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ABSTRACT

In March 2020, the Federal Reserve eased the terms on its standing swap lines in collaboration with other central banks, reactivated temporary swap agreements, and then introduced the new Foreign and International Monetary Authorities (FIMA) repo facility. We provide new evidence on how the central bank swap lines and FIMA repo facility reduce strains in global dollar funding markets and US Treasury markets during extreme stress events. These facilities are found to contribute to the narrowing of foreign exchange swap basis spreads and to reduce the sensitivity of global funding strain metrics to risk sentiment deterioration. Cross border flows through banks for excess liquidity support purposes are reduced in the near term, and the risk sensitivity of equity and bond fund flows declines. However, access to these facilities leave longer-term patterns of liquidity and capital flows across borders broadly unchanged. While official sector liquidity hoarding and “dash for cash” type of activity is expected to be lower with access to these facilities, initial evidence does not show general differential changes in foreign exchange reserve holdings by foreign central banks in line with the type of liquidity access.

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1. Introduction

The severe global economic impact of the rapid spread of COVID-19 manifested in March 2020 through strains in offshore dollar funding markets and U.S. Treasury market dislocation. The Federal Reserve (the Fed) reacted with many measures, including expanding and enhancing the central bank dollar liquidity swap arrangements with selected foreign central banks (hereafter CB dollar swaps) and establishing a new repurchase operation (repo) facility to Foreign and International Monetary Authorities (FIMA) with accounts at the Fed (hereafter FIMA repo facility).

This article provides new evidence on the effects of CB dollar swaps and FIMA repo facility for global US dollar funding markets, international financial flows, and credit provision. It builds on the detailed discussion of the operations and developments of these facilities during the COVID-19 period by Choi, Goldberg, Lerman and Ravazzolo (2021). That paper describes how address strained global dollar funding market conditions and support to credit provision abroad and in the United States are among the objectives of the facilities.

In brief, the Fed's CB dollar swaps network is designed to contain deterioration in global dollar funding markets by providing foreign central banks with U.S. dollar liquidity, which they can distribute to financial institutions in their respective jurisdictions.² The CB swaps are also priced as a "backstop" facility to help ensure that the facility is used largely in times of acute and systemic stress, and not as a replacement for private markets in normal times. The new FIMA repo facility, established on March 31, 2020, also serves as a backstop. It also helps support the smooth functioning of the U.S. Treasury market by providing reassurance to FIMA account holders of their ability to secure dollar liquidity through repo transactions with the Fed in times of unusual market strains, rather than through selling their U.S. Treasury securities or financing U.S. Treasury securities in the private repo market.³ The facility, complementing the CB dollar swaps in helping to ease strains in global dollar funding markets, provides temporary dollar liquidity to a much broader range of foreign official institutions (FIMA account holders) at a backstop interest rate. Unlike FIMA repo, in a CB swap transaction the reserve assets of the foreign central bank are unencumbered.

Are these facilities effective? Prior analytics and market commentary after the experience of the Global Financial Crisis (GFC) provide a positive assessment. The CB dollar swaps were assessed a successful

² The Fed's standing swap line central bank partners include the Bank of Canada, the European Central Bank, the Bank of Japan, the Swiss National Bank, and the Bank of England. From March 19, 2020 to December 31, 2021, the Fed had also [temporary CB dollar swaps facilities](#) to support the provision of U.S. dollar liquidity in amounts up to \$60 billion each for the Reserve Bank of Australia, the Banco Central do Brasil, the Bank of Korea, the Banco de Mexico, the Monetary Authority of Singapore, and the Sveriges Riksbank and \$30 billion each for the Danmarks Nationalbank, the Norges Bank, and the Reserve Bank of New Zealand.

³ The amount of available dollar liquidity via the FIMA repo facility for any FIMA account holder is limited to the smaller of the U.S. Treasuries held at the Federal Reserve by the FIMA account holder or the counterparty limit set bilaterally. In comparison, the standing swap lines have no specific limits, while the temporary swap lines had been capped at \$30 or \$60 billion during the recent pandemic crisis.

innovation when they were introduced and expanded in the GFC). At that time, banks across countries had extra demand for dollar funding after experiencing shocks to their balance sheets and had been working to obtain dollars either in global funding markets or for some through their affiliated banking operations in the United States (Cetorelli and Goldberg 2011; Goldberg and Skeie 2011). The swap associated dollars became available to banks in jurisdictions that drew on the swap line with the Fed. Accordingly, dollars provided through swap lines reduced pressures on bank balance sheets outside the United States, in particular in relation to strains on banks that came from the currency mismatch on assets and liabilities, as well as from immediate strains to dollar funding availability to those banks with higher asset backed commercial paper positions. Some of the dollars that flowed through swap lines' usage in late 2007 through 2008 replaced funding that was being sourced in the United States through related bank branches, and also through usage of the discount window and term auction facilities.

Access to CB dollar swaps had been associated with significant declines in offshore dollar funding strains, measured by so-called foreign exchange (FX) swap basis spreads (and covered interest parity deviations). Evidence establishing these effects draws on different empirical techniques, with largely similar conclusions in studies by Baba and Packer (2009), Fleming and Klagge (2010), and Goldberg, Kennedy and Miu (2011). In additional, Bahaj and Reis (2021) examine data for 2011 and argue that CB dollar swaps put a ceiling on deviations from uncovered interest parity, lower average ex post bank borrowing costs, and tilt investments toward assets in the country providing the underlying liquidity.

Other research focused more on the features of recipient countries or on the future of the international monetary system. Some research focuses on the relative characteristics of countries with access to swap lines (Rose and Spiegel 2012). Other analytics on the GFC period argued that real variables were not much impacted (Aizenman and Pasricha 2010), discussed implications for the self-insurance of countries outside the Fed's standing swap line network including via accumulation of official foreign currency reserves (Aizenman, Ito and Pasricha 2021) or considered swap line use relative to the adequacy of official reserve balances (Obstfeld, Shambaugh and Taylor 2009).

Our current paper builds on this prior literature, providing a range of evidence based on the experience of the Covid-19 pandemic event. We focus on evidence on the potential effects of the CB dollar swaps and FIMA repo facilities by examining data for the period just preceding the Covid-19 shock with data over the days, weeks, months and quarters that followed. The analytics mostly rely on difference-in means tests, as well as regression specifications conducted over time periods through 2020, with distinctions across groups of countries and over time. Comparisons are provided across three groups of foreign countries, those with standing swap lines (SSLs), those with temporary swap lines (TSLs), and other countries without swap lines that established FIMA repo facility accounts. These types of country and data distinctions make our work both a methodological and data span complement to prior work, also embedding a focus on specific forms and timing of access to the different liquidity facilities.

The evidence we provide can be summarized by three key observations:

- First, central bank swap lines and the Foreign International Monetary Authorities (FIMA) repo facility—the Fed's international dollar liquidity facilities—effect conditions in global dollar funding markets and influence cross border funding flows of banks. Evidence of effects is concentrated in the first half of 2020, also covering foreign country U.S. Treasury holdings, official foreign reserve positions, bank-based credit and liabilities, and global portfolio flows.
- Second, country access to the Fed's international dollar liquidity facilities is associated with reduced costs of borrowing dollars locally in the FX swap market, initially only for countries of central banks with access to standing or temporary swap lines and then later also for countries with access to the FIMA repo facility. This access is also shown to be associated with reduced sensitivity of overseas dollar funding conditions to changes in risk sentiment.
- Third, credit provision in the United States and abroad are supported by dollars settled through central bank swap lines, and potentially by liquidity transactions associated with usage of the FIMA repo facility. After March 2020, international capital flows through banks normalized quickly, although reversion for countries without access to standing arrangements occurred at a lower speed and extent. Flows through bond mutual funds reverted quickly and on average grew rapidly, while those through equity mutual funds remained more depressed. Patterns were not clearly differentiated by facility access.

The paper is organized as follows. Section 2 presents a brief anatomy of the evolution of strains that contributed to offshore dollar funding market strains and Treasury market disruptions in March 2020, and then presents the evolution of conditions and use of Fed international dollar facilities. Section 3 presents the methodology and analytical results for offshore funding strains and credit provision positions across borders. Section 4 concludes with policy-relevant discussion.

2. Dollar funding, the Fed's international dollar liquidity facilities and the COVID-19 Shock

Extreme uncertainty and expectations of a severe global economic downturn in March 2020 led to simultaneous supply and demand shocks in global U.S. dollar funding markets. Greater risk aversion and a desire to hold precautionary cash balances led banks and non-bank financial institutions (NFBIs) to reduce dollar intermediation in funding markets. Corporations, also faced with tightened access to US dollar funding markets, turned to banks for draws on their committed credit lines with banks.

As some of the US hosted branches of foreign banking organizations (FBOs) had large liquidity risk exposures through this channel, the resulting increases in bank loans contributed new dollar funding needs. Cetorelli, Goldberg, and Ravazzolo (2020b) show that such needs were met, in part, through internal capital markets within banks, with the branches either retaining dollars that might have flowed to their parents or parents reorienting balance sheets to obtain needed dollars. In addition, some non-

U.S. banks and corporations sought to build extra liquid dollar balances, plug holes in their balance sheets due to currency mismatch, or increased hedging demand for U.S. dollars.⁴ As the post GFC period was characterized by a shift in the structure of dollar funding markets (BIS CGFS 2020), this time the strains manifested differentially across currencies and tenors of funds sought in offshore dollar markets.

