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Article — Published Version

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Journal of Money, Credit and Banking

Provided in Cooperation with:

John Wiley & Sons

Suggested Citation: Eguren-Martin, Fernando; Ossandon Busch, Matias; Reinhardt, Dennis (2023) : Global Banks and Synthetic Funding: The Benefits of Foreign Relatives, Journal of Money, Credit and Banking, ISSN 1538-4616, Wiley, Hoboken, NJ, Vol. 56, Iss. 1, pp. 115-152, <https://doi.org/10.1111/jmcb.13037>

This Version is available at:

<https://hdl.handle.net/10419/293956>

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Global Banks and Synthetic Funding: The Benefits of Foreign Relatives

This paper examines the effect of dislocations in foreign currency (FX) swap markets (“CIP deviations”) on bank lending. Using data from UK banks we show that when the cost of obtaining swap-based funds in a particular foreign currency increases, banks reduce the supply of cross-border credit in that currency. This effect is increasing in the degree of banks’ reliance on swap-based FX funding. Access to foreign relatives matters as banks employ internal capital markets to shield their cross-border FX lending supply from the described channel. Partial substitution occurs from banks outside the UK not affected by changes in synthetic funding costs.

JEL codes: F34, G21

This paper was previously circulated under the title of “*FX funding shocks and cross-border lending: fragmentation matters.*” We would like to thank Iñaki Aldasoro, Saleem Bahaj, Thorsten Beck, Valentina Bruno, Steve Bond, Barbara Casu, Nicola Cetorelli, Matthieu Chavaz, Ricardo Correa, Mariassunta Gianetti, Michael McMahon, Friederike Niepmann, Steven Ongena, Daniel Paravisini, Ilaria Piatti, Horacio Sapriza, Philip Strahan, Elod Takats, Neeltje van Horen and seminar/conference participants at the Bank of England, the 4th BIS-CGFS workshop on the use of BIS international banking and financial statistics, the Bundesbank, Cass Business School, Annual Meetings of the European Economic Association, Federal Reserve Bank of New York, Federal Reserve Board, Halle Institute for Economic Research and Oxford University for useful comments and discussions. We thank the Bank of England Research Collaboration Fund for supporting this work (RCF 201909). The views expressed in this paper are solely those of the authors and should not be taken to represent those of the Bank of England or SPX Capital. In the case of Fernando Eguren, all his contributions to this paper were made when he was employed at the Bank of England.

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Received June 1, 2021; and accepted in revised form February 28, 2022.

Journal of Money, Credit and Banking, Vol. 56, No. 1 (February 2024)

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Keywords: cross-border bank lending, covered interest rate parity deviations, FX swaps, internal capital markets

THE INTERNATIONAL MARKET FOR CROSS-BORDER bank lending is characterized by the widespread origination of claims in currencies which are “foreign” from the lenders’ perspective. As of end-2016, around 82% of global cross-border claims in U.S. dollars were originated outside the United States, while 35% of euro claims came from jurisdictions outside the Euro Area.¹ This feature of the international financial landscape highlights the importance of FX funding markets, on which banks rely to fund the global supply of cross-border foreign currency (FX) loans (Bruno and Shin 2015, Ivashina, Scharfstein, and Stein 2015, Correa, Sapriz, and Zlate 2016).

One of these markets for FX funds, namely, that of FX swaps (usually called “synthetic” funding), is central to the functioning of global banking operations (Borio, McCauley, and McGuire 2017) and has seen large dislocations in its pricing since the global financial crisis, leading to the emergence of apparent arbitrage opportunities (“CIP deviations”). The turmoil in financial markets resulting from the acceleration in the Covid-19 pandemic is the most recent example of these dynamics, as the price of accessing U.S. dollars offshore shot up as cases accumulated, with direct consequences for the global banking system (see, e.g., Avdjiev, Eren, and McGuire 2020, Borio 2020, and Eren, Schrimpf, and Sushko 2020). These dislocations in FX swap markets have been the focus of a series of recent studies (Avdjiev et al. 2019, Cenedese, Della Corte, and Wang 2019, Cerutti, Obstfeld, and Zhou 2021, Du, Tepper, and Verdelhan 2018, Heidorn and Mamadalizoda 2019, Borio et al. 2016), which have nevertheless largely focused on their causes but not the consequences for other variables of interest.²

In this paper, study how dislocations in the market for FX swaps directly affect the stability of cross-border credit supply. We find that increases in the relative cost of synthetic FX funding lead to a reduction in the supply of cross-border credit denominated in the currency affected. Our analysis shows that these dynamics are not exclusive of crisis periods and that the effect on lending (intensive margin) is increasing in the size of the dislocation (as measured by CIP deviations). An important element of our identification strategy is that we use cross-sectional variation in our sample to show that the lending of banks’ with greater reliance on swap-based FX funding is more affected than the lending of banks which are less reliant in the face of these shocks. We also show that the effect of these dislocations in FX swap markets on bank lending is particularly acute in combination with institutional frictions that prevent banks to access alternative sources of FX funding abroad. When these frictions are alleviated—for instance via access to networks of foreign “relatives”—

1. The number for the United States is lower (i.e., 75%) when counting USD originated in the Cayman Islands toward U.S. originated claims. See Figure 2 for data sources.

2. One exception is Liao (2020), who relates CIP deviations to corporate debt issuance.

the lending effect of FX swap shocks weakens. The data set we rely on to uncover these effects offers rich bank-level information for banks operating from the United Kingdom, an ideal vantage point given that the United Kingdom is the single largest global originator of cross-border bank credit, a large share of which is denominated in currencies other than sterling.

Why would we expect changes to the cost of swap-based FX funding to affect banks' lending decisions? At first glance, FX swaps are only one of several alternative FX funding channels banks can rely on to access FX liquidity. Banks could, for instance, issue debt directly in money markets, raise FX deposits, or exploit their internal capital markets (ICM) to tap FX liquidity abroad. If these alternative FX funding channels are available for banks—that is, in a world of frictionless and well-integrated FX funding markets—changes to the costs of accessing FX swap markets should only alter banks' funding mix, without translating into disruptions in banks' credit supply in different currencies. Liquidity strains affecting one distinct FX funding channel could be compensated by accessing liquidity in other markets. In reality, however, some banks may face restrictions in accessing funding sources alternative to swap-based FX funding, triggering an effect on cross-border lending from funding shocks to FX swap markets. Limits to the capacity of on-balance-sheet funding to offset synthetic funding shocks could arise from a variety of sources, including possibly regulation-driven lack of access to certain funding markets, an inelastic demand for FX deposits, as well as time delays involved in the issuance of certain securities such as bonds.

If frictions existed and banks had limited access to on-balance-sheet FX funding, then these institutions may resort to swap-based FX funding as a way of overcoming geographical, regulatory, or informational barriers. In this scenario, banks with large reliance on FX swap funding could be expected to adjust their balance sheet by more once funding shocks in FX swap markets occur. We test for this hypothesis by analyzing heterogeneities in the reaction of bank lending to shocks to the cost of synthetic funding, particularly as a function of banks' access to alternative funding sources, including ICM.

In order to measure funding shocks in FX swap markets we rely on the time series of deviations from the covered interest rate parity condition (in what follows “CIP deviations”) between sterling on the one side and U.S. dollar and euro on the other, between 2003 and 2016.³ We work under the assumption that for banks operating in the United Kingdom access to funding in sterling should be easier than that to foreign currencies, so that sterling can be used as a base currency in swap trades aimed at securing dollar and euro funds. We exploit violations in the CIP condition observed most markedly since 2008 to proxy for funding cost shocks—positive and negative—

3. CIP deviations measure the difference between the “cash” or money market interest rate in a given FX and the corresponding synthetic funding rate resulting from raising funds in banks' domestic currency and using the proceeds to buy foreign currency while hedging the FX risk. Following convention, a negative CIP deviation of sterling vis-à-vis the U.S. dollar reflects a situation in which direct U.S. dollar funding in cash markets is cheaper than the synthetic alternative.

affecting FX swaps of sterling vis-à-vis U.S. dollars and euros. For this purpose, we build on previous contributions documenting how CIP deviations reflect changing funding conditions in FX swap markets (see Ivashina, Scharfstein, and Stein 2015).

We base our analysis on an identification strategy that exploits balance sheet data on global banks operating from the United Kingdom, tracing their cross-border assets and liabilities (and other balance sheet characteristics) on a destination country-currency-quarter dimension. Adapting the established literature (i.e., Cetorelli and Goldberg 2011, Ongena, Peydró, and van Horen 2015), we define the destination country-currency dimension as banks' relevant markets and estimate the effect of FX synthetic funding shocks on currency-specific cross-border lending, conditional on banks' *ex ante* exposure to FX synthetic funding. The richness of the data allows us to saturate the empirical model with country-currency-quarter fixed effects, absorbing nonobservable time-varying confounders such as borrowers' (currency-specific) demand shocks. We implement this identification strategy on a sample that covers the activities of 106 banks lending to 70 countries between 2003 and 2016.

Our results suggest that shocks in global synthetic FX funding markets significantly affect the supply of cross-border FX lending by banks located in the United Kingdom. Importantly, the effect on lending we document is increasing in the degree of banks' reliance on synthetic funding (RSF). Consider a bank that has a ratio of U.S. dollar synthetic funding relative to total dollar assets that is one standard deviation above the sample mean. A widening of the CIP deviation of 14 basis points in the sterling-U.S. dollar basis (i.e., the standard deviation of its changes) leads the bank in consideration to cut back U.S. dollar lending growth by 1.4 percentage points in comparison to a bank with average synthetic funding exposure.

