost to income ratio. All controls are expressed as moving averages from quarter t-4 to t-1. Results in Columns (1) correspond to all recipient economies. Results in Columns (2) correspond to the top 10 recipients. Results in Columns (3) correspond to the rest recipients. Standard errors are clustered at the economy level in all regressions. *** p<0.01, ** p<0.05, * p<0.1.

VII. Appendix

Figure A 1. Testing for endogenous relationship between CCFR and CCB



Source: IMF staff estimates.
Notes: The figure reports the impulse response functions (IRF) of CCB to one standard deviation shock of selected CCB drivers. Coefficients are estimated using a panel VAR of order three with the following Cholesky order: term spread differential, USD dollar index, VIX, CCFR, FX implied volatility, BID-ASK spread, Economy i default probability, Libor-OIS spread and three-month CCB. Confidence level is 95 percent.

Table A 2. Amplification Effect of US Dollar Funding Vulnerability on the Relationship between Funding Costs and Home Economy Financial Stress (Euro Area)

VARIABLES	ΔlogPD				
	USD Asset Share	CCFR		LCR	SFR
	(1)	(2)	(3)	(4)	(5)
ΔFunding Cost	-0.028	0.047		-0.082	-0.002
	(0.146)	(0.044)		(0.104)	(0.119)
USD Assets/Total Assets, lag annual average	0.010				
	(0.505)				
ΔFunding Cost X (USD Assets/Total Assets, lag annual average)	0.097				
	(0.110)				
CCFR, lag annual average		-0.484			
		(0.247)			
ΔFunding Cost X (CCFR, lag annual average)		0.113*			
		(0.052)			
1.[CCFR, lag annual average>=0]			0.614*		
			(0.243)		
ΔFunding Cost X 0.[CCFR, lag annual average>=0]			0.216		
			(0.114)		
ΔFunding Cost X 1.[CCFR, lag annual average>=0]			-0.275		
			(0.206)		
CCFR, lag annual average X 0.[CCFR, lag annual average>=0]			-0.651		
			(0.325)		
CCFR, lag annual average X 1.[CCFR, lag annual average>=0]			-1.038*		
			(0.420)		
ΔFunding Cost X CCFR, lag annual average X 0.[CCFR, lag annual average>=0]			0.350		
			(0.174)		
ΔFunding Cost X CCFR, lag annual average X 1.[CCFR, lag annual average>=0]			0.494*		
			(0.235)		
Quintile LCR, lag annual average				0.015	
				(0.059)	
ΔFunding Cost X Quintile LCR, lag annual average				0.057*	
				(0.027)	
Quintile SFR, lag annual average					0.010
					(0.047)
ΔFunding Cost X Quintile SFR, lag annual average					0.027
					(0.030)
Observations	363	363	363	261	282
R-squared	0.134	0.152	0.180	0.169	0.159
Country FE	Yes	Yes	Yes	Yes	Yes
Macro Control	Yes	Yes	Yes	Yes	Yes
Bank Control	Yes	Yes	Yes	Yes	Yes

Notes: Focusing on euro area countries, this table shows that the impact of increases in US dollar funding costs on changes in the log probability of default (ΔlogPD) of the home economy banking sector is amplified by higher USD funding fragility. Specification is the same used for the full sample (Table 7). Results in Column (1) correspond to specification with US dollar asset share. Results in Column (2) correspond to the specifications with US dollar funding gap/US dollar assets (CCFR). Results in Column (3) correspond to the specifications with sign dummy of US dollar funding gap/US dollar assets (CCFR). Results in Column (4) correspond to the specification with USD liquidity ratio (LCR). Results in Column (5) correspond to the specification with USD stable funding ratio (SFR). Standard errors are clustered at the economy level in all regressions. Standard errors are clustered at the economy level in all regressions. *** p<0.01, ** p<0.05, * p<0.1.