One useful indicator of the magnitude of strains is the FX swap basis spread (hereafter the basis), constructed by comparing the implied cost of U.S. dollar funding from a FX swap transaction of a specific tenor to a direct U.S. dollar interest rate.⁵ A positive basis reflects a premium paid to borrow U.S. dollars in the FX swap market, meaning that borrowers pay a higher cost for obtaining funds than the relevant U.S. dollar unsecured rates would suggest. The formula below provides an example based on the cost of borrowing the currency of country c in unsecured markets and converting it to US dollars via the FX swap market and then comparing that with the rate paid to borrow U.S. dollars directly in the unsecured market, for example on overnight Indexed Swaps (OIS):

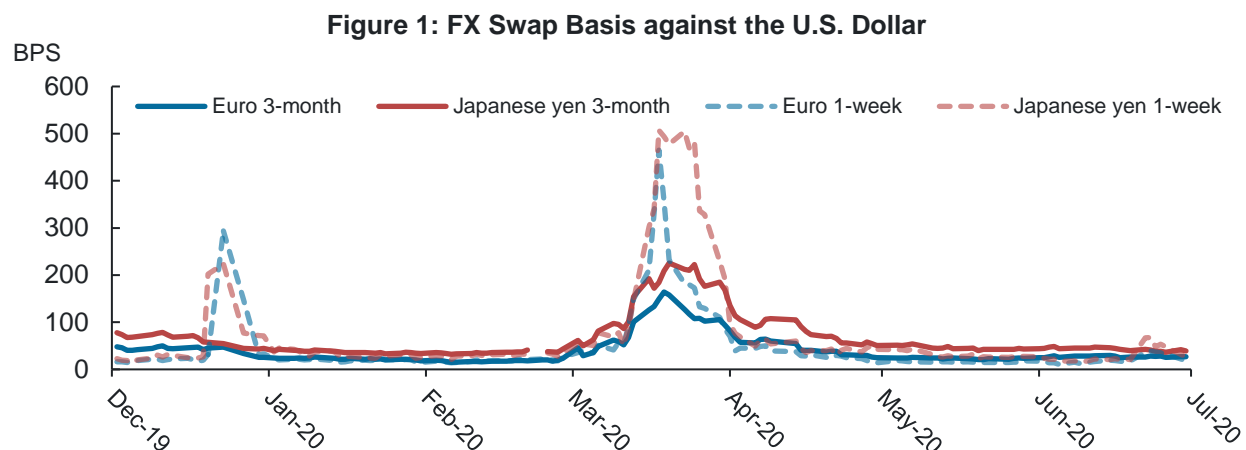
$$FXbasis_{c,t} = \left[\frac{360}{tenor} \left(\left(\frac{forward_{c,t}(tenor)}{spot_{c,t}} \right) \left(1 + r_{c,t}(tenor) \frac{tenor}{360} \right) \right) - 1 \right] - r_{us,t}(tenor) \quad (1)$$

where $spot_{c,t}$ is the foreign exchange spot rate at time t , $forward_{c,t}(tenor)$ is the foreign exchange forward rate contracted at time t for delivery at time $t + tenor$, and $r_{c,t}(tenor)$ is the uncollateralized foreign country c (US dollar) interest rate from time t to time $t + tenor$. This measure is similar in construction to covered interest rate parity deviations, which have received considerable researcher attention in the post GFC period (Du, Tepper and Verdelhan 2018, Mancini Griffoli and Rinaldo 2012, Cerutti, Obstfeld and Zhou 2020).

The differences across selected currencies and tenors during the early COVID-19 pandemic events are shown in Figure 1. The basis of the dollar-yen and euro-dollar currency pairs moved up in tandem early in March 2020 and across tenors of funds. The strains in funding dollars via yen for longer durations (about 3 months) were higher than those in euros. The short term (one week) currencies manifested the steepest increase, with extreme strains in dollar-yen short term funding taking longer before normalizing to pre-pandemic levels. As we discuss further Section 3, some of the basis adjustments were the result of CB swaps related announcements and the settlement of dollars taken-up through this facility, detailed in Cetorelli, Goldberg, Ravazzolo (2020a).

⁴ Liao and Zhang (2020) show that there was a larger rise in the cost of dollar funding through FX swaps for currencies whose home jurisdictions have more positive net international investment positions (that is, their investment in foreign assets is larger than their foreign debts), corresponding to more demand for hedging of dollar investments.

⁵ Afonso, Ravazzolo and Zori (2019) and BIS CGFS (2020) provide rich insights on dollar funding markets.



Data: Bloomberg, L.P., authors' calculations.

Note: As of 11 a.m., London time. Based on OIS. A positive number reflects a premium to borrow or hedge U.S.\$.

March 2020 was also characterized by sharp adjustments in international capital flows, both through banks and nonbanks, a widespread increase in demand for liquidity - sometimes described as the “dash for cash” and an exit from investment positions viewed as riskier and less liquid. Some foreign official investors sold U.S. Treasuries held as part of their official foreign currency reserves in order to raise dollar liquidity to build precautionary buffers, support dollar funding needs of local institutions, and for foreign exchange intervention. The significant volume of these foreign official sales was widely seen as exacerbating strained liquidity conditions in the U.S. Treasury market (FSB 2020).

Many countries implemented extensive policy and facility responses after the initial pandemic shock. In the dollar liquidity funding space, important Fed actions include changes to features of CB dollar swaps and the introduction of the new FIMA repo facility to enhance dollar provision abroad, as discussed in detail in Choi, Goldberg, Lerman and Ravazzolo (2021). For the network of standing swap central banks (SSCBs), which includes the Bank of Canada (BoC), Bank of Japan (BoJ), European Central Bank (ECB), Bank of England (BoE), and Swiss National Bank (SNB), the access to standing arrangements was enhanced by lowering the price to a spread of overnight indexed swaps plus 25 basis points from a spread of 50 basis points (March 15), adding an operation for 84-day term funding (March 15) to its existing weekly operation for 7-day funds, and increasing the frequency of the operations for 7-day funds from weekly to daily (March 20). The Federal Open Market Committee (FOMC) granted temporary swap lines (TSLs) to additional nine other temporary swap central bank (TSCB) counterparties, all of whom had previously received the facility during the GFC (March 19). Swap usage peaked at \$449 billion in late May 2020 compared to \$598 billion drawn during the GFC with the BOJ and ECB usage at 82 percent of the total peak.

The FIMA repo facility was introduced on March 31, 2020, and available to all foreign and international account holders, facilitating making liquid investments in Treasuries in New York Fed accounts, without having to liquify these U.S. Treasuries when cash dollars were needed. As this was a new facility, the FIMA specific contracts and access occurred over time, and at different dates across account holders.

These dates, and the information about names of foreign officials with FIMA repo accounts, are not in the public domain.

3. Testing for central bank dollar swaps and the FIMA repo facility effects

Both policy arguments and theory analyses posit ways that the dollar liquidity facilities could influence real and financial variables. We conjecture that access to official dollar liquidity backstop lowers strains, consistent with the model of Bahaj and Reis (2021), but additionally reduces risk sensitivity of flows as private agents and official institutions have reduced incentives to hoard liquidity. We further conjecture that these forces support provision of more stable credit and real economic activity compared with in the absence of the facilities. Evidence from global banking shows that internal capital markets can play a powerful role in shifting liquidity across the global banking organization in response to shocks, with this role in the COVID-19 events also at play through bank specific data (Cetorelli, Goldberg, and Ravazzolo 2020b) and through banking aggregates (Aldosoro et al 2020, 2021).

Below we provide a range of complementary quantitative evidence with a range of data and with different methods. The data span strains in dollar funding markets (FX swap basis spreads), foreign country U.S. Treasury holdings, official FX reserve balances, and cross-border global liquidity flows through banks and mutual funds. The analytics test for differences across currencies or associated countries, with the currencies or countries grouped according to their status of access to dollar swap lines, including a distinction between *SSCBs* or *TSCBs*, and according to whether they did not have this swap line access but later established FIMA repo accounts (*Other*). The analytics also distinguish over time, with an initial pre-pandemic *Period 1* (typically starting in Dec 2019 and proceeding through early March 2020), followed by heavy strains in *Period 2* (typically March 19 through early April), and then by a *Period 3* that occurs after the additional central banks without swap lines had established FIMA repo accounts (typically mid-late April/May through June 2020). The specific period dating vary by exercise and is associated with the frequency of available data, as summarized in Table 1. Our analytics rely on difference in means tests and on time series panel regressions. Some of the analytics using dollar values across countries express country data relative to *Period 1* series averages, so that indices take the respective pre-pandemic period to have a value of 100.

Table 1: Periods of Difference-In-Mean Tests

	PERIOD 1	PERIOD 2	PERIOD 3
DATA BY CURRENCY OR COUNTRY	PRE-PANDEMIC	PANDEMIC AFTER SETTLEMENT OF INITIAL \$ CENTRAL BANK SWAP OPERATIONS	PANDEMIC AFTER FIMA REPO ACCESS IN PLACE
<i>FX Swap Basis Spreads (daily, weekly)</i>	February 1, 2020, to March 10, 2020	March 19, 2020, to April 4, 2020	May 21, 2020, to June 30, 2020
<i>FX Official Reserve Balance (monthly)</i>	December 2019 to February 2020	March 2020 to April 2020	May 2020 to July 2020
<i>U.S. Treasury Holdings of Foreign Countries (monthly)</i>	December 2019 to February 2020	March 2020	April 2020 to June 2020
<i>Cross Border Liabilities (quarterly)</i>	Q4 2019	Q1 2020	Q2 2020
<i>Bond and Equity Funds allocated in Counterparty Countries (monthly)</i>	December 2019 to February 2020	March 2020 to April 2020	May 2020 to July 2020

Source: Authors' calculations.

3.1 Evidence based on FX swap basis spreads

Settlement of dollars through CB swap operations calmed funding strains, even more than the announcement of facility-related announcements. For this claim, standard announcements and new specifications are applied to test for changes in selected basis spreads changed around key facility announcement dates and around auction settlement dates. Cetorelli, Goldberg, and Ravazzolo (2020a) set the announcements as: (i) changes on the terms for SSCBs on March 15, (ii) around reestablishment of the TSCB lines on March 19, (iii) the increase to daily frequency of 7-day tenor funds for the SSCBs, and (iv) the introduction of the FIMA repo facility on March 31, 2020. The announcement window was set to include the day of, and, in some cases, the day following the announcement. The FX swap basis spread changes over this window are compared with the average basis during the two days prior to the announcement. Key announcements were associated with some stabilization in the basis, especially outside of the major currency pairs. Those currencies directly tied to announcements related to SSCBs and TSCBs did not have significantly greater declines in the basis on and after announcement dates. By contrast, settlement of dollar auctions of swap central banks mattered, along with the increased frequency of 7-day U.S. dollar operations.