In a second step, we explore whether banks' access to alternative (on-balance-sheet) FX funding sources shields their supply of FX cross-border lending. Indeed, we find that large access to alternative sources of FX funding shields banks' cross-border FX lending supply from synthetic FX funding shocks, but only if such access occurs via ICM. We corroborate these findings by documenting how banks effectively draw FX funds from their internal (foreign) network in these events; that is, there are *advantages of having foreign relatives* in these instances. These results inform discussions on the financial stability implications of possible institutional frictions and fragmentation in international funding markets (see, for instance, Dobler et al. 2016 and FSB 2019).

In a final exercise, and in order to estimate the aggregate effect of shocks to the cost of synthetic funding, we explore potential substitution effects from borrowers into unaffected lenders. By aggregating data at the destination country-currency level, we find that banks from the relevant currency areas tend to step in and increase lending in the event of a retreat of UK banks when synthetic funding shocks hit, particularly in the case of the most affected markets. However, this does not typically lead to a full offset of the cut back in UK-originated lending.

Even though the reliance on synthetic FX funding as a share of total FX funding by banks has been significant over the past decades, the implications of funding shocks in these markets for cross-border lending have not yet been investigated to the best

of our knowledge.⁴ By exploring the conditions under which global banks' reliance on FX swap funding affect their cross-border FX credit supply we are, to the best of our knowledge, the first to document the existence and functioning of a cross-border lending channel of funding shocks to the synthetic FX funding market.

Our work contributes to three strands of the literature. The first relates to studies documenting how market imperfections in bank funding markets affect credit supply in general, and the provision of cross-border credit by globally active banks in particular (a literature that has boomed since the studies of Peek and Rosengren 1997 and Peek and Rosengren 2000). For example, Cetorelli and Goldberg (2012a) show how global banks managed liquidity from a group-level perspective during the global financial crisis by exploiting their network of bank branches worldwide when facing liquidity shocks.⁵ Compared to previous studies we are able to focus on a detailed channel of intragroup support in specific currencies, which can address the reliance on FX synthetic funding in times when such funding becomes more expensive. More specifically, compared to the work by Cetorelli and Goldberg (Cetorelli and Goldberg 2012a, ,2012b, ,2012c), we find that this support channel is at work for both parent banks (as they find) but also for foreign affiliate branches. These studies do not focus on the FX composition of such lending and do not address the role of banks' reliance on FX synthetic funding.

A second strand of literature we relate to focuses specifically on the effect of FX funding costs on banks' credit supply (see Acharya, Afonso, and Kovner 2017 and Correa, Saprizza, and Zlate 2016, among others). While many existing studies focus on the syndicated loan market within the United States, we widen the scope and consider overall lending globally (albeit originated in the United Kingdom) with particular attention given to currencies of denomination. Therefore, and in comparison to previous studies, we concentrate on a different financial friction (namely, global banks' reliance on FX synthetic funding as a mean to overcome fragmented FX funding markets) and look at the effect of shocks on a broader set of FX-denominated bank claims.

Particularly noteworthy for our analysis is the study of Ivashina, Scharfstein, and Stein (2015).⁶ This paper provides a theoretical framework in which a creditworthiness shock affects foreign banks' U.S. dollar lending as U.S. dollar wholesale funding

4. Borio, McCauley, and McGuire (2017) come up with a figure for the share of U.S. dollar synthetic funding in the neighborhood of 10%.

5. Correa, Du, and Liao (2020) also document an important role for within-group liquidity management to sustain credit to third parties in the face of U.S. dollar liquidity shortages in the case of U.S. Global systemically important banks (GSIBs) Previously, De Haas and van Lelyveld (2014) found that during the global financial crisis parent banks did not act as significant providers of intragroup support.

6. Bräuning and Ivashina (2020) also present a model (and related empirics) of banks that can access synthetic funding. Their results suggest that ICM are used by banks to exploit interest rate differentials caused by changes in monetary policy, eventually leading to a high demand for FX swaps and liquidity shortages in jurisdictions where this internal liquidity is reallocated. In contrast, we document that ICM can also play a role in the opposite direction, offsetting shortages in the supply of FX swaps.

in U.S. markets is withdrawn. Banks respond to this shock by increasing their reliance on U.S. dollar synthetic funding, putting pressure on the FX swap market, driving up costs, and eventually leading to cuts in U.S. dollar lending compared to lending in their domestic currency. In their empirical extension, they show that European banks exposed to a creditworthiness shock reduced their supply of U.S. dollar syndicated loans relative to euro loans both in Europe and the United States at the height of the European debt crisis. Our work differs from this study in two central dimensions. First, our empirical setup allows us to focus on the direct consequences of changes in CIP deviations, rather than analyzing those as an intermediate channel of other shocks (e.g., credit worthiness or monetary policy shocks). Importantly, the effect we find is: (i) increasing in its intensive margin on the size of the underlying dislocations and (ii) also present in noncrisis periods. Second, we concentrate the analysis on cross-border lending in multiple FX currencies—U.S. dollar and euro—while using banks’ domestic currency—sterling—as a benchmark.

Finally, our paper is also related to the recent set of studies investigating the occurrence of CIP deviations (see, e.g., Borio et al. 2016, Abbassi and Bräuning 2018, Du, Tepper, and Verdelhan 2018, Cenedese, Della Corte, and Wang 2019). In contrast to most of these, we focus on the side of “liquidity takers” in these markets and take CIP deviations as given, instead focusing on the consequences of these in terms of cross-border bank lending.

The remainder of the paper proceeds as follows. Section 1 provides an overview of currency choice in cross-border banking and describes the data set. Section 2 presents the identification strategy and reports our baseline results and robustness checks. Section 3 explores the role of access to alternative FX funding markets. Section 4 presents results accounting for potential lender-substitution effects across borrowers. Section 5 concludes.

1. DATA AND STYLIZED FACTS

1.1 Currency Choice in Cross-Border Bank Lending

A distinct feature of the international financial system is the large share of cross-border banking claims denominated in “foreign” currencies (i.e., not the domestic currency of the originator country). This share has been relatively stable around 60% of total cross-border banking claims in the period between 2003 and 2017 (Figure 2). Most significantly, as of end-2016, cross-border flows in U.S. dollars originated outside the United States represented around 40% of total (world-level) claims. In terms of geographic origin, cross-border banking claims’ origination is dominated by the world’s financial centres: Figure 1 shows that the United Kingdom is the largest lender by a wide margin.

Given the prominence of “foreign currency” loans in cross-border bank lending, it follows that the supply of these loans depends to a large extent on global banks being able to access FX funding. Borio, McCauley, and McGuire (2017) discusses how

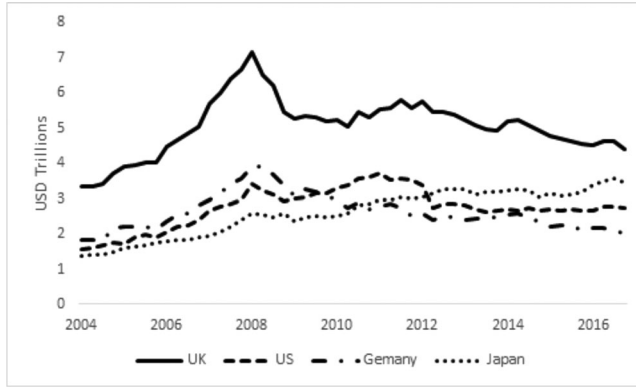


Fig 1. Cross-Border Bank Claims by Country of Origin.

NOTES: This figure depicts aggregate cross-border claims in U.S. dollar trillions from 2004 to 2016 on a quarterly basis. The figure is based on data from the BIS Locational Banking Statistics. Each line represents the aggregate claims originated by banks located in the United Kingdom, the United States, Germany, and Japan. German data are interpolated when missing.

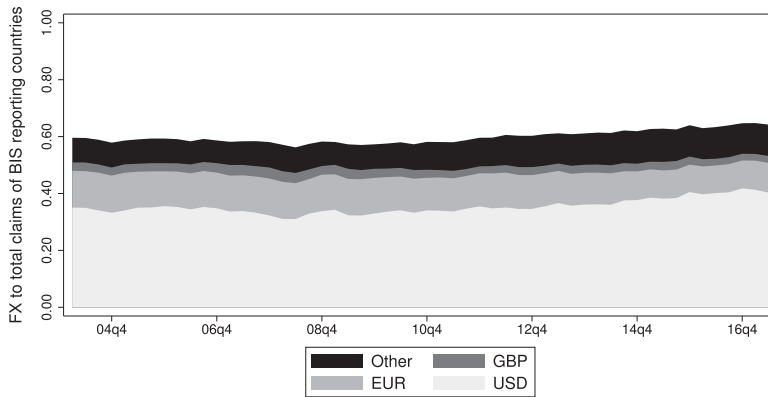


Fig 2. Cross-Border Bank Claims in Currencies Other than Originator Home Currency.

NOTES: Authors' calculations based on the BIS Locational Banking Statistics. The figure shows the share of cross-border claims originated outside the currencies' domestic countries with respect to total currency-specific claims originated in all BIS reporting countries. The figure reports the breakdown for U.S. dollar (USD), sterling (GBP), euro (EUR), and other currencies (Other). The figure shows that around 60% of cross-border claims originate outside the home countries of their currencies of denomination. Cross-border flows in U.S. dollar originated outside the United States represent around 40% of total (world-level) claims.

these funding sources can be divided into four main channels: banks' FX deposit liabilities to nonbanks, interbank FX liabilities (interbank and intragroup), international bonds, and net FX swaps. As of 2016, out of an estimated 10 trillion of non-U.S. banks' U.S. dollar liabilities, FX deposits were the largest funding source, accounting for 60% of the total. Deposits were followed by international bonds (25%), FX swaps

(10%), and interbank liabilities (5%). This emphasizes the variety of sources potentially available for banks when choosing a given FX funding mix. These figures are similar to analogous ones computed considering the sample of banks operating from the United Kingdom that are at the core of our analysis, as described in more detail in the next section.