Here, our new analytics take a longer horizon and the further analytics aim to provide broader perspectives on the swap lines and FIMA repo facility effects across groups of countries or currencies and multiple periods. The difference-in-means (DIM) analytics consist of a series of statistical comparisons of the basis across groups of foreign countries, those (*SWAP All*) with standing and temporary swap lines and those with other countries without swap lines that established FIMA repo accounts (*Other*), and then comparing standing swap line (SSCB) basis with temporary swap line (TSCB) basis.⁶ For the DIM tests we create average basis spreads by currency and by period, with the testing

⁶ Currencies (countries) in the SSCB group, are the euro, yen, Swiss franc, Pound sterling, Canadian dollar; in the TSCB group are the Australian dollar, New Zealand dollar, Singaporean dollar, Korean won, Danish, Norwegian and Swedish kronas, Mexican peso and Brazilian real. The identities of central banks which entered FIMA repo account

procedure accounting for the range of experiences across countries in each group, and then across the pre-pandemic, initial pandemic, and post FIMA account periods, with results in Table 2.

Table 2, columns labeled *Period 1*, *Period 2*, and *Period 3* present the mean values of basis spreads by currencies grouped according to the row labels. The latter three columns indicate the DIM test, along with its statistical significance. Key additional information are the difference in difference (DID) tests, highlighted in blue, which consider how values of the respective grouped currencies compared with each other across periods. On average, currencies exhibited an increase in basis in the initial pandemic stress period (*Period 2*) in comparison with the pre-pandemic period (*Period 1*). The DID results show that, on average, those currencies with access to swap lines had significantly lower strains, and *SSCB* currencies on average experienced lower strains than *TSCB* currencies. After the activation of FIMA repo accounts, those currencies had large declines in dollar funding strains, despite minimal aggregate usage of the FIMA repo facility in Spring 2020. While dollar funding conditions for countries with *SSCBs* returned to pre-pandemic levels, the experiences across countries with *TSCBs* and *Other* without swap lines remained more differentiated.⁷ With this important delineation across currencies according to direct facility access, the results show that a magnitude of differences around 50 basis points in the comparisons of *SSCB* currencies with *Other* currencies between *Period 2* versus *Period 1*, and oppositely signed differences for *Period 3* versus *Period 2*. The blue highlighted difference in difference cells of Table 2 show that they are statistically significant for *SSCB* currencies versus *Other* and also the *TSCB* currencies in *Period 3* versus *Period 2*.

Beyond levels of strains in global dollar funding declining with facility access, risk sensitivity of funding conditions also can respond. Access to Fed international dollar liquidity facilities could reduce the need for precautionary liquidity when risk sentiment deteriorates and thereby reduce the sensitivity of the basis to changes in risk sentiment. Accordingly, we conduct related analytics to test whether access to dollar liquidity through swap lines, or later through the FIMA repo accounts, is associated with reduced sensitivity of the basis to changes in risk sentiment. These tests utilize daily data spanning February 1, 2020, through June 30, 2020, with time frames included across specifications set up to enhance testing distinctions about time variation in the sensitivity to risk conditions. This analysis excludes key periods to sharpen the emphasis on differences across the groups of currencies and over time.

Table 2: Foreign Currency Swap Basis Spreads: Difference in Means Tests across Groups and Periods

arrangements are not in the public domain. Accordingly, we do not list the names of the countries or currencies, or the numbers of countries or currencies that are included in the *Other* group with FIMA repo accounts while not already having swap lines with the Federal Reserve.

⁷ See also Avdjiev, Eren et al (2020) and Aldosoro et al (2020). Aizenman, Ito, and Gurnicha (2021) explore whether the announcement of swap lines and the dollar auctions effect exchange rates, CIP deviations, CDS spreads, and government bond yields, using a local projection model and daily data from January 1 2020 to May 31 2020 over 45 economies. They find that the announcement of swap line changes and FIMA repo did not impact cross-currency basis, but improved CDS spreads and lowered the 10-year government bond yields.

	<i>PERIOD 1</i>	<i>PERIOD 2</i>	<i>PERIOD 3</i>	<i>PERIOD 2- PERIOD 1</i>	<i>PERIOD 3- PERIOD 2</i>	<i>PERIOD 3- PERIOD 1</i>
<i>SWAP All</i>	19.92	44.06	31.78	24.14 (15.67)	-12.28 (14.45)	11.86 (10.97)
<i>Other</i>	65.73	124.80	62.34	59.07*** (16.45)	-62.46*** (14.91)	-3.39 (18.02)
<i>Swap All - Other</i>	-45.81	-80.74	-30.56	-34.93** (14.12)	50.18*** (12.82)	15.25 (9.69)
<i>Standing Swap</i>	26.38	39.94	27.25	13.56 (8.53)	-12.69 (8.08)	0.87 (6.75)
<i>Temporary Swap</i>	16.33	46.34	34.30	30.02 (24.38)	-12.05 (22.49)	17.97 (16.88)
<i>Standing - TSCB</i>	10.05	-6.4	-7.1	-16.45 (12.6)	-0.65 (11.22)	-17.1** (6.94)
<i>Standing Swap - Other</i>	-39.35	-84.86	-35.09	-45.41** (11.84)	49.77*** (11.28)	4.26 (8.4)
<i>Temporary Swap - Other</i>	-49.4	-78.46	-28.04	-29.06 (16.91)	50.41** (15.28)	21.36* (10.83)

*p<0.1 **p<0.05 ***p<0.001. Standard errors are between brackets.

Data: Bloomberg. Note: *Period 1* covers from February 1, 2020 through March 10, 2020; *Period 2* covers from March 19, 2020 through April 4, 2020; and *period 3* covers from May 21, 2020, through June 30, 2020. *Swap All* includes currencies of jurisdictions with CB swaps (*Standing Swap* or *SSCB*: CAD, CHF, EUR, GBP, JPY; *Temporary Swap* or *TSCB*: AUD, DKK, KRW, NOK, NZD, SEK, SGD, BRL and MXP), *Other* includes those of jurisdictions with availability to access the FIMA repo facility but not CB swaps with names suppressed for confidentiality.

The regression specifications take the form

$$FXbasis_{c,t}(tenor) = \alpha + \beta \cdot period \cdot VIX_t + \gamma \cdot group \cdot VIX_t + \delta \cdot period \cdot group \cdot VIX_t + \epsilon_t \quad (2)$$

Regressions use daily data for the same range of currencies, time span, and three periods in the first half of 2020 as detailed in Table 1. Each regression includes two subperiods of this daily data, respectively corresponding to *Period 1* and *Period 2*, *Period 2* and *Period 3*, or *Period 1* and *Period 3*. Risk sentiment is proxied by the VIX_t (Chicago Board of Exchange volatility index, or volatility of an equity index), *period* is a dummy equal to 1 during the latter period, the interaction captured by *period*· VIX captures any change in sensitiveness in the second period compared with the former. *group* is equal to 1 for FX swap basis spreads of currencies of jurisdictions with swap lines with the Federal Reserve. Table 3 provides the results of specifications comparing all currencies with swap lines versus the broader group of currencies (panel a), and SSCB versus TSCB currencies in specifications that only include the associated 14 FX swap basis spreads (panel b).

Table 3: Risk Sensitivity of Daily FX swap basis Spreads across Currency Groups and Periods

Panel A: <i>Swap All</i> (Group Dummy) and <i>Other</i> Only			
	(1) <i>PERIOD 1 & PERIOD 2</i>	(2) <i>PERIOD 2 & PERIOD 3</i>	(3) <i>PERIOD 1 & PERIOD 3</i>
VIX (a)	1.57*** (0.19)	2.25*** (0.26)	1.62*** (-0.1)
period·VIX (b)	1.23*** (0.14)	-2.22*** (0.26)	-0.43*** (0.06)
group·VIX (c)	-0.84*** (0.24)	-0.54* (0.32)	-1.00*** (0.12)
group·period·VIX (d)	-0.32* (0.17)	1.62*** (0.32)	0.69*** (0.07)
H(0): a + b = 0	2.81***	0.03	1.18***
H(0): a + c = 0	0.73***	1.71***	0.61***
H(0): a + b + c + d = 0	1.65***	1.12***	0.87***
Panel B: <i>SSCB</i> (Group Dummy) and <i>TSCB</i>			
VIX (a)	0.58*** (0.18)	1.58*** (0.23)	0.46*** (0.07)
period·VIX (b)	0.96*** (0.12)	-0.44** (0.23)	0.49*** (0.04)
group·VIX (c)	0.44 (0.29)	0.37 (0.39)	0.42*** (0.12)
group·period·VIX (d)	-0.14 (0.2)	-0.43 (0.39)	-0.64*** (0.07)
H(0): a + b = 0	1.54***	1.14***	0.95***
H(0): a + c = 0	1.02***	1.95***	0.88***
H(0): a + b + c + d = 0	1.84***	1.08*	0.74***

*p<0.1 **p<0.05 ***p<0.001. Standard errors are between brackets.

Note: $basis_{c,t} = constant + a \cdot VIX_t + b \cdot period \cdot VIX_t + c \cdot group \cdot VIX_t + d \cdot group \cdot period \cdot VIX_t + e_t$. In (1), *VIX* is CBOE volatility index, *period* is a dummy equal to 1 during the later period of each data period included in the column. *period·VIX* (b) captures any change in sensitiveness in the second period; *group* is equal to 1 for FX swap basis spreads of currencies of jurisdictions with swap lines (*Swap All*, panel a; *SSCB*, panel b). *Period 1* covers from February 1, 2020, through March 10, 2020; *Period 2* covers from March 19, 2020, through April 4, 2020; *Period 3* covers from May 21, 2020, through June 30, 2020. *Swap All* includes currencies of jurisdictions with CB swaps (*Standing Swap* or *SSCB*: CAD, CHF, EUR, GBP, JPY; *Temporary Swap* or *TSCB*: AUD, DKK, KRW, NOK, NZD, SEK, SGD, BRL and MXP), *Other* includes those of jurisdictions with availability to access the FIMA repo facility but not CB swaps with names suppressed for confidentiality.

The average effect of risk on the FX swap basis is positive, indicating a widening as risk sentiment deteriorates (*VIX* increases). This type of result is already well established in studies of FX swap bases or CIP deviations relative to USD. More novel are the comparative results. The group of currencies associated with swap lines have *ex ante* sensitivity differences from the *Other* grouping, as reflected in the interaction of *group* with *VIX*. The average risk sensitivity increased on average across currencies

from *Period 1* to *Period 2* (column 1, panel a), yet the increase in sensitivity is significantly lower for those currencies with access to swap lines.