1.2 Banks Balance Sheet Data

In order to explore the effect of liquidity shocks in FX swap markets on cross-border bank lending in “foreign” currencies, we take the perspective of banks operating in the United Kingdom and providing cross-border FX loans in currencies different than sterling. In particular, we focus on banks lending abroad in U.S. dollars and euros. Our main data source is a panel of quarterly banks’ balance sheet data constructed from regulatory filings submitted to the Bank of England by domestic and foreign banks operating in the United Kingdom.⁷

Our baseline-dependent variable measures the quarter-to-quarter growth rate in currency-specific international claims between bank i and all borrowers located in country j . This measure of FX claims includes borrowers both from the financial and nonfinancial sectors. We focus our analysis on different country-currency markets outside the United Kingdom. For each bank i , we look at its cross-border claims vis-à-vis country j in two currencies, namely, U.S. dollars and euros. Further positions in yen, Swiss franc, and “other currencies” are not considered given the impossibility to trace back banks’ RSF in those currencies due to data limitations.⁸ This latter exclusion should not be problematic given the small size of claims denominated in these currencies.

We start from a raw data set containing information on 376 banks reporting cross-border claims in at least one quarter over 2003–16. We implement a sampling procedure to focus on stable bank-country-currency relationships that can be observed throughout the period of analysis, as the identification strategy outlined below requires tracing bank-market relationships over time so as to pin-down the effect of FX swap funding shocks. Also for identification purposes, only country-currency destination markets in which claims are held by at least two different banks in each quarter are considered. Our final data set covers 106 banks. These banks lend to borrowers in 70 countries, creating a sample of 1,315 bank-country-currency relationships. The final sample covers on average 71.2% of U.S. dollar and euro cross-border claims

7. We combine data contained in three of these forms. First, we obtain selected balance sheet variables from form BT, which reports a comprehensive picture of the structure of each bank’s balance sheet. Second, we use information reported in forms CC and CL, which provide detailed data on banks’ international claims and liabilities. These data are reported on a bank-country-currency-quarter basis. This source provides a currency breakdown for each asset position in sterling and other major currencies. These data have been used in previous papers, such as Aiyar et al. (2014) and Forbes, Reinhart, and Wieladek (2017).

8. Specifically, the measure of RSF requires information on domestic funding from “BT” forms, which only contain data for assets and liabilities in sterling, euros, and “other,” where “other” is constituted mainly of U.S. dollars.

originated in the United Kingdom during the sample period, with each bank lending to 10 countries on average.⁹

Central to our analysis is the need to quantify banks' reliance on "synthetic" funding in the currencies listed above (that is, funding obtained using FX swaps). Given the lack of detailed data on banks' derivatives positions, we follow Borio, McCauley, and McGuire (2017) and quantify banks' RSF by residual; that is, we measure the difference between consolidated assets and liabilities in a given currency (as a share of total assets in that currency), and assume the "missing" funding comes from FX swaps. This proxy for banks' RSF is based on the notion that banks do not typically hold unhedged FX positions, which may be in part driven by regulatory factors. Bräuning and Ivashina (2020) rely on an analogous sector-level proxy and, reassuringly, find it to correlate strongly with interest rate differentials in the direction predicted by their model, lending some confidence to its ability to capture banks' FX swapping activity. Barajas et al. (2020) also rely on an analogous proxy using aggregate system-wide data.¹⁰

Algebraically our proxy takes the following form:

$$RSF_{i,k,t-l} = \frac{Claims_{i,k,t-l} - Liabilities_{i,k,t-l}}{Claims_{i,k,t-l}}, \quad (1)$$

where $RSF_{i,k,t-l}$ is the reliance on synthetic funding of bank i in currency k at time $t - l$.

Banks in our sample do make use of synthetic funding to a significant extent. Table 1 shows that banks' average reliance on this type of funding is approximately 9% of total assets in a given FX. Figure 3 further shows that synthetic funding has accounted for c. 17% of U.S. dollar positions on average since 2008, being similar in magnitude to repo-based funding from nonbanks (c. 13%), and bigger than bond-based funding (c. 12%) and interbank funding (c. 6%, considering repos and deposits).¹¹ Nonbank deposits dominate as the main funding source for U.S. dollars (50%). The importance of U.S. dollar synthetic funding is in line with the figures discussed in Borio, McCauley, and McGuire (2017). In the case of euro positions, synthetic funding was of similar magnitude compared to U.S. dollars during the first part of the sample, but receded since the Euro Area crisis (see Figure A.1 in the Online Appendix).

9. A detailed description of this sampling procedure is reported in the Online Appendix A.1.

10. By construction, this ratio of synthetic funding exposure can be either positive or negative. The latter case may reflect a situation in which a bank obtains relatively large amounts of FX via deposits or FX money markets without using the proceedings to lend. Since we are mainly interested in tracing a lending channel of positive synthetic funding exposures, we truncate the RSF variable by replacing negative RSF values by 0. Even though this approach is more consistent with the proposed research question, the main results are unchanged if the negative values of RSF are included in the sample (see Section 2.3).

11. These numbers constitute a lower bound for interbank liabilities, as we cannot discriminate banks from nonbanks for the nonresident positions in both deposits and repo entries.

TABLE 1
BANK LEVEL DATA SET—DESCRIPTIVE STATISTICS

	Mean I	Median II	S.D. III	Min IV	Max V	RSF		Dif VIII
						Large VI	Low VII	
Dep. var.								
$\Delta L_{i,j,k,t}$	0.01	0.00	0.77	-3.15	3.30	0.05	0.05	0.01
Exposure var.								
RSF_{t-5}	0.09	0.00	0.17	0.00	0.70	0.09	0.01	0.081*
Control var.								
Log assets_{t-1}	17.68	17.78	1.83	13.33	19.83	17.47	17.52	-0.05
Dep. ratio_{t-1}	0.76	0.75	0.32	0.03	1.75	0.77	0.68	0.10
Liq. ratio_{t-1}	0.39	0.34	0.22	0.01	0.96	0.38	0.35	0.03
Cap. ratio_{t-1}	0.08	0.04	0.09	-0.06	0.38	0.08	0.06	0.03
$\Delta L_{i,k,t}^{\neq k}$	0.01	0.01	0.27	-0.90	0.95	0.06	0.06	0.00
CIP deviation								
GBP-CB	-0.07	-0.08	0.18	-0.76	0.41			
ΔCIP	0.00	0.00	0.14	-0.74	0.46			

NOTE: This table reports descriptive statistics for our main variables of interest. The dependent variable $\Delta L_{i,j,k,t}$ is computed as the quarter-to-quarter change in log total claims of bank i in country j , currency k , and quarter t . The variable RSF represents the ratio of synthetic funding to assets at the bank-currency-quarter level. The table reports descriptive statistics for the following control variables: Banks' size (Log Assets_{t-1}), deposit-to-assets ratio (Dep. ratio_{t-1}), liquid-to-total assets ratio (Liq. ratio_{t-1}), and capital-to-assets ratio (Cap. ratio_{t-1}). The variable $\Delta L_{i,k,t}^{\neq k}$ represents the average change in log total claims of bank i in all currencies different than k . The table reports for each variable its sample average (mean), median, standard deviation (S.D.), and the minimum (Min.) and maximum (Max.) values. Columns VI and VII report the pre-2008 average for each variable for two subsamples: Banks with an average pre-2008 RSF ratio above (VI) and below (VII) the sample median. Column VIII shows the difference in means between large and low RSF banks. * indicates whether this difference is statistically significant by normalized differences (Imbens and Wooldridge 2009). The last two rows report summary statistics for two measures of CIP deviations: GBP currency basis (level, $GBP\text{-}CB$) and the quarter-to-quarter change in the GBP currency basis (ΔCIP).

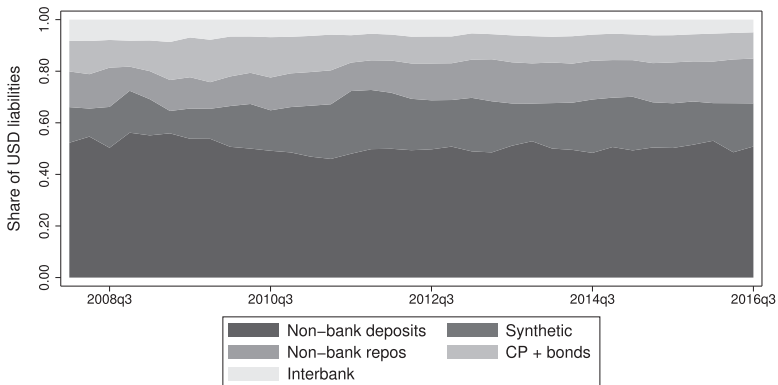


Fig 3. Share of USD Liabilities by Instrument (Average across Banks).

NOTES: Authors' calculations based on regulatory data. The figure shows the relative importance of a range of instruments used by banks' to secure U.S. dollar funding, on a consolidated basis. These instruments (displayed in different shades of gray) include deposits from nonbanks, (FX swap-based) "synthetic" funding, repurchase agreement ("repo") operations vis-à-vis nonbanks, commercial paper, certificates of deposit and other bonds ("CP + bonds"), and interbank funding (deposits and repos). It should be noted that these numbers constitute a lower bound for interbank liabilities, as we cannot discriminate banks from nonbanks for the nonresident positions in both deposits and repo entries. That is, deposits and repos against foreign banks do not show up in our "interbank" category but in the respective "nonbank" categories. The figure depicts averages across banks operating from the United Kingdom.

Table 1 reports more general descriptive statistics computed from the resulting baseline sample.¹² The final panel includes 62,739 observations at the bank-country-currency-quarter level. Out of the 106 banks in the sample 95 are foreign-owned institutions (both branches and subsidiaries) and 11 correspond to UK-owned banks. The 70 destination countries correspond to the United States, 13 Euro Area economies, and 56 countries from the rest of the world. The first five columns of Table 1 report information on the whole sample. Thereafter, the mean value for each variable in the pre-2008 sample is reported for two groups of banks: those with an average RSF ratio above the sample median (“high RSF”) and those below that threshold (“low RSF”). We focus on the pre-2008 period given the lack of large liquidity shocks in FX swap markets in that period. The variables reported are winsorized at the 1st and 99th percentiles. Variables’ definitions are reported in Table A.1 in the Appendix.

This latter split of our sample by size of banks’ RSF ratio allows identifying bank characteristics that could be correlated with banks’ RSF. These control variables include measures of banks’ size (log of total assets), capitalization (capital-to-assets ratio), liquidity (liquid-to-total assets ratio), and reliance on deposits (total deposits to assets ratio). The final column in Table 1 reports a test of difference in means between both groups which uses the Imbens and Wooldridge (2009) test of normalized differences. We find that none of the balance sheet items considered are significantly different across the two groups.¹³ Importantly, we do not find evidence of both groups of banks reporting a different trend in the growth rate of cross-border claims before 2008. This result indicates that deviations in this growth rate after liquidity shocks in FX swap markets started occurring in 2008 should not be attributed to preexisting differences across banks.

1.3 CIP Condition and Currency-Specific Shocks

The CIP condition states that the cost of obtaining funds in a given currency should be equalized across cash and FX swap markets. That is, from the point of view of a borrower looking for funds in a particular currency, it should be equally costly to pay the relevant cash-market interest rate, or, alternatively, to obtain funds in the cash market in a second currency and transform those proceeds into the target currency,

12. The difference in magnitude for synthetic funding between Table 1 and Figure 3 results from three factors. First, our RSF measure is normalized by claims, while in Figure 3 synthetic funding is normalized by total liabilities (i.e., ex-capital). Second, Figure 3 is obtained by first averaging sterling-equivalent values for each liability type across banks and then computing ratios of these averages, while in Table 1 RSF values are computed at the bank level. Finally, Table 1 cover both U.S. dollar and euro RSF, while Figure 3 describes U.S. dollar liabilities exclusively.

13. Direct correlation between RSF and other balance sheet items suggest that the only variable that is (weakly) positively correlated with RSF is total assets (see Table A.1 in the Online Appendix). We include this variable as a control in our benchmark specification and also run a robustness test dropping large banks from our sample.

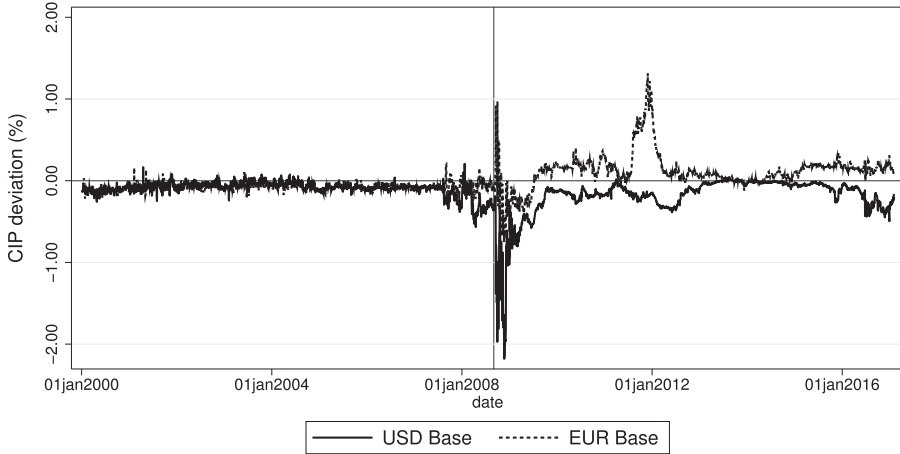


Fig 4. Sterling-Based CIP Deviations by Currency.

NOTES: Authors' elaboration based on data from Bloomberg. The figure depicts the cross-currency basis between GBP, on the one hand, and USD and EUR, on the other. A negative CIP deviation denotes a situation in which foreign currency funding is more expensive in FX swap markets compared to cash markets.

locking-in the exchange rate at the moment of repayment via the use of an FX forward contract. Algebraically:

$$(1 + I_{t,t+n}^{USD})^n = \frac{S_t}{F_{t+n}} (1 + I_{t,t+n}^{GBP})^n. \quad (2)$$

That is, it should be equivalent to borrow one U.S. dollar at time t and pay back $(1 + I_{t,t+n}^{USD})^n$ at time $t + n$, and to borrow instead the S_t sterling needed to buy one dollar, transform those proceeds into one U.S. dollar, and lock-in a given exchange rate (F_{t+n}) in the derivatives market to pay back the sterling debt at time $t + n$ at the relevant interest rate (i.e., $(1 + I_{t,t+n}^{GBP})^n$).¹⁴ If this condition did not hold, then an arbitrage opportunity would arise. Let us suppose, for the sake of argument, that the U.S. dollar cash market interest rate (LHS of equation (2)) is lower than the FX-swap-implied interest rate (RHS of equation (2)). If this was the case, an arbitrageur could make a positive risk-free profit by borrowing U.S. dollars in the cash market and lending them via an FX swap in the derivatives market. It is worth noting that this profit would be risk-free, as all cash flows (and exchange rates) are locked-in at the time trades are executed simultaneously.

The described CIP condition held remarkably well in the pre-Great Financial Crisis era (Figure 4). However, beginning in 2008, international financial markets witnessed

14. In our baseline specification, we rely on 3-month Libor interest rates and matching FX forward rates. In robustness checks, we repeat the baseline exercise using 1- and 12-month interest rates instead, with the results remaining unchanged.

the breakdown of this no-arbitrage relation, as it has been documented in the literature (see, e.g., Avdjiev et al. 2019, Abbassi and Bräuning 2018). Figure 4 considers sterling as a base currency and shows that the cost of obtaining FX funding in U.S. dollars or euros via the FX swap market has differed from that of doing so in cash markets during several periods. It can be seen that this is not exclusively true for crisis periods.¹⁵

A deviation from the CIP condition means that there exists a wedge in the cost of obtaining funds in a given currency in cash and FX swap markets. In the absence of frictions, borrowers (including banks) would then turn to the cheapest source of funding, rendering the more expensive alternative irrelevant. However, while FX derivatives can be readily accessible in international markets, access to cash markets (or insured deposits) for certain currencies is not automatic for some borrowers. In the case this fragmentation of funding markets was important, CIP deviations would constitute a funding shock to those borrowers with no access to FX cash markets or insured deposits, while the cost of funds for borrowers with access to both cash and derivatives markets would be unaffected (as they would turn to the cheapest alternative). Throughout the paper, we will consider a *negative* change in CIP deviations as a situation in which cash market funding becomes cheaper in relation to synthetic funding via FX swaps.¹⁶ Algebraically:

$$CIP_{k,t} = y_{t,t+n}^k - y_{t,t+n}^{GBP} + \frac{1}{n} [\log(F_{t,t+n}) - \log(S_{t,t+n})], \quad (3)$$

where $CIP_{k,t}$ is the sterling-based CIP deviation vis-à-vis currency k at time t ; that is, the difference between the cost of obtaining funds in currency k via cash markets (at interest rate $y_{t,t+n}^k$) and doing so synthetically by borrowing sterling (at interest rate $y_{t,t+n}^{GBP}$) and locking in the exchange rate using spot ($S_{t,t+n}$) and forward ($F_{t,t+n}$) markets, as described above. Note that this equation is the wedge in the log version of equation (2). This spread or wedge is typically referred to as “cross-currency basis” (see, e.g., Du, Tepper, and Verdelhan 2018). Alternatively, synthetic funding conditions could also be measured by looking at the spread between cash markets and outright “synthetic” rates, with the latter explicitly quoted as part of an FX swap arrangement.

From the point of view of a bank with no access to FX cash markets, and which therefore obtains its FX funding via swaps, changes in CIP deviations only constitute a proxy of the relevant funding shocks it is subject to. In principle, one could focus on changes in the FX-swap leg of the CIP trade (only the RHS of equation (2)). However, the price of FX swaps can change due to shifts in supply and demand (i.e., the shock

15. The wedge in funding costs across markets cannot be explained by counterparty risk. Du, Tepper, and Verdelhan (2018) document the existence of CIP deviations using risk-free securities denominated in different currencies.

16. This measure is also used in other banking studies to measure stress in offshore U.S. dollar markets (see, e.g., Barajas et al. 2020).

we are interested in) or due to revisions to expected exchange rates. The latter does not constitute necessarily a net funding shock, as changes in the price of synthetic funding would be compensated by changes in expected asset values in domestic currency. However, there is a way of abstracting from these cases: revisions to exchange rate expectations should be matched by changes in interest rate differentials across countries, leading to an unchanged CIP condition. Therefore, we use changes in CIP deviations as a proxy for friction-driven currency-specific funding shocks to banks securing FX in swap markets.

A relevant potential confounding factor is the possibility of endogeneity of CIP deviations with respect to banks' balance sheets, driven by either supply or demand forces. Regarding supply considerations, it is worth noting that the structure of the FX derivatives market is such that a relatively small group of big banks act as "market makers" or "dealers," concentrating a large portion of trades, while the rest of the banks usually operate whenever they have nonspeculative needs to borrow or lend FX. Recent papers, including Du, Tepper, and Verdelhan (2018) and Cenedese, Della Corte, and Wang (2019), point to a regulation-driven reduction in the balance sheet capacity of these market makers to engage in FX derivatives trades as one of the main reasons behind the existence of arbitrage possibilities (e.g., of a wedge in the CIP relation). To guard against the possibility that these market makers (which could potentially influence CIP deviations) are behind our baseline results, we repeat our benchmark exercise excluding these banks from our sample (see Section 2.3).