Table 3 column 2, comparing *Period 3* with *Period 2*, shows in panel (a) that the currencies without swap lines but which then were associated with new FIMA repo accounts, experienced significantly larger reductions in the sensitivity of the swap basis to daily changes in risk sentiment. These results are suggestive but not necessarily causal, as controls are not in place for all of the market, pandemic and facility developments during the first half of 2020, or other country-specific drivers of risk sensitivity. However, these results are consistent with the conjecture that access to the Fed's dollar liquidity facilities had a stabilizing effect of global dollar funding markets.

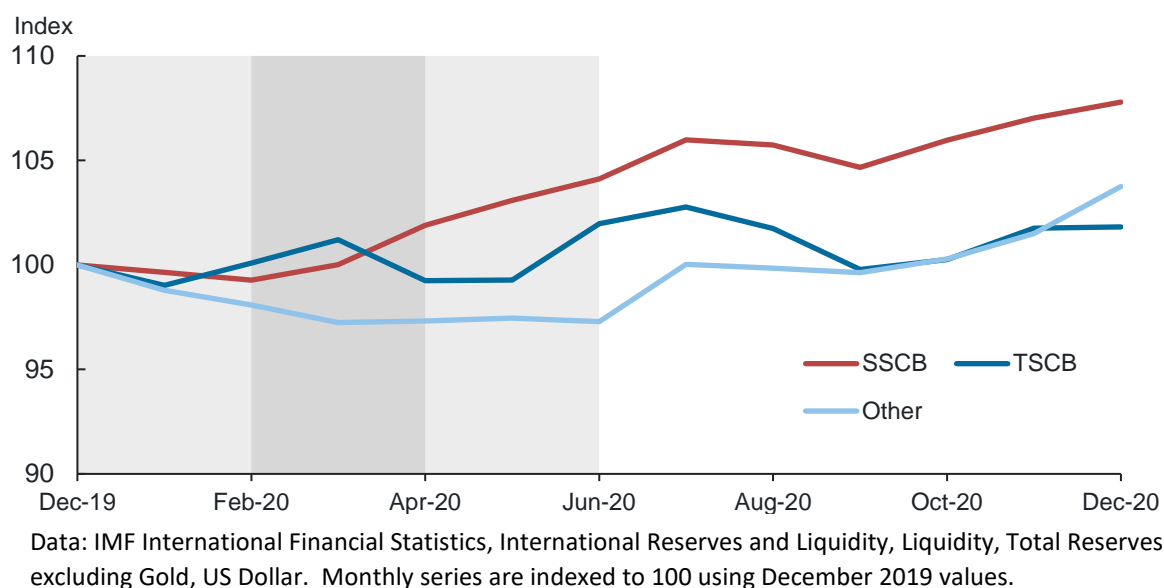
Table 3 panel (b) provides results inclusive of only the SSCB currencies and the TSCB currencies. The SSCB currencies include so-called safe-haven currencies which typically include a combination of Swiss francs and Japanese yen, and in some earlier time periods the UK pound and euro (Goldberg and Krogstrup 2019). These currencies are expected to have lower sensitivity to changes in risk or oppositely signed sensitivity, compared with TSCB currencies. The results do not show statistically different average sensitivities across the basis grouped by type of swap line access (column 1, panel b), perhaps due to the significant heterogeneity of currency types, with this sensitivity increasing with the initial pandemic period strains. This sensitivity partially reverted in Period 3 (column 2, panel b), but overall remained elevated relative to pre-pandemic for both the SSCB and TSCB currencies (column 3, panel b). The associated test results making this point are statistical tests $H(0)$ versus $H(2)$.

3.2 Evidence from Official Foreign Exchange Reserves and Foreign Holdings of US Treasuries

The next aspects of dynamics are in dollar stock and flow variables relevant for credit provision at home and abroad. In the early part of the pandemic, some countries liquidated stocks of official FX reserves and changed the composition of their holdings, especially by selling some US Treasuries and moving into cash dollars positions. In the so-called “dash for cash” some countries sold US dollar-denominated assets out of their foreign exchange reserves to raise dollar liquidity to build precautionary buffers, support dollar funding needs of local institutions, and for foreign exchange intervention.

We examine patterns across countries sorted into groups in relation to their facility access. These are illustrated in Figure 2, with country official foreign currency reserves indexed so that their Dec 2019 value equals 100. Values above 100 demonstrate higher levels of official reserves compared to *ex ante* values, while values below 100 are lower reserve balances relative to the pre-pandemic period. The lines within this figure are unweighted averages of these index values, by country group, contrasting patterns for countries with access to SSCBs, TSCBs or without these swap lines but which activated FIMA repo facility accounts later in the second quarter of 2020. The respective periods, relatively similarly to the pre-pandemic, initial pandemic, and post FIMA periods are highlighted with vertical grey bars. Throughout, official FX reserve balances can change either due to actual foreign reserves accumulation or decumulation, or when the value of underlying assets in the portfolio change when reported in US dollars.

Figure 2: FX Reserve Balances



Countries with SSCBs on average had official FX reserve increases even during the pandemic period, consistent with a combination of not actively using reserves or serving as so-called safe havens for funds and attracting inflows during risky times (such as Switzerland).⁸ The experiences across the mix of advanced and emerging market countries with access to temporary lines is varied, on average dipping and then accumulating over time. For example, Australian official FX reserves dipped by over 30 percent while Sweden's declined by closer to 5 percent. By contrast, countries without the swap lines had larger cumulative declines in FX reserve balances and took longer than countries with swap lines to revert balances to pre-pandemic values and accumulate greater balances through late 2020.

⁸ Goldberg and Krogstrup (2019) use exchange market exchange rate pressure correlations with risk proxies to identify the time-varying status of currencies as so-called safe havens.

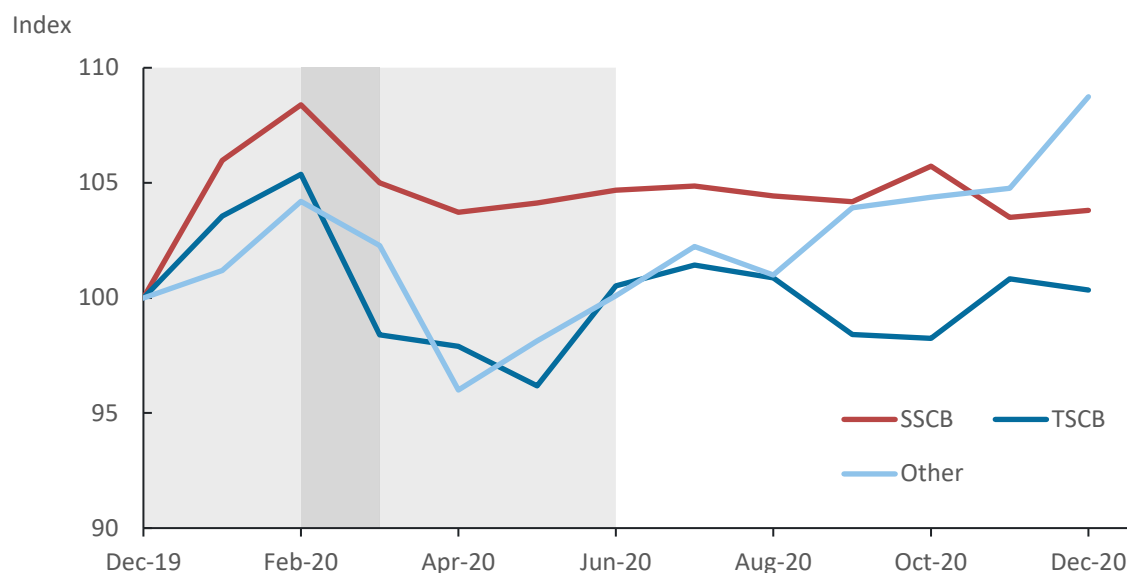
Statistical evidence provided by DIM tests better reflects the variation in experiences across countries in each of the groupings and over time. These analytics, provided in Table 4, demonstrate that the *Other* countries on average had a decline of 2.6 percent of the value of their FX official reserve portfolio in the stress *Period 2* compared to pre-pandemic. While the swap line countries (*SWAP All*) on average had mild gains (close to 1 percent), the experience was differentiated and not statistically significant from zero on average. *Other* countries on average lost about 2.6 percent of official reserves in the initial stress period (statistically significant), with a relative loss closer to 3.6 percent.

Table 4: Official Foreign Exchange Reserves: Difference in Means across Currency Groups and Periods

	<i>PERIOD 2</i>	<i>PERIOD 3</i>	<i>PERIOD2- PERIOD1</i>	<i>PERIOD3- PERIOD2</i>	<i>PERIOD3- PERIOD1</i>
<i>SWAP All</i>	100.99	101.19	0.99 (2.23)	0.2 (3.25)	1.19 (2.37)
<i>Other</i>	97.44	98.50	-2.56** (1.06)	1.06 (1.39)	-1.5 (0.89)
<i>Swap All - Other</i>	3.55	2.69	3.55 (2.47)	-0.86 (3.35)	2.69 (2.53)
<i>Standing Swap</i>	100.42	103.05	0.42 (0.47)	2.63* (1.3)	3.05* (1.22)
<i>Temporary Swap</i>	101.31	100.16	1.31 (3.53)	-1.15 (5.09)	0.16 (3.67)
<i>Standing - TSCB</i>	-0.89	2.89	-0.88 (3.56)	3.77 (5.08)	2.89 (3.86)
<i>SSCB-Other</i>	2.98	4.55	2.98** (1.16)	1.57 (1.83)	4.55** (1.51)
<i>TSCB-Other</i>	3.87	1.66	3.86 (3.68)	-2.2 (5.01)	1.66 (3.77)

Data: IMF International Financial Statistics, International Reserves and Liquidity, Liquidity, Total Reserves excluding Gold, US Dollar. Note: Monthly series are indexed to 100 using December 2019 to February 2020 average values. *Swap All* includes currencies of jurisdictions with CB swaps (*Standing Swap* or *SSCB*: CAD, CHF, EUR, GBP, JPY; *Temporary Swap* or *TSCB*: AUD, DKK, KRW, NOK, NZD, SEK, SGD, BRL and MXP), *Other* includes those of jurisdictions with availability to access the FIMA repo facility but not CB swaps, with names suppressed for confidentiality.