In terms of potential demand considerations affecting CIP deviations, it could be argued *a priori* that banks of certain characteristics could rely more heavily on swaps for their FX funding, and, in periods in which this demand increased, be subject to monopolistic pricing from dealers. If this was the case, then there could be an omitted variable driving both changes in cross-border lending and deviations in the CIP condition. There are two considerations that suggest this is not an issue for our results. First, our findings are *currency-specific*; that is, if a bank's funding access was under stress and hence it had to cut back on lending and be subject to differential FX swap pricing, one would expect this to happen across currencies. However, our results are currency-specific in the sense that they link changes in the cost of, say, U.S. dollar funding to U.S. dollar lending, and actually disappear if we link euro CIP deviations to dollar lending and vice versa (Section 2.3). Second, even if differential pricing did occur, existing research points to heterogeneities being relatively small in comparison to the magnitude of CIP deviations (see, e.g., Abbassi and Bräuning 2018). Therefore, we would expect banks in the sample to be exposed to a common underlying shock.

2. THE EFFECT OF FX SWAP FUNDING SHOCKS ON CROSS-BORDER BANK LENDING

2.1 *Identification and Benchmark Specification*

Our objective is to estimate the effect of currency-specific funding shocks originating in the FX swap market on UK banks' cross-border lending in those specific currencies. Hence, our variable of interest consist of percentage changes in UK banks' cross-border claims, denominated in both U.S. dollars and euros. The "shock" variable we consider is defined by quarter-to-quarter changes in sterling-based CIP deviations with respect to both euros and U.S. dollars. The sign convention is as follows: a negative change in this deviation reflects swap-based FX funding costs going up relative to the cash market costs.

Our specification needs to address two main concerns. First, there could be a third force driving both changes; that is, a third shock could push up on FX-specific funding costs and lead to reduced cross-border lending in that currency at the same time. In addition, lending growth could as well be driven by changing demand. If borrowers increased demand for FX bank loans in the face of funding shocks in the FX swap market, then an increase in lending could just be a reflection of this increased demand and not of changes in banks' supply. Observing quantities is not enough to be able to isolate the effect of supply.

We exploit the richness of our data set in a series of ways to address the concerns outlined above. In the hypothetical case, an omitted third variable was driving both changes, then the correlation should not necessarily be stronger for banks with a higher exposure to our sketched mechanism. That is, banks with a high RSF (i.e., relying on FX swaps) would have no reason to adjust lending particularly strongly in the face of shocks. We are able to test for this feature explicitly by incorporating balance sheet information on individual banks' RSF. Furthermore, the discussion in Section 1.2 shows that other relevant balance sheet characteristics are not correlated with banks' RSF.

To control for demand constituting a confounding factor, we leverage on the fact that we observe the lending of several banks in a particular currency into a particular destination country. This panel structure allows for adding currency-destination-quarter fixed effects, which allow us to control for unobserved changes in demand for funds in the spirit of Khwaja and Mian (2008). This setup does not require lending into a currency-destination country market to be concentrated on a particular sector, but only that the demand for credit from this market (independently of the type of borrower) is homogeneous vis-à-vis the various UK banks servicing it.

A final consideration is that our results are driven by differences in bank-specific cross-border lending in different currencies. Therefore, there are no grounds to expect that shocks at the bank level could be driving our results, as they would need to imply a differential reaction across the different currencies in a bank's lending portfolio. Despite this consideration, we add a series of time-varying bank level controls in our main specification, and also explore bank-quarter fixed effects in the robustness

section to absorb relevant time-varying bank characteristics such as bank-specific demand trends.

These design features result in the following benchmark specification:

$$\begin{aligned} \Delta L_{i,j,k,t} = & \alpha + \beta_1 RSF_{i,k,t-5} + \sum_{l=1}^4 \beta_{2,l} \Delta CIP_{k,t-l} * RSF_{i,k,t-5} \\ & + \beta_3 \Delta L_{i,k,t}^{\neq k} + \beta_4 X_{i,t-1} + \gamma_{i,j,k} + \delta_{j,k,t} + \epsilon_{i,j,k,t}, \end{aligned} \quad (4)$$

where $\Delta L_{i,j,k,t}$ represents the percentage change in the cross-border claims of bank i to recipient country j in currency k at time t , $\Delta CIP_{k,t}$ is the first difference in the sterling-based CIP deviation of currency k at time t and $RSF_{i,k,t}$ is the reliance on synthetic funding of bank i in currency k at time t (see equations (3) and (1), respectively). $X_{i,t}$ represent bank-quarter specific controls and $\gamma_{i,j,k}$ and $\delta_{j,k,t}$ are bank-country-currency and country-currency-quarter fixed effects, respectively. The former allows us to control for time-invariant unobserved characteristics of banks lending to a particular country in a given currency, while the latter allows us to control for potential changes in country-specific demand for funds in a particular currency (hence constituting a key control variable). The bank-quarter controls include total assets, deposits ratio, liquidity ratio, and capital ratio. We also consider the average cross-border lending in the currencies other than currency k ($\Delta L_{i,k,t}^{\neq k}$) which works as a benchmark and controls for banks overall lending behavior which might respond to factors other than changes in currency-specific synthetic funding costs.¹⁷

Following conventional use in the empirical banking literature (e.g., Kashyap and Stein 2000), we consider the first four lags of our main object of interest: the interaction between ΔCIP and RSF . Using the fifth lag of RSF allows us to alleviate concerns that RSF may react to the dynamics in ΔCIP , and it builds on the fact that this reliance is very sticky at the bank-currency level (the autocorrelation coefficient of RSF is 0.92). To further validate our approach, we run a set of preliminary regressions of RSF on ΔCIP in order to shed light on a possible systematic correlation between the two variables (see Table A.2 in the Online Appendix). However, we do not find evidence of ΔCIP being correlated with banks' RSF , neither contemporaneously nor via a lead-lag effect.¹⁸

The interaction between ΔCIP and RSF emphasizes that the identification of the effect of CIP deviations operates over the distribution of RSF . Therefore, the model captures heterogeneous effects beyond banks' common exposure to—for example—reduced lending spreads in FX when CIP deviations become negative. We then focus our analysis on the sum of these four interaction terms. Moreover, the focus on the

17. Variable $L_{i,k,t}^{\neq k}$ includes lending in sterling, which is not analyzed specifically in our baseline model because CIP deviations are measured with respect to it. Below, we test the robustness of our results to including sterling lending on the dependent variable, matched with null CIP deviations to help improve the pinning down of the intercepts.

18. This alleviates concerns of banks' RSF being contemporaneously correlated with synthetic funding costs, for example, in line with the mechanism set out in Ivashina, Scharfstein, and Stein (2015).

sum of the coefficients is important to trace banks' lending adjustment to ΔCIP over a time horizon of four quarters, recognizing the fact that this adjustment is likely to take place with a certain delay. Following our hypothesis, we would expect coefficient β_2 to be positive and significant.

Equation (4) could also be estimated by adding a vector of bank-quarter fixed effects, which would absorb unobserved bank-specific demand shocks. However, we refrain from following this approach given our interest in bank-quarter variation. This variation matters given the currency profile of UK banks' external lending. While there is a large share of banks which lend at the intensive margin in both U.S. dollars and euros, it is also often the case that U.S. dollar lending is predominant in many bank-country pairs (e.g., lending to many countries in Latin America).¹⁹ In these cases, euro lending can be quite small compared to U.S. dollar lending, and is also likely to vary due to idiosyncratic factors, making it difficult to obtain a precise quantification of the results from within-bank, across-currencies variation. Nonetheless, recognizing that there is a trade-off in terms of better controlling for bank-specific demand shocks and exploiting the most relevant dimensions of variation, we show in Section 2.3 that the estimation remains robust to including bank-quarter fixed-effects.

2.2 Benchmark Results

Table 2 shows the results from bringing the benchmark specification outlined in equation (4) to the data set described in Section 1.1. For each regression, we report the sum of the coefficients corresponding to the lags considered in equation (4). We find strong evidence that banks adjust currency-specific cross-border lending in the face of funding shocks to the same currency in the FX swap market.

Column I in Table 2 reports the results of a plain specification that does not factor in bank heterogeneity in terms of reliance of synthetic funding, but instead looks at average common variation in cross-border bank lending in the face of changes in CIP deviations. This estimation, although lacking a sharp identification, allows us to get a first idea of the empirical relationship between the growth rate in cross-border claims and currency-specific funding shocks in FX swap markets. An increase in the funding cost of using FX swaps is associated with a decrease in banks' currency-specific lending growth. In the remainder of the analysis, we do incorporate bank heterogeneity in their exposure to shocks to the cost of FX swaps by considering their reliance on this type of funding.

The specification underlying the results in column II factors in this bank heterogeneity, and delivers results which are in line with the unconditional correlation reported in column I. That is, in the face of an increase in the cost of synthetic funding, it is banks with a high reliance on this type of funding that cut back currency-specific lending particularly sharply. In column III, we add a series of control variables, and in column IV we further tighten the specification by adding bank and country-quarter

19. The median share of euro lending in total euro and U.S. dollar lending is 7.5%.

TABLE 2
BENCHMARK RESULTS

	I	II	III	IV	V
Joint $\Delta CIP \times RSF_{t-5}$		0.745** (0.287)	0.678*** (0.251)	0.617*** (0.195)	0.605*** (0.176)
Joint ΔCIP	0.108** (0.0506)	0.0259 (0.0912)	0.0224 (0.0836)	-0.0241 (0.0811)	
RSF_{t-5}		-0.022 (0.015)	-0.024 (0.017)	0.007 (0.021)	0.020 (0.031)
Interaction terms:					
$\Delta CIP_{t-1} \times RSF_{t-5}$		0.306** (0.127)	0.287** (0.122)	0.204* (0.110)	0.192** (0.087)
$\Delta CIP_{t-2} \times RSF_{t-5}$		0.278* (0.142)	0.257* (0.137)	0.271** (0.122)	0.261** (0.107)
$\Delta CIP_{t-3} \times RSF_{t-5}$		0.190 (0.117)	0.178 (0.118)	0.192 (0.130)	0.170 (0.126)
$\Delta CIP_{t-4} \times RSF_{t-5}$		-0.029 (0.116)	-0.045 (0.105)	-0.050 (0.098)	-0.018 (0.083)
Controls:					
Log assets_{t-1}			0.001 (0.002)	-0.013 (0.010)	-0.013 (0.010)
Dep. ratio_{t-1}			-0.002 (0.012)	0.004 (0.014)	0.008 (0.017)
Liq. ratio_{t-1}			-0.016 (0.018)	-0.033 (0.044)	-0.037 (0.046)
Cap. ratio_{t-1}			0.035 (0.041)	-0.096 (0.088)	-0.093 (0.087)
$\Delta L_{i,k,t}^{\neq k}$			0.107*** (0.022)	0.076*** (0.023)	0.084*** (0.022)
Constant	0.011*** (0.003)	0.012* (0.007)	0.001 (0.023)	0.262 (0.180)	0.256 (0.183)
No. of Banks	106	106	106	106	106
Fixed effects	None	None	None	i j, t	i, j, k j, k, t
Obs	62,739	62,739	62,739	62,739	62,739
R^2	0.000	0.000	0.002	0.060	0.108

NOTE: This table reports the results from estimating equation (4) for different specifications of the model. All constitutive terms of the interactions are included in the regressions. Coefficients for $\Delta CIP_{k,t}$ are not reported. Column I reports the results of regressing $\Delta L_{i,j,k,t}$ only on the four lags of $\Delta CIP_{k,t}$, showing the respective joint coefficient in the upper row (Joint ΔCIP). In column II, we add the four lags of the interaction term between $\Delta CIP_{k,t}$ and $RSF_{i,k,t-5}$. Column III further includes our set of control variables. Column IV adds both bank (i) and country-quarter (j, t) fixed effects. Finally, column V reports our preferred benchmark specification including both bank-country-currency (i, j, k) and country-currency-quarter fixed effects (j, k, t). This latter model absorbs any variation that is specific to banks serving a particular country-currency market, as for instance borrowers' credit demand in that currency. Robust standard errors clustered at the bank- and quarter-level are reported between parentheses. Variables are winsorized at the 1st and 99th percentiles. Variables' definitions are reported in Table A.1 in the Appendix. *** indicates significance at the 1% level; ** at the 5%; and * at the 10%.

fixed effects. In our final specification (column V), we allow the potential demand shocks (and other potential confounding factors) to be currency-specific by including country-currency-quarter fixed effects combined with the bank-country-currency time-invariant fixed effects. Our main findings hold after saturating the model with this structure.²⁰

20. While our results speak to dynamics occurring in the UK banking system, the findings in Barajas et al. (2020), although arising from a different empirical setup, suggest the dynamics we uncover in our exercises could be generalizable to other banking systems.

The effect of currency-specific funding shocks on banks' cross-border credit supply is not only statistically significant but also economically meaningful. Consider the case of a bank that has a ratio of U.S. dollar synthetic funding relative to total U.S. dollar assets that is one standard deviation above the sample mean; that is, 17 percentage points above the sample mean of 9%. Based on the results from our benchmark model, a negative CIP deviation of 14 basis points in the sterling-U.S. dollar basis (i.e., the standard deviation of its changes) leads the bank in consideration to cut back U.S. dollar lending by 1.4 percentage points in comparison to the behavior of a bank with average synthetic funding exposure. These estimates are conservative considering the existence of banks with 70% RSF and observed changes CIP deviations above 40 basis points.

Another useful exercise to calibrate the economic magnitude of our baseline effect is to focus on a particular point in time and develop an alternative hypothetical scenario.²¹ Consider the second quarter of 2012, when the sterling-U.S. dollar basis widened by seven basis points (i.e., approximately 50% of a standard deviation in the change in CIP deviations). In this quarter, the group of banks in our sample with positive RSF cut back cross-border U.S. dollar lending (to all destinations) by 184 billion U.S. dollars. By making use of our benchmark results, we can estimate the hypothetical lending behavior of these banks facing the observed basis widening had they not been exposed to the shock to the cost of synthetic funding; that is, if these banks had not relied on synthetic funding at all. In order to do this, we calculate a bank-specific lending adjustment that arises from mapping a hypothetical reduction of their RSF to zero into their lending behavior, in the context of the observed shock.²² By doing this, we calculate that these banks would have cut back lending by 160 billion U.S. dollars instead; that is, the fall in lending would have been 24 billion U.S. dollars (i.e., 13%) smaller.

2.3 Robustness Tests

In this section, we discuss a number of robustness tests to assess the sensitivity of our findings to different specifications of the model. These tests are reported in the Online Appendix.

We first examine whether our baseline findings can respond to or be biased by events that are time-clustered with CIP deviations. Figure 4 shows that, although CIP deviations do occur at different periods, they are particularly large during the 2008–09 global financial crisis, and later during the Euro Area crisis. Our results may therefore be driven by the fact that banks largely exposed to FX synthetic funding are also more exposed to funding markets that were severely hit during these crises. To address

21. This exercise is an adaptation of a calculation presented in Cornett et al. (2011) in the context of liquidity risk in the global financial crisis.

22. The calculation we do for each bank is: $\Delta CIP * \Delta RSF * \beta_2$, where ΔRSF is the distance between their observed RSF and zero. We then add up these adjustments across banks.

this concern, we reestimate our model after alternatively dropping the 2008–09 and 2011–12 periods from our sample. Results, reported in columns I and II in Table A.3, confirm that excluding the potential biases induced by crisis periods does not alter our findings.

One additional potential issue is that CIP deviations could be contemporaneous to (or even a reflection of) other market-wide dynamics, which could be the “true shocks” bank lending is reacting to. We conduct two robustness checks to address these concerns. First, consider a “placebo” FX swap funding shock by assigning U.S. dollar CIP deviations to euro lending and euro deviations to U.S. dollar lending. The fact that we do not find any results (column III in Table A.3) confirms the currency-specific nature of the results.²³ Relatedly, we also find that results cease to be significant when replacing CIP shocks with changes in the U.S. dollar index (column IV).²⁴

So far we have analyzed banks as “liquidity takers” which tap FX swap markets when in need of (synthetic) FX funds. However, some institutions necessarily have to “make markets” and take the other side of the trades. If these “market makers” engage in cross-border lending, while also having the capacity to influence the price of FX swaps, then our results could be biased. We address this concern by estimating our benchmark model after excluding the top-five banks in FX derivatives’ trading volume.²⁵ Results, reported in column V in Table A.3, show that our findings remain in place when excluding these banks. On the “liquidity takers” side, we also rerun our baseline specification excluding the largest banks in our sample by assets, which leaves results virtually unchanged (see column VI in Table A.3).

A further concern relates to a potential correlation between RSF and other bank traits. For example, a high value of RSF may also reflect a relatively high exposure to short-term interbank market debt, capturing banks’ overall exposure to financial contagion. Even though our identification should prevent a bias via such confounding factors, we implement a set of tests to explore the role of bank characteristics. First, we replace the fixed-effects structure in equation (4) by alternative structures including bank-quarter fixed effects, which absorb both observed and unobserved bank traits. The results of this test, reported in Table A.4 in the Appendix, show that our findings remain largely unchanged once we include bank-quarter fixed-effects under different specifications. Importantly, the size of the main coefficient of interest

23. This result also suggests that banks do not increase credit in alternative currencies to compensate for the reduction in credit in the currency affected by synthetic funding shocks. Interestingly, Keller (2021) does find a change in the composition of lending in the face of CIP deviations in banks operating from Peru, which do compensate the fall in lending in the affected currency by increasing lending in other currencies.

24. This test matters considering that Avdjiev et al. (2019) document a triangular relationship between a stronger dollar, larger deviations from CIP, and contractions in cross-border dollar lending. One important mechanism the authors discuss when linking dollar appreciation episodes with a reduction in the supply of cross-border credit is the “risk-taking” channel of the exchange rate (Bruno and Shin 2015). The additional mechanism we put forward links the relative costs of synthetic funding to currency-specific cross-border lending, offering a complementary, microfounded interpretation to the results in Avdjiev et al. (2019).

25. We identify these banks from *Euromoney 2016 FX rankings*. We consider the top-five banks in overall market share, which account for around 60% of the market on average.

remains stable when we include bank-quarter fixed effects together with our preferred set of country-currency-quarter fixed effects (see column V in Table A.4).

A second related exercise entails running “horse races” in which we replace our quantification of banks’ exposure to shocks to synthetic funding markets with other balance sheet characteristics which we would expect to be unrelated to our story. We find that the shocks to the cost of synthetic funding particularly affect the lending of banks with high reliance on this type of funding, but not that of banks with particularly high values of other balance sheet characteristics (see Table A.5 in the Appendix).

Figure 4 shows heterogeneous dynamics for CIP deviations in U.S. dollars and in euros when considering sterling as a base currency. Given this feature of the data, we test the robustness of our results to allowing for (i) heterogeneities across currencies and (ii) a potential asymmetric effects depending on the sign of CIP changes and levels. Estimation results (displayed in Table A.6) show that the effect of CIP deviations on cross-border bank lending is actually homogeneous across these dimensions.