Table 4 demonstrates that the main statistical distinctions arise from the comparing official FX reserve paths of the *SSCB* countries with those of the *Other* countries. The pattern of reserve balance changes were not statistically different between the full group of *TSCB* countries and the *Other* countries. Some central banks with temporary swap lines actually continued to build liquidity buffers and add to reserves in *Period 3*, possibly for further insurance or even in anticipation of the expiration of the temporary swap lines, while the *Other* group ended with lower official reserve stocks.

Figure 3: U.S. Treasury Holdings of Foreign Countries

Data: Treasury International Capital (TIC) System, U.S. Treasury Department. Monthly series are indexed 100 using December 2019 values.

Another indicator of pressures on currencies and liquidity positions appears through monthly data on country holdings of US Treasuries, reported as part of the Treasury International Capital (TIC) data (Figure 3). Compared with the period immediately preceding the pandemic strains, US holdings of Treasuries declined for all three groupings of countries early in the pandemic. *SSCB* countries thereafter on average maintained or increased holdings through 2020. By contrast, *TSCB* countries continued to reduce Treasury holdings through May 2020, recovering initial positions by June. The average pattern shown in Figure 3 is broadly similar for the *Other* countries compared to the *TSCB* group, however for *Other* the second half of 2020 manifested a continued rise in US Treasury holdings beyond pre-pandemic values. As the official reserve holdings of foreign central banks did not increase at this rate, the TIC data suggest the accumulation may be led by a shift in the composition of official reserves toward US Treasuries or an increase in private demand.

The reasons for *TSCB* countries reducing Treasury holdings are not completely clear, but the example of Sweden as leading part of the decline may be informative. Gislen, Hansson and Melander (2021), in discussing the experience of the Scandinavian region, argue that as there is no guarantee that the Federal Reserve or other central banks provide liquidity in a crisis, sufficiently large foreign exchange reserves and Treasuries are a complement to locally sourced liquidity.⁹ Indeed, in the spring of 2020, the

⁹ After the global financial crisis, the Riksbank entered into swap agreements with a number of other Nordic-Baltic countries, agreeing in November 2020 on a set of principles for their usage during times of crisis and also noting that swap arrangements can never replace a central bank's foreign currency reserves.

Riksbank used its own resources and did not draw on its temporary swap line with the Fed during the pandemic period.

DIM tests applied to data for US Treasury Holdings of foreign countries are shown in Table 5, with Period 3 ending in June 2020. Statistical tests support these patterns and also indicate the extent of differences across and within the SSCB and TSCB related countries. The data show that the liquidation of US Treasuries in the initial pandemic stress period was concentrated in only some TSCB countries, which liquidated a greater share of their US Treasuries than the *Other* countries. On average, the group of *Other* countries continued to reduce Treasury holdings in *Period 3*, while *TSCB* countries tended to maintain post pandemic positions into this time frame.

Table 5: US Treasury Holdings of Foreign Counterparties: Difference in Means Tests across Country Groups and Periods

	<i>PERIOD 2</i>	<i>PERIOD 3</i>	<i>PERIOD2- PERIOD1</i>	<i>PERIOD3- PERIOD2</i>	<i>PERIOD3-PERIOD1</i>
<i>SWAP All</i>	96.93	96.25	-3.07 (2.08)	-0.68 (2.93)	-3.75* (2.07)
<i>Other</i>	98.54	93.14	-1.46 (4.55)	-5.39 (5.7)	-6.86* (3.43)
<i>Swap All - Other</i>	-1.61	3.11	-1.61 (5.00)	4.71 (5.33)	3.1 (4.01)
<i>Standing Swap</i>	100.40	98.40	0.4 (4.32)	-2 (5.69)	-1.6 (3.7)
<i>Temporary Swap</i>	95.39	95.29	-4.61* (2.29)	-0.1 (3.44)	-4.71* (2.57)
<i>Standing - Temporary Swap</i>	5.01	3.11	5.01 (4.89)	-1.90 (2.77)	3.12 (4.51)
<i>Standing Swap - Other</i>	1.86	5.26	1.86 (6.28)	3.40 (5.32)	5.26 (5.05)
<i>Temporary Swap - Other</i>	-3.15	2.15	-3.15 (5.10)	5.29 (5.57)	2.14 (4.29)

Data: Treasury International Capital (TIC) System, U.S. Treasury Department. Note: Monthly series are indexed to 100 using December 2019 to February 2020 average values. *Swap All* includes currencies of jurisdictions with CB swaps (*Standing Swap* or *SSCB*: CAD, CHF, EUR, GBP, JPY; *Temporary Swap* or *TSCB*: AUD, DKK, KRW, NOK, NZD, SEK, SGD, BRL and MXP), *Other* includes those of jurisdictions with availability to access the FIMA repo facility but not CB swaps with names suppressed for confidentiality.

Overall, while the introduction of temporary swap lines and the FIMA repo facility appear to have helped stabilize the reductions in U.S. Treasury holdings of countries eligible to access these facilities. The data analysis shows that some countries continued to rely on their own funds to support dollar liquidity provision to local entities instead of drawing on available facilities with the Fed. Some countries

without access to swap lines may have also continued to reduce positions for a longer horizon, including as it took some time for them to establish their FIMA repo accounts.

3.3 Evidence from Cross-border Bank-Based Flows to Bank and Nonbank Borrowers

One category of effectiveness of the Fed's dollar liquidity facilities pertains to the extent to which financial institutions are able to maintain credit supply to households and businesses, in the United States and abroad, and avoid liquidity shortfalls that generate fire sales of assets that amplify and spread strains. We provide associated empirical insights by examining the relative movements of both bank-based and market-based flows across borders, focusing on both bank and nonbanks.

One perspective is based on US regulatory data on the hosted branches of foreign banking organizations (FBOs). The COVID-19 shock had a significant impact on US FBO branch balance sheets beginning in late February 2020 and the early pandemic period, discussed in Cetorelli, Goldberg and Ravazzolo (2020b). As broad-based bank and corporate funding strains became evident, bank deposits began to decline. The net funding that US FBOs received from parent organizations then rose, as did other borrowings, including those secured through the Fed Funds market, the repo market, and the Federal Reserve's discount window. More sizable changes in bank balance sheets occurred in the third week of March, when the balance sheets of the US hosted branches of FBOs registered a combined sharp decline in deposits, a marked increase in lending, further increase in other borrowing, and a substantial jump in funding received on net from their parent organizations. The sharp increase in lending was likely due to large customer draws on the sizable credit commitments in place with the branches rather than reflecting new loan extensions. The freezing up of the corporate credit market had led customers to draw on those lines, resulting—all else equal—in the United States. FBOs facing an increase in funding needs to match the increased amount of loans on their balance sheet. US branches of FBOs with access to dollar liquidity through the dollar operations of SSCBs borrowed more internally from their parent organizations.

The share of net internal borrowing among US branches of FBOs, after the changes in dollar availability through the standing swap lines, increased by significantly more for the US branches of FBOs with larger needs for such funding, if they had access to these dollars through their parent bank organizations. The swap dollars supported flow of funds back to the United States, where hosted branches of foreign banks met needs generated by committed credit lines demands when corporate funding markets were strained. The response to the shock through the activation of an internal funding channel within these banking organizations was more than sufficient to support the balance sheet needs of FBO branches and continue the flow of credit to borrowers in the United States. These internal capital market flows are typically important during periods of strains, as already evident for the pandemic based on the US data around FBOs (Cetorelli, Goldberg and Ravazzolo 2020b) and these BIS data observing that injections of

liquidity flow across borders take the form of a rise in cross-border liquidity and intragroup claims (Aldasoro et al 2020).

Next, we provide additional evidence from a cross-country perspective based on types of international capital flows. Subject to data availability, comparisons can be made from the vantage point of sources of credit and of recipients of credit flowing across borders. We again present the DIM tests, using the bank asset and liability data reported in BIS Locational Banking Statistics, which measure international banking activity from the perspective of residence, meaning the physical location of the banking office. Banks record their positions on an unconsolidated basis, so these data include intragroup positions between offices of the same banking group. This type of data is used broadly to explore push and pull drivers in international capital flows and the strength of the global financial cycle (for example, see Avdjiev, Gambacorta, Goldberg and Schiaffi 2020).¹⁰

The first set of DIM tests compare the relative strength of outward flows by country bank locations to bank borrowers and to nonbank borrowers (Table 6, panels a and b). The second set of DIM tests compare the strength of inward funding flows (Table 7, panels a and b).

Table 6, panels a and b, shows that banking systems with access to swap lines continued to provide credit to both bank and nonbank borrowers in external locations in the early part of the pandemic, growing on average at 5 to 6 percent relative to the pre-pandemic baseline and by at a higher rate than provided by banks in *Other* countries without access to swap lines. The credit provision through banks located in *SSCB* countries continued strongly through June 2020, while provision from both *TSCB* and *Other* countries both slowed, with *TSCB* ending at significantly lower levels than the pre-pandemic baseline while still higher than from *Other* countries.

The recipient country perspective is summarized by the difference in means tests represented by Table 7, panels a and b. The first observation is that growth rates (relative to pre-pandemic) were robust or still positive in the initial pandemic period, with inflows to swap line countries from both bank and nonbank lenders particularly robust in comparison with *Other* countries. This gap closed in the later period (Period 3), after FIMA repo accounts were established, as the surge in liabilities of banks in swap line countries somewhat reverted and banks in *Other* countries had further increases in inflows.

¹⁰ An additional important issue is how nonfinancial corporations finance receivables with their own resources, essentially providing something like trade credit to their customers including in supply chains (Boissay, Patel and Shin 2020).

Table 6: BIS Locational Banking Statistics, Bank Claims, across Country Groups Periods

a. Bank Claims by Country on Bank Borrowers					
	<i>PERIOD 2</i>	<i>PERIOD 3</i>	<i>PERIOD2- PERIOD1</i>	<i>PERIOD3- PERIOD2</i>	<i>PERIOD3- PERIOD1</i>
<i>SWAP All</i>	105.62	100.96	5.62** (2.28)	-4.66 (3.4)	0.96 (2.53)
<i>Other Countries</i>	102.40	96.67	2.4 (2.98)	-5.73 (4.6)	-3.33 (3.51)
<i>Swap All - Other</i>	3.22	4.29	3.22 (3.75)	1.07 (3.49)	4.29 (4.32)
<i>Standing Swap</i>	103.96	107.12	3.96 (3.47)	3.16 (4.24)	7.12* (2.44)
<i>Temporary Swap</i>	106.36	98.22	6.36* (3)	-8.14* (4.34)	-1.78 (3.13)
<i>Standing - TSCB</i>	-2.4	8.9	-2.4 (4.59)	11.3** (4.38)	8.91** (3.97)
<i>Standing Swap - Other</i>	1.56	10.45	1.56 (4.58)	8.9* (3.92)	10.45** (4.27)
<i>Temporary Swap - Other</i>	3.96	1.55	3.95 (4.23)	-2.41 (3.72)	1.55 (4.7)
b. Bank Claims by Country on Non-Bank Borrowers					
	<i>PERIOD 2</i>	<i>PERIOD 3</i>	<i>PERIOD2- PERIOD1</i>	<i>PERIOD3- PERIOD2</i>	<i>PERIOD3- PERIOD1</i>
<i>SWAP All</i>	104.72	103.55	4.72* (2.44)	-1.17 (3.63)	3.55 (2.69)
<i>Other Countries</i>	99.55	99.53	-0.45 (1.67)	-0.01 (2.88)	-0.47 (2.35)
<i>Swap All - Other Countries</i>	5.17	4.02	5.17* (2.96)	-1.16 (2.26)	4.02 (3.58)
<i>Standing Swap</i>	108.26	101.78	8.26 (5.85)	-6.48 (6.78)	1.78 (3.43)
<i>Temporary Swap</i>	103.15	104.34	3.15 (2.5)	1.19 (4.44)	4.34 (3.67)
<i>Standing - TSCB</i>	5.11	-2.56	5.11 (6.36)	-7.67* (3.45)	-2.56 (5.03)
<i>Standing Swap - Other</i>	8.71	2.25	8.71 (6.08)	-6.47* (3.15)	2.24 (4.16)
<i>Temporary Swap - Other</i>	3.6	4.81	3.6 (3)	1.2 (2.33)	4.8 (4.36)

Data: BIS Locational Banking Statistics Data. Note: Quarterly series are indexed to 100 using Q4 2019 values. *Swap All* includes currencies of jurisdictions with CB swaps (*Standing Swap* or *SSCB*: CAD, CHF, EUR, GBP, JPY; *Temporary Swap* or *TSCB*: AUD, DKK, KRW, NOK, NZD, SEK, SGD, BRL and MXP), *Other* includes those of jurisdictions with availability to access the FIMA repo facility but not CB swaps. Currency names suppressed for confidentiality.

Table 7: BIS Locational Banking Statistics, Bank Liabilities, across Country Groups and Periods**a. Bank Liabilities by Country Groups from Bank Lenders**

	<i>PERIOD 2</i>	<i>PERIOD 3</i>	<i>PERIOD2- PERIOD1</i>	<i>PERIOD3- PERIOD2</i>	<i>PERIOD3- PERIOD1</i>
<i>SWAP All</i>	117.11	111.23	17.11*** (3.05)	-5.87 (3.87)	11.23*** (2.38)
<i>Other</i>	106.08	108.11	6.08 (3.98)	2.02 (10.08)	8.11 (9.26)
<i>Swap All - Other</i>	11.03	3.12	11.02** (5.02)	-7.9 (7.6)	3.13 (9.56)
<i>Standing Swap</i>	119.51	113.13	19.51** (5.79)	-6.39 (6.7)	13.13** (3.36)
<i>Temporary Swap</i>	116.04	110.39	16.04*** (3.76)	-5.64 (4.93)	10.39*** (3.18)
<i>Standing - Temporary Swap</i>	3.47	2.74	3.48 (6.91)	-0.75 (5.7)	2.73 (4.62)
<i>Standing Swap - Other</i>	13.43	5.02	13.43 (7.03)	-8.41 (7.88)	5.02 (9.85)
<i>Temporary Swap - Other</i>	9.96	2.28	9.95* (5.48)	-7.67 (8.17)	2.29 (9.79)

b. Bank Liabilities by Country Groups from NonBank Lenders

	<i>PERIOD 2</i>	<i>PERIOD 3</i>	<i>PERIOD2- PERIOD1</i>	<i>PERIOD3- PERIOD2</i>	<i>PERIOD3- PERIOD1</i>
<i>SWAP All</i>	113.23	108.12	13.23*** (2.36)	-5.11 (3.49)	8.12*** (2.58)
<i>Other</i>	104.46	108.76	4.46 (3.31)	4.3 (5.94)	8.76 (4.93)
<i>Swap All - Other</i>	8.77	-0.64	8.76** (4.06)	-9.41** (3.72)	-0.64 (5.56)
<i>Standing Swap</i>	115.48	108.92	15.48** (3.23)	-6.55 (5.3)	8.92 (4.21)
<i>Temporary Swap</i>	112.23	107.76	12.23*** (3.14)	-4.47 (4.61)	7.76** (3.38)
<i>Standing - Temporary Swap</i>	3.25	1.16	3.25 (4.51)	-2.09 (5.89)	1.17 (5.39)
<i>Standing Swap - Other</i>	11.02	0.16	11.01** (4.63)	-10.85 (5.72)	0.16 (6.48)
<i>Temporary Swap - Other</i>	7.77	-1.00	7.76 (4.57)	-8.76** (4.11)	-1.0 (5.98)

*p<0.1 **p<0.05 ***p<0.001. Standard errors are between brackets.

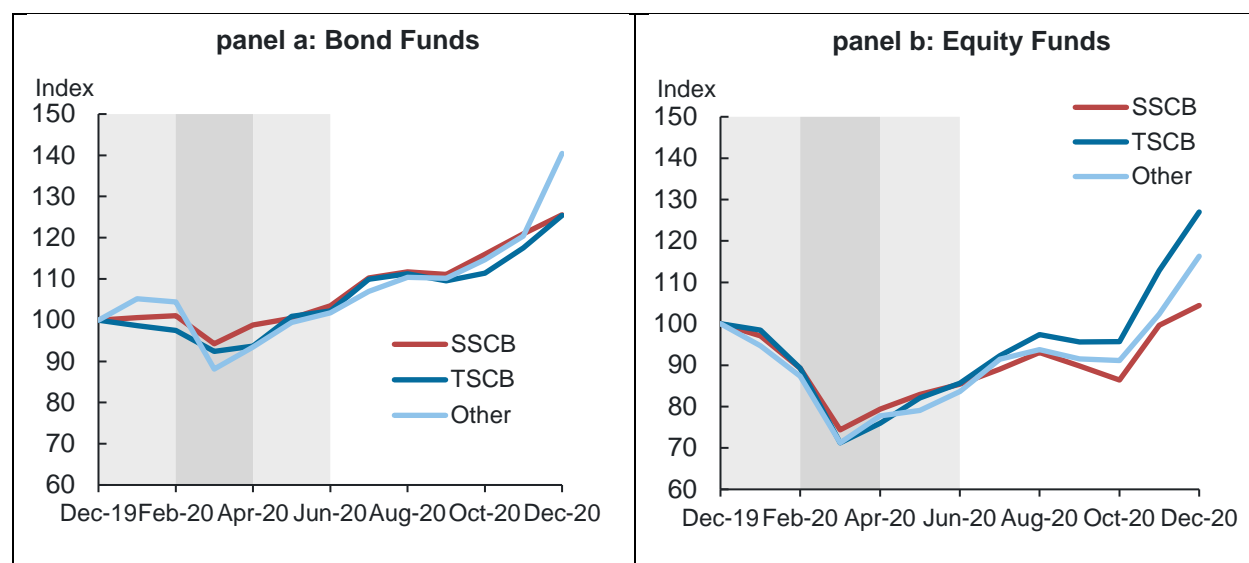
Data: BIS Locational Banking Statistics Data. Note: *Swap All* includes countries from jurisdictions with CB swaps (AUD, CAD, CHF, DKK, EUR, GBP, JPY, KRW, NOK, NZD, SEK, SGD, BRL and MXP). *Other* includes those of jurisdictions with availability to access the FIMA repo facility but not CB swaps. Currency names suppressed for confidentiality. *Period 1* Q4 2019; *period 2* Q1 2020; and *period 3* Q2 2020. Quarterly observations and each country data are normalized to its average period 1 value.

3.4 Evidence from Cross-border Bond and Equity Mutual Fund flows

As a counterpart to the cross-border flows into banks, we next consider equity and bond portfolio fund flows. Analytics on the basis showed that the sudden shift in risk sentiment contributed to higher levels of the FX swap basis in *Period 2*, with the consequent “dash for cash” encouraging entities to build extra liquidity buffers. Thus, if risk aversion remains high while central bank tools are in place as backstop for entities to get temporary funding in case of need, part of the sell-off should end. This type of dynamic is consistent with our analytical results around the basis and some of the flows associated with holdings of US Treasuries, official foreign currency reserves, and flows through banks. One related question is whether developments in the size of asset under management (AUM) of mutual funds provide insight into any role played by the Fed's international dollar liquidity backstop tools in stabilizing and normalizing investment or financial flows globally. These funds have been playing an increasingly important role across financial markets and countries (BIS CGFS 2020).

We explore how much mutual funds and EFTs invested in bonds and equities of analyzed countries using Informa Funds. Figure 4, panels (a) and (b) show that in March 2020 global asset managers facing redemptions sold some of their foreign assets and currencies holdings to raise cash and reduce risk, rather than take even larger losses on their global holdings. Many countries experienced significant outflows from their local debt and equity markets. Bond funds appear to have reverted very quickly back across all groups of countries, before increasing well beyond pre-pandemic levels. The normalization was much slower for equity funds, where on average flows did not return to pre-pandemic values until the third quarter of 2020. While patterns were similar across all groups of countries by facility access, the proportionate increases were greatest for the TSCB countries.

Figure 4: Bond and Equity Funds of Foreign Counterparties



Data: Emerging Portfolio Fund Research, Informa Funds Flow data. Shadow areas are periods defined as in Table 1. Monthly series are indexed to 100 using December 2019 values.

DIM tests (Table 8, panel b) show the sharp cross-border average declines in equity fund flows in the initial pandemic period, to about 80 percent of pre-pandemic levels, and then some mild recoveries in the latter period, for the three groupings of countries sorted by facility access. While there is some variation across individual countries, the broader pattern is that all groups of countries ended up in early summer (June-end) with significantly lower equity fund flows than pre-pandemic but completely reverted by late summer 2020 (end of August 2020). Bond fund flows on average declined in the initial pandemic stress period for *TSCB* and *Other* countries but relatively stable for *SSCB* countries. Bond fund flows recovered across the board in *Period 3*, and more rapidly than equity funds, with *Other* countries on average ending up with 9 percent greater inflows than pre-pandemic. There was not differentiation in patterns associated with type of access to Fed dollar liquidity facility, however the longer period of normalization of equity funds flows than bond funds suggests that as risk sentiment improved, funds were allocated to safer assets first and only later to more riskier assets.