We also explore the potential special role played by the United States and the Euro Area, being the “home areas” of the two foreign currencies considered. In terms of robustness checks (reported in Table A.7), we find that our results are robust to excluding the United States and the Euro Area as destination countries and, separately, U.S. and Euro Area banks lending from the United Kingdom as originators. Interestingly, we also find that our baseline effects are offset to some degree when considering U.S. dollar flows to the United States and euro flows to the Euro Area, signaling that the supply of funds into these markets seems to be less sensitive to the price of synthetic funding (see column III, Table A.6).²⁶

We also test the robustness of our results to more mechanical modifications of our baseline setup (the following results are reported in Tables A.8, A.9, and A.10). Our results are robust to (i) considering alternative swap maturities and alternative (within-quarter maximum) CIP deviations, (ii) truncating our left-hand-side variable, increasing the winsorization threshold and replacing aggregate lending with a narrower measure of loan growth, (iii) modifying the clustering of standard errors to bank and currency-quarter units, (iv) considering alternative measures of banks’ RSF, and (v) adding sterling flows to our panel with corresponding null CIP deviations to help anchor the baseline.

Finally, we also explore the effect of synthetic funding shocks on banks’ total assets in the matching currency (rather than cross-border credit alone). While losing the destination country dimension results in both a smaller set of observations and the impossibility to implement our fixed effects-based demand controls, it is interesting to see that total assets indeed react in the same direction as cross-border credit in the face of the analyzed shocks (see column IV, Table A.8).

26. We note that the results from excluding the United States and Euro Area from the destination countries also mitigate concerns that borrowing firms in the destination markets may explain the dynamics in global FX swap prices. We consider it rather unlikely that firms in the remaining (mostly emerging) markets will exert a major influence on global FX swap prices.

3. THE BENEFITS OF FOREIGN RELATIVES

In this section, we test whether the documented effect of synthetic funding shocks on bank lending reflects banks' incapacity to access alternative FX funding.

We first analyze whether the effect of synthetic funding shocks on cross-border lending differs across banks' organizational structures, focusing on the differences between branches, which have frictionless access to their parents abroad, and other banks. We then consider effective access to alternative sources of on-balance-sheet FX funding in general, and ICM in particular, and test whether this access shields banks' lending from synthetic funding shocks. Finally, we also analyze whether banks' actual liability management in the event of synthetic funding shocks goes in line with our hypothesis.

3.1 Banks Organizational Structure

At first glance, the hypothesis that alternative FX funding sources can provide a cushion against synthetic funding shocks seems easily testable *a priori*; however, measuring access to funding sources is not straightforward: banks could have access in case of need, without this ever materializing in the balance sheet data we observe. One alternative is to consider banks' organizational structure, relying on the idea that UK-regulated banks and foreign branches could have a differential access to FX markets given different intragroup links and regulatory arrangements. Therefore, we first explore whether there are differential effects for UK-regulated banks on the one hand, and foreign branches on the other.

It has been profusely documented that branches tend to have tighter links with their banking groups (see, e.g., Cerutti, Dell'Ariccia, and Martínez Pería 2007; Dell'Ariccia and Marquez 2010). This phenomenon relates to the fact that branches have no separate legal standing but form an integral part of the parent's balance sheet, thus in most cases enjoying a more direct and frictionless access to intragroup funding.

This stylized fact is also present in our sample of UK-based banks. Figure 5 (Panel B) depicts the share of branches in each quartile of the distribution of banks by their ratio of ICM funding to assets. This figure reveals a clear pattern in which higher quartiles of the ICM distribution report a higher presence of branches. However, branches are not special in terms of their RSF. Replicating the same exercise for the quartiles of the RSF distribution (Figure 5, Panel A) shows that branches are evenly distributed across quartiles. These charts highlight the distinctive aspects of banks' FX liquidity management captured by RSF and ICM.²⁷

27. In our sample, branches report on average a higher ratio of on-balance-sheet FX funding to total assets (0.42) compared to the group of UK-regulated banks (0.29). Most importantly, this difference stems mostly from the ICM funding from abroad (ratio to total assets is 0.13 vs. 0.04). On the contrary, the ratio of non-ICM FX funding from abroad to assets does not vary much between these two groups (0.29 vs. 0.24). Despite these differences, branches report on average a similar RSF compared to other banks. These descriptive statistics are reported in Table A.11 in the Online Appendix.

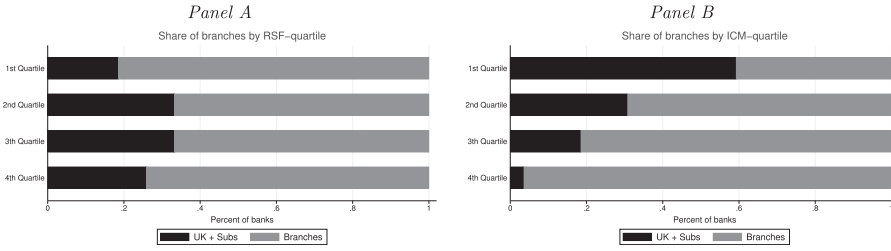


Fig 5. Share of Branches by Variables' Distribution.

NOTES: This figure shows the share of bank branches across the distribution of relevant variables. Panel A shows the share of foreign branches (gray area) and UK-regulated banks (black area) as a share of the total number of banks in the four quartiles of the *RSF* distribution. Panel B shows the share of the total number of banks in the four quartiles of the distribution of the ratio of ICM liabilities to assets. *RSF* represents the ratio of synthetic funding to assets. *ICM* stands for the ratio of ICM liabilities from abroad (currency-specific) to total bank assets. The figure is constructed from the working sample used for the econometric analysis and based on regulatory data from the Bank of England.

This pattern suggests that branches can be used as a quasi-control group in the context of our analysis, considering that they typically share a similar *RSF* exposure but, simultaneously, a larger access to ICM on average compared to other banks. Therefore, we next test whether nonbranches' low institutional access to alternative markets via ICM affects the adjustment of their credit supply following synthetic funding shocks. For this test, we adjust equation (4) by adding a triple-differences term which equals 1 if a bank in the sample is a branch and 0 otherwise. We then focus the analysis on the joint coefficient of the triple interaction ($\Delta CIP \times RSF_{t-5} \times Branch_{t-5}$) after saturating the model with our preferred fixed-effects structure.²⁸

Results are reported in Table 3. We find that, for the same level of dependence on synthetic funding, foreign branches adjust their cross-border FX lending by around two-thirds less than other banks (column II). In columns III and IV, we tighten the analysis by identifying those foreign branches owned by banking conglomerates headquartered in the Euro Area and the United States. The rationale for this exercise is that, in the event of system-wide shocks to the cost of FX swaps, branches of banking groups headquartered in the relevant currency area will benefit from a more direct access to cash funding in that particular currency than other banks. With this in mind, we replicate the previous exercise by defining a new dummy variable that takes the value of 1 if a bank is (i) a foreign branch and (ii) owned by a bank headquartered in one of these currency areas. This test, reported in column IV in Table 3, shows that these particular branches are behind the “shielding” effect identified in column III. On the contrary, when we define as branches only those entities owned

28. In unreported results, we find that benchmark results can be replicated both for the subsamples of branches and UK-regulated banks. This finding confirms that a large heterogeneity in the use of synthetic funding exists, even within the group of the arguably “well-integrated” branches. These results are available upon request.

TABLE 3
ACCESS TO FX FUNDING: FOREIGN BRANCHES

	Triple interaction term ($Trait_{t-5}$):			
	None I	Branch II	CA branch III	Non-CA branch IV
Joint $\Delta CIP \times$ $RSF_{t-5} \times Trait_{t-5}$		-0.522** (0.246)	-0.795** (0.390)	0.194 (0.479)
Joint $\Delta CIP \times RSF_{t-5}$	0.605*** (0.176)	0.813*** (0.227)	0.793*** (0.238)	0.594*** (0.170)
Joint $\Delta CIP \times Trait_{t-5}$		0.0379 (0.107)	0.0800 (0.0761)	-0.0445 (0.108)
$RSF_{t-5} \times Trait_{t-5}$		0.061 (0.066)	0.005 (0.072)	0.124* (0.069)
$Trait_{t-5}$		0.000 (0.000)	0.211*** (0.035)	-0.228*** (0.030)
RSF_{t-5}	0.020 (0.031)	-0.012 (0.043)	0.019 (0.040)	-0.003 (0.032)
Controls:				
$Log\ assets_{t-1}$	-0.013 (0.010)	-0.013 (0.011)	-0.022** (0.009)	-0.020** (0.009)
$Dep. ratio_{t-1}$	0.008 (0.017)	0.010 (0.018)	0.010 (0.017)	0.013 (0.018)
$Liq. ratio_{t-1}$	-0.037 (0.046)	-0.031 (0.046)	-0.031 (0.045)	-0.024 (0.046)
$Cap. ratio_{t-1}$	-0.093 (0.087)	-0.075 (0.082)	-0.138* (0.081)	-0.119* (0.071)
$\Delta L_{i,k,t}^{\neq k}$	0.084*** (0.022)	0.084*** (0.023)	0.082*** (0.022)	0.083*** (0.022)
Constant	0.256 (0.183)	0.245 (0.190)	0.333** (0.154)	0.428** (0.169)
Observations	62,739	62,739	62,739	62,739
R^2	0.108	0.108	0.108	0.108

NOTE: This table reports the results from estimating equation (4) by adding an interaction term between $\Delta CIP \times RSF_{t-5}$ and variables measuring banks' different organizational structure and access to global FX funding. All constitutive terms of the interactions are included in the regressions. The variable $Trait_{t-5}$ represents the respective interaction term in each column lagged in five quarters. Column I replicates the benchmark results from column V in Table 2. Columns II–IV include triple interactions with a foreign branch dummy (Branch, column II); a dummy for foreign branches from the United States or the Euro Area (CA Branch, column III); and a dummy for foreign branches with a headquarter in currency areas different than the United States or the Euro Area (Non-CA Branch, column IV). Robust standard errors clustered at the bank and quarter level are reported between parentheses. All regressions include the full set of fixed effects at the bank-country-currency and country-currency-quarter level. Variables are winsorized at the 1st and 99th percentiles. Variables' definitions are reported in Table A.1 in the Appendix. *** indicates significance at the 1% level; ** at the 5%; and * at the 10%.

by banks headquartered in regions different than the Euro Area or the United States, the branches do not seem to be shielded any more (see column V in Table 3).

3.2 Alternative FX Funding Sources: ICM

Starting from the differential effect of synthetic funding shocks on branches' cross-border FX lending, we next explore a dimension that could be expected to be behind this finding; namely, their differential access to alternative sources of FX funding. We conjecture that if institutional frictions related to banks' capacity to tap alternative FX funding markets matter, then wide access to these alternative sources should indeed lead to a smaller effect of synthetic funding shocks.

In particular, we look at banks' on-balance-sheet FX funding in general, and the split between ICM and non-ICM funding in particular. In principle, ICM funding could be superior to alternatives for obtaining FX funds. For example, deposits tend to be relatively price-inelastic (and hence difficult to increase suddenly in the face of shocks), and there can be time frictions in the issuance of bonds and other securities. In addition, political economy considerations could also play a role in facilitating access to internal funding. While branches benefit from a swifter access to internal funding, we may expect also subsidiaries and especially UK-owned banks—given their role as bank headquarters—to benefit from access to alternative sources of FX funds.

To test for this conjecture, we compute a ratio of on-balance-sheet FX funds to total assets at the bank-currency-quarter level, given a lack of further breakdowns by jurisdiction in the data. We then zoom into the type of funds by computing the ratios of foreign ICM and non-ICM funds to total assets. ICM funds represent *FX-specific* intrabank liabilities from abroad vis-à-vis related entities within the same banking conglomerate. For completeness, we compute non-ICM funds as the net liabilities when subtracting ICM from total FX funds. The level of on-balance-sheet funding is not mechanically correlated with the RSF: a bank with a given level of RSF can have low or high on-balance-sheet funding (if overall FX operations are small or large, respectively). In effect, the correlation of these two variables in our sample is negative but low.

In order to arrive at a discrete proxy for large and small access to *FX-specific* intragroup funding, we assign observations above the 75th percentile of the respective ratio to a group of “high access” banks and use a dummy based on this categorization to introduce a triple interaction term in equation (4).²⁹ We also explore potential heterogeneities of this channel across UK-owned banks and foreign-owned banks to assess whether the benefit of accessing ICM for shielding credit supply is equally strong for parents and affiliates. These dummies enter the model with the same five-lag structure as the RSF variable. Due to data limitations, we restrict this analysis to the period from 2008Q1 to 2016Q1, as the information on banks' ICMs' funding is not available for earlier periods.

The results from this exercise are reported in Table 4. We find that the aggregate access to on-balance-sheet FX funding *per se* does not shield banks' lending from the effect of dislocations in synthetic funding markets (column II). However, when zooming in into the different types of on-balance-sheet funding (columns III and IV) we see that a high *ex ante* ICM ratio does indeed reduce the effect of synthetic funding shocks on FX credit supply. On the contrary, access to non-ICM funds does not have a similar shielding effect. We therefore conclude that, for the full set of banks in the

29. We split observations at the 75th percentile to properly capture the skewness of the ICM ratio distribution. As it can be seen in Figure A.2 in the Online Appendix, the low median (solid vertical line) in the ratio's distribution implies that many low ICM observations would be assigned to the high ICM group if using a median split. For consistency, we follow the same definition when generating splits in the other relevant ratios throughout the analysis.

TABLE 4
ACCESS TO FX FUNDING: ON-BALANCE-SHEET FX-FUNDING

	Branch I	Total FX II	Triple interaction term ($Trait_{t-5}$):			ICM rat.: Foreign V	ICM rat.: UK-owned VI
			ICM rat. III	Non-ICM rat. IV			
Joint $\Delta CIP \times$	-0.522**	-0.795	-1.263***	2.367	-2.339*	-5.218***	
$RSF_{t-5} \times Trait_{t-5}$	0.246	1.783	0.395	3.318	1.372	1.307	
Joint $\Delta CI \times RSF_{t-5}$	0.813***	0.693**	1.059***	0.518**	0.888**	0.450	
	0.227	0.299	0.328	0.223	0.362	0.520	
Joint $\Delta CIP \times Trait_{t-5}$	0.0379	0.0101	0.0979	-0.175**	0.0889	3.043***	
	0.107	0.108	0.174	0.0825	0.182	0.867	
$RSF_{t-5} \times Trait_{t-5}$	0.061	-0.070	0.039	0.108	0.038	0.284	
	(0.066)	(0.226)	(0.055)	(0.262)	(0.124)	(0.203)	
$Trait_{t-5}$	0.000	-0.018	-0.009	-0.055***	-0.001	-0.193	
	(0.000)	(0.025)	(0.022)	(0.013)	(0.020)	(0.130)	
RSF_{t-5}	-0.012	0.056	0.038	0.042	0.047	-0.023	
	(0.043)	(0.039)	(0.032)	(0.037)	(0.039)	(0.086)	
Controls:							
$Log\ assets_{t-1}$	-0.013	-0.019	-0.019	-0.023*	-0.039***	-0.059	
	(0.011)	(0.014)	(0.014)	(0.012)	(0.010)	(0.056)	
$Dep. ratio_{t-1}$	0.010	0.030	0.029	0.020	0.045	-0.022	
	(0.018)	(0.025)	(0.023)	(0.023)	(0.027)	(0.054)	
$Liq. ratio_{t-1}$	-0.031	-0.045	-0.049	-0.041	-0.088**	0.007	
	(0.046)	(0.041)	(0.040)	(0.037)	(0.039)	(0.190)	
$Cap. ratio_{t-1}$	-0.075	-0.022	-0.019	-0.036	-0.245*	0.623**	
	(0.082)	(0.139)	(0.133)	(0.139)	(0.134)	(0.221)	
$\Delta L_{i,k,t}^{\neq k}$	0.084***	0.062**	0.063**	0.060**	0.052*	0.008	
	(0.023)	(0.026)	(0.026)	(0.025)	(0.026)	(0.099)	
Constant	0.245	-0.070	0.039	0.108	0.038	0.284	
	(0.190)	(0.226)	(0.055)	(0.262)	(0.124)	(0.203)	
Obs.	62,739	36,573	36,573	37,887	26,037	9,547	
R^2	0.108	0.112	0.112	0.112	0.126	0.292	

NOTE: This table reports the results from estimating equation (4) by adding an interaction term between $\Delta CIP \times RSF_{t-5}$ and variables measuring banks' different degree of access to on-balance-sheet FX funding. The sample period is restricted to 2008Q1 to 20016Q1. The variable $Trait_{t-5}$ represents the respective interaction term in each column lagged in five quarters. For comparison, column I replicates the exercise using triple differences with the branch dummy reported in column III in Table 3. Columns II-IV report triple interaction regressions with dummies equal to one for banks above the 75th percentile of the respective variable. The variables of interest (i.e., $Trait_{t-5}$) are the ratio of (FX-specific) FX funding to total assets (Total FX, column II); the ratio of (FX-specific) internal FX funding (ICM) to total assets (ICM rat., column III); and the ratio of non-ICM funding to total assets (Non-ICM rat., column IV). Columns V and VI replicate the exercise from column III for the subset of foreign banks (column V) and UK-owned banks (column VI). Robust standard errors clustered at the bank and quarter level are reported between parentheses. All regressions include the full set of fixed effects specified in equation (4). Variables are winsorized at the 1st and 99th percentiles. Variables' definitions are reported in Table A.1 in the Appendix. *** indicates significance at the 1% level; ** at the 5%; and * at the 10%.

sample, a large access to ICM does shield banks' FX lending from the effect of shocks to the cost of synthetic funding.

Interestingly, when we replicate the exercise separately for the subsamples of UK-owned and foreign-owned institutions (columns V and VI), we find the effect of a higher marginal ICM-access to be present in both. That is, the cushioning effect of ICM on lending in the face of synthetic funding shocks is not exclusive to parents but also present in affiliates of foreign banks.³⁰

30. The smaller coefficients found in the group of foreign-owned banks could be related to a higher reliance on ICM funding for this group overall (which makes identification through the intensive margin more difficult). We note that also political economy considerations matter, as banks (especially UK-owned

To lend further weight to the interpretation of the results discussed in this section, we check whether banks with large ICM-access do indeed increase their internal intragroup funding in the face of synthetic funding shocks. In particular, we test whether branches or high-ICM banks do indeed increase their ICM liabilities in the face of synthetic funding shocks.³¹ Results (displayed in Table A.12 in the Appendix) show that indeed both branches and banks with large ICM-access do increase their internal FX funding liabilities more than other banks in the face of synthetic funding shocks, in line with our previous findings.

4. THE MACRO-ECONOMIC DIMENSION: SUBSTITUTION ACROSS BANKS AND COUNTRIES

Our main results do not necessarily mean that synthetic funding shocks should have aggregate consequences: borrowers in a recipient country could offset the credit supply shock by shifting their demand for credit to less affected banks, either UK-based or not. With this in mind, exploring aggregate effects becomes important both to calibrate the macro-economic consequences of our findings and, relatedly, to assess whether banks' stronger access to global (intrabank) liquidity sources could help limit the effect of the shocks analyzed for the real economy.

In this section, we analyze whether a funding substitution across banks or originator countries takes place. We divide this analysis in two steps. We first assess the existence of substitution in credit supply in the cross-section of UK-based banks. Second, we further assess a possible substitution of credit supply across banking systems. This latter substitution could take place if borrowers shift their demand out of affected UK banks into banks outside the United Kingdom, importantly into banks located in the United States or the Euro Area.

To conduct these tests, we adjust our