As weekly data are available for these funding flows, we specifically test the evolution and scale of risk sensitivity, reporting results in Table 9. Results for equity fund flows do not show statistically significant differences in the risk sensitivity progression of *Swap All* countries as a group compared with the *Other* countries (Table 9 panel a). However, the *SSCB* countries do exhibit a greater risk sensitivity overall compared with *TSCB* countries, maintained through the full estimation period inclusive of the pre-pandemic period as indicated by the coefficient tests in the lower part of the panel [$H(0): a+c=0$ compared with $H(0): a+b+c+d=0$.]

Tests over international bond fund flows (Table 10) show that swap line countries on average had inflows when risk sentiment deteriorated (panel a, column 1, $H(0): a+c=0$), with patterns shifting to milder outflow sensitivity in the initial part of the pandemic (panel a, column 1, $H(0): a+b+c+d=0$). These distinct patterns arose from the bond flow dynamics of the *SSCB* countries compared to the *TSCB* countries, as the *SSCB* countries had much stronger inflows on average associated with increased risk sentiment, and a much stronger flattening of this sensitivity in the initial part of the pandemic. By the end of the estimation period, the *SSCB* country inflow sensitivity to risk appeared even stronger than was the case pre-pandemic (panel b, column 3, [$H(0): a+c=0$ compared with $H(0): a+b+c+d=0$.])

Table 8: EPFR Equity and Bond Fund Flows, across Country Groups and Periods**a. Equity fund flows by recipient country group (weekly data)**

	<i>PERIOD 2</i>	<i>PERIOD 3</i>	<i>PERIOD2- PERIOD1</i>	<i>PERIOD3- PERIOD2</i>	<i>PERIOD3- PERIOD1</i>
<i>SWAP All</i>	78.26	85.26	-21.74*** (2.88)	7 (4.75)	-14.74*** (3.78)
<i>Other</i>	82.52	89.84	-17.48** (5.62)	7.32 (9.22)	-10.16 (7.3)
<i>Swap All - Other</i>	-4.26	-4.58	-4.26 (6.32)	-0.32 (3.43)	-4.58 (8.22)
<i>Standing Swap</i>	79.41	86.21	-20.59*** (4.89)	6.79 (7.49)	-13.79* (5.67)
<i>Temporary Swap</i>	77.62	84.74	-22.38*** (3.77)	7.12 (6.42)	-15.26** (5.2)
<i>Standing - Temporary Swap</i>	1.79	1.47	1.79 (6.18)	-0.32 (2.73)	1.47 (7.69)
<i>Standing Swap - Other</i>	-3.11	-3.63	-3.11 (7.45)	-0.53 (3.34)	-3.63 (9.25)
<i>Temporary Swap - Other</i>	-4.9	-5.1	-4.9 (6.77)	-0.21 (3.87)	-5.11 (8.97)

b. Bond Fund Flows by recipient country group (weekly data)

	<i>PERIOD 2</i>	<i>PERIOD 3</i>	<i>PERIOD2- PERIOD1</i>	<i>PERIOD3- PERIOD2</i>	<i>PERIOD3- PERIOD1</i>
<i>SWAP All</i>	95.54	100.75	-4.46 (4.05)	5.21 (6.1)	0.75 (4.57)
<i>Other Countries</i>	100.34	108.97	0.34 (7.45)	8.63 (15.64)	8.97 (13.76)
<i>Swap All - Other</i>	-4.8	-8.22	-4.8 (8.48)	-3.42 (6.77)	-8.22 (14.5)
<i>Standing Swap</i>	98.52	102.50	-1.48 (1.2)	3.98 (2.3)	2.5 (1.97)
<i>Temporary Swap</i>	93.88	99.78	-6.12 (6.33)	5.9 (9.56)	-0.22 (7.17)
<i>Standing - TSCB</i>	4.64	2.72	4.63 (6.44)	-1.91 (3.59)	2.72 (7.43)
<i>SSCB - Other</i>	-1.82	-6.47	-1.82 (7.54)	-4.65 (6.78)	-6.47 (13.9)
<i>TSCB-Other</i>	-6.46	-9.19	-6.45 (9.77)	-2.73 (7.12)	-9.19 (15.51)

*p<0.1 **p<0.05 ***p<0.001. Standard errors are between brackets.

Data: Emerging Portfolio Fund Research, Informa Funds Flow data. Note: Weekly series are indexed to 100 using December 2019 to February 2020 average values. *Swap All* includes countries from jurisdictions with CB swaps (AUD, CAD, CHF, DKK, EUR, GBP, JPY, KRW, NOK, NZD, SEK, SGD, BRL and MXP). *Other* includes those of jurisdictions with availability to access the FIMA repo facility but not CB swaps. Currency names suppressed for confidentiality.

Table 9 Risk Sensitivity of EFPR Equity Fund Flows across Country Groups and Periods

Panel A: Equities. Swap All (Group Dummy) and Other			
	(1) <i>PERIOD 1 & PERIOD 2</i>	(2) <i>PERIOD 2 & PERIOD 3</i>	(3) <i>PERIOD 1 & PERIOD 3</i>
VIX (a)	-49.39 (212.72)	-3.79 (293.74)	-41.58 (139.89)
period_VIX (b)	-18.14 (164.1)	51.95 (308.07)	-34.25 (81.92)
group_VIX (c)	-413.88 (260.53)	-223.09 (359.76)	-388.26*** (171.32)
group_period_VIX (d)	-65.91 (200.98)	269.94 (377.31)	-67.95 (100.33)
H(0): a + b = 0	-67.52	48.15	-75.83
H(0): a + c = 0	-463.26***	-226.88	-429.83***
H(0): a + b + c + d = 0	-547.31***	95	-532.03***
Panel B: Equities. SSCB (Group Dummy) and TSCB			
VIX (a)	-73.93 (157.17)	-50.49 (249.18)	-68.38 (129.97)
period_VIX (b)	-30.72 (121.24)	29.82 (261.33)	-58.36 (76.11)
group_VIX (c)	-1090.12*** (262.99)	-493.91 (416.95)	-1012.08*** (217.49)
group_period_VIX (d)	-149.3 (202.88)	817.79* (437.29)	-122.75 (127.36)
H(0): a + b = 0	-104.66*	-20.67	-126.73
H(0): a + c = 0	-1164.06***	-544.4	-1080.46***
H(0): a + b + c + d = 0	-1344.08***	303.21	-1261.57***

*p<0.1 **p<0.05 ***p<0.001. Standard errors are between brackets.

Data: Emerging Portfolio Fund Research, Informa Funds Flow data; Bloomberg. Note: The table shows a range of specifications with (1) being: $FXbasis_{c,t} = constant + a \cdot VIX_t + b \cdot period_VIX_t + c \cdot group_VIX_t + d \cdot group_period_VIX_t + e_t$. In (1), VIX is Cboe volatility index, period is a dummy equal to 1 during the later period of each data period included in the column. period_VIX (b) captures any change in sensitiveness in the second period; group is equal to 1 for FX swap basis spreads of currencies of jurisdictions with swap lines (Swap All, panel a; SSCB, panel b). Note: *Period 1* covers from February 1, 2020, through March 10, 2020; *period 2* covers from March 19, 2020, through April 4, 2020; and *period 3* covers from May 21, 2020, through June 30, 2020. *Swap All* includes currencies of jurisdictions with CB swaps (*Standing Swap or SSCB*: CAD, CHF, EUR, GBP, JPY; *Temporary Swap or TSCB*: AUD, DKK, KRW, NOK, NZD, SEK, SGD, BRL and MXP), *Other* includes those of jurisdictions with availability to access the FIMA repo facility but not CB swaps. Currency names suppressed for confidentiality.

Table 10 Risk Sensitivity of EFPR Bond Fund Flows across Country Groups and Periods

Panel A: Bonds. Swap All (Group Dummy) and FIMA Repo Only			
	(1)	(2)	(3)
	PERIOD 1 & PERIOD 2	PERIOD 2 & PERIOD 3	PERIOD 1 & PERIOD 3
VIX (a)	13.42 (45.65)	-7.28 (106.72)	10.38 (49.65)
period_VIX (b)	-1.04 (35.22)	9.96 (111.93)	30.14 (29.07)
group_VIX (c)	70.45 (53.19)	-0.19 (124.33)	78.94 (57.84)
group_period_VIX (d)	-112.11*** (41.03)	144.9 (130.39)	-12.77 (33.87)
H(0): a + b = 0	12.37	2.68	40.52
H(0): a + c = 0	83.86***	-7.48	89.32***
H(0): a + b + c + d = 0	-29.29***	147.38	106.69***
Panel B: Bonds. SSCB (Group Dummy) and TSCB			
VIX (a)	9.82 (33.82)	-13.56 (76.3)	9.95 (38.22)
period_VIX (b)	-22.52 (26.09)	24.74 (80.02)	3.05 (22.38)
group_VIX (c)	207.32*** (56.59)	17.03 (127.67)	222.23*** (63.96)
group_period_VIX (d)	-253.78*** (43.65)	364.33*** (133.89)	40.1 (37.46)
H(0): a + b = 0	-12.7	11.18	13
H(0): a + c = 0	217.14***	3.47	232.17***
H(0): a + b + c + d = 0	-59.16***	392.55*	275.33***

*p<0.1 **p<0.05 ***p<0.001. Standard errors are between brackets.

Data: Emerging Portfolio Fund Research, Informa Funds Flow data; Bloomberg. Note: The table shows a range of specifications with (1) being: $FXbasis_{c,t} = constant + a \cdot VIX_t + b \cdot period_VIX_t + c \cdot group_VIX_t + d \cdot group_period_VIX_t + e_t$. In (1), *VIX* is Cboe volatility index, *period* is a dummy equal to 1 during the later period of each data period included in the column. *period_VIX* (b) captures any change in sensitiveness in the second period; *group* is equal to 1 for FX swap basis spreads of currencies of jurisdictions with swap lines (Swap All, panel a; SSCB, panel b). Note: *Period 1* covers from February 1, 2020, through March 10, 2020; *period 2* covers from March 19, 2020, through April 4, 2020; and *period 3* covers from May 21, 2020, through June 30, 2020. *Swap All* includes currencies of jurisdictions with CB swaps (*Standing Swap or SSCB*: CAD, CHF, EUR, GBP, JPY; *Temporary Swap or TSCB*: AUD, DKK, KRW, NOK, NZD, SEK, SGD, BRL and MXP), *Other* includes those of jurisdictions with availability to access the FIMA repo facility but not CB swaps. Currency names suppressed for confidentiality.

4. Concluding remarks

During the GFC and the COVID-19 period the Federal Reserve demonstrated a commitment to well-functioning offshore U.S. dollar funding and credit markets. The dollar liquidity made available through swap lines with other central banks, and potentially later through the FIMA repo facility, helped calm global dollar funding markets, supported continuing provision of credit, and limited disruptive financial amplification effects of the worldwide pandemic shock. This paper shows a range of effects of the Fed's international dollar liquidity facilities in the Spring of 2020, among which some are relevant for policy considerations. These effects we identify should be viewed as suggestive but not definitive, as the pandemic shock and policy responses evolved together across countries, but also with dramatic differences that are difficult to capture in any simple analytics.

First, there is evidence that in a very short time offshore dollar funding market conditions stabilized, their sensitivity to risk decreased, and credit provision stabilized or increased, particularly in countries with standing swap arrangements. For the medium-term horizon, access to the different types of the Fed's international dollar facilities appear to matter for the speed and degree of normalization, with both pricing and credit availability largely normalized across all countries by Summer 2020, with the exception of equity fund flows.

Some of the countries with access to temporary facilities, in the form of temporary swap lines or the FIMA repo facility, continued to rely on their own funds, and sell part of the U.S. Treasury holdings, to support dollar liquidity provision to local entities or increase liquidity, instead of drawing on available facilities with the Fed. These countries may view the facility as a complement to locally sourced liquidity and sufficiently large FX reserve balances, possibly with a view that there is no guarantee that the Fed would provide liquidity in volatile periods. Countries without swap lines continued to rely on their own funds for longer as it took some time for them to establish their FIMA repo accounts.

Second, in the early part of the pandemic banking systems of all countries continued to provide credit to both bank and nonbank borrowers in external locations, particularly those banking systems from countries with swap lines access. Inflows to countries with swap lines were also particularly robust in the spring of 2021 in comparison to other countries. The gap closed after the FIMA repo accounts were established, as the surge in liabilities of banks in swap line countries reverted and banks in other countries received increases in inflows. Along with evidence drawn from examining internal capital flows between foreign banks hosted in the United States and their parent organizations, it appears that availability of Fed facilities supports continuation of cross-border lending and credit provision for countries that can access these facilities.

Third, despite evidence that the global portfolio flows sensitivity to risk declined, longer-term patterns of liquidity and capital flows across borders was not broadly changed by type of access to the Fed's international dollar facilities. Bond flows attracted funds, while equity flows remained depressed in the higher risk environment.

Finally, some new vulnerabilities of the post-GFC dollar funding landscape, as well as the speed and extend of related normalization, were related to the increased role played by NBFIs, a point discussed in BIS CGFS (2021) and in Choi, Goldberg, Lerman and Ravazzolo (2021). Non-banks have access to a narrower range of US dollar funding sources, including central bank backstop facilities. The large

footprint of non-bank financial institutions in some market also increases the risk of possible fire sales of dollar assets in cases of stress that could amplify any market volatility. Some of these dynamics in March 2020 raised questions about reducing such vulnerabilities and the span of availability of dollar liquidity from backstop tools at local central banks.

5. References

Afonso, Gara, Fabiola Ravazzolo and Alessandro Zori, 2019. "From Policy Rates to Market Rates—Untangling the U.S. Dollar Funding Market". *Federal Reserve Bank of New York Liberty Street Economics* July 8, 2019.

Aizenman, Joshua and Gurnain Kaur Pasricha, 2010. "Selective Swap Arrangements and the Global Financial Crisis." *International Review of Economics and Finance* 19(3) 353-365.

Aizenman, Joshua, Hiro Ito and Gurnain Kaur Pasricha, 2022. "Central Bank Swap Arrangements in the COVID-19 Crisis", *Journal of International Money and Finance* vol. 122.

Aldasoro, Inaki, Christian Cabanilla, Piti Disyatat, Torsten Ehlers, Patrick McGuire and Goetz von Peter, 2020. "Central bank swap lines and cross-border bank flows", *BIS Bulletin*, no.34, Bank for International Settlements, December.

Aldasoro, Inaki, Egemen Eren, Wenqian, Huang, 2021. "Dollar funding of non-US banks through COVID-19", *BIS Quarterly Review* Bank for International Settlements, March.

Avdjiev, Stefan, Egemen Eren and Patrick McGuire, 2020. "Dollar funding costs during the Covid-19 crisis through the lens of the FX swap market." *BIS Bulletin* no 1 Bank for International Settlements, April.

Avdjiev, Stefan, Leonardo Gambacorta, Linda Goldberg and Stefano Schiaffi, 2020. "The Shifting Drivers of International Capital Flows", *Journal of International Economics* vol. 125 (c).

Baba, Naohiko and Frank Packer, 2009. "From turmoil to crisis: dislocations in the FX swap market before and after the failure of Lehman Brothers", *Journal of International Money and Finance*, vol 28, no 8, December 2009, pp 1350-74.

Bahaj, Saleem and Ricardo Reis, 2021. "Central Bank Swap Lines: Evidence on the Effects of the Lender of Last Resort", *Review of Economic Studies*.

BIS CGFS, 2020. "US dollar funding: an international perspective", *BIS CGSF Paper No 65*, Bank for International Settlement.

BIS CGFS, 2021. "Changing patterns of capital flows", *BIS CGSF Paper No 66*, Bank for International Settlement.

Boissay, F, N Patel and Hyun Song Shin, 2020. "Trade credit, trade finance, and the Covid-19 Crisis", *BIS Bulletin* 24, 19 June.

Cetorelli, Nicola and Linda Goldberg, 2011. "Global Banks and Their Internal Capital Markets during the Crisis", *Federal Reserve Bank of New York Liberty Street Economics*, July 11, 2011.

Cetorelli, Nicola, Linda Goldberg and Fabiola Ravazzolo, 2020a. "Have the Fed Swap Lines Reduced Dollar Funding Strains during the COVID-19 Outbreak?" *Federal Reserve Bank of New York Liberty Street Economics* May 22.

Cetorelli, Nicola, Linda Goldberg and Fabiola Ravazzolo, 2020b. "How Fed Swap Lines Supported the U.S. Corporate Credit Market amid COVID-19 Strains", *Federal Reserve Bank of New York Liberty Street Economics* June 12.

Choi, Mark, Linda Goldberg, Robert Lerman, and Fabiola Ravazzolo, 2022. "COVID Response: The Fed's Central Bank Swap Lines and FIMA Repo Facility." Federal Reserve Bank of New York, *Economic Policy Review*.

Du, Wenxin, A. Tepper and Adrien Verdelhan, 2018. "Deviations from covered interest rate parity", *Journal of Finance* 73 (3) 915-957.

Eguren-Martin, Fernando, 2020. "Dollar shortages and central bank swap lines", Staff working paper no. 879 Bank of England.

Eren, Egemen, Andreas Schrimpf and Vladyslav Sushko, 2020b. "US dollar funding markets during the Covid-19 crisis – the international dimension", *BIS Bulletin*, no. 15, Bank for International Settlements, May.

EMEAP, 2020. "Study on US dollar Liquidity and Funding Dynamics in the EMEAP Region", EMEAP Working Group on Financial Markets.

Financial Stability Board, 2020. "Holistic Review of the March Market Turmoil", Issue 2020/11, Report to the G20.

Fleming, Michael J. and Nicholas Klagge, 2010. "The Federal Reserve's Foreign Exchange Swap Lines". *Current Issues in Economics and Finance*, Vol. 16, No. 4, April.

Gislén, Marushia, Ida Hansson and Ola Melander, 2021. "Dollar liquidity from the Federal Reserve to other central banks", 27 *Sveriges Riksbank Economic Review* 2021:1 .

Goldberg, Linda, Craig Kennedy, and Jason Miu, 2011. "Central Bank Dollar Swap Lines and Overseas Dollar Funding Costs", *Federal Reserve Bank of New York Economic Policy Review* vol. 17 no.1 pp. 3-20 (May).

Goldberg, Linda, Cindy Hull and Sarah Stein, 2013. "Do Industrialized Countries Hold the Right Foreign Exchange Reserves?" *Federal Reserve Bank of New York Current Issues in Economics*, vol. 19, no. 1, April.

Goldberg, Linda and Signe Krogstrup, 2019. "International Capital Flow Pressures." NBER working paper #24286 (October).

Goldberg, Linda and David R. Skeie, 2011. "Why Did U.S. Branches of Foreign Banks Borrow at the Discount Window during the Crisis?" *Federal Reserve Bank of New York Liberty Street Economics*, April 13.

Liao, Gordon and Tony, Zhang, 2020. "The Hedging Channel of Exchange Rate Determination", International Finance Discussion Papers Number 1283, Board of Governors of the Federal Reserve System.

Mancini Griffoli, Tommaso and Angelo, Ranaldo, 2012. "Limits to Arbitrage during the Crisis: Finding Liquidity Constraints and Covered Interest Parity," Working Papers on Finance 1212, University of St. Gallen, School of Finance.

McCauley, Robert N. and Catherine R. Schenk, 2020. "Central bank swaps then and now: swaps and dollar liquidity in the 1960s", BIS Working Papers No 851.

Obstfeld, Maurice, Jay Shambaugh, and Alan Taylor, 2009. "Financial instability, reserves, and central bank swap lines in the panic of 2008" *American Economic Review* 99 (2) 480-86.

Persi, Gianluca, 2020. "US dollar funding tensions and central bank swap lines during the COVID-19 crisis". ECB *Economic Bulletin*, Issue 5/2020 (europa.eu)

Rose, Andrew and Mark Spiegel. 2012. "Dollar illiquidity and central bank swap lines during the global financial crisis" *Journal of International Economics* vol 88(2) 326-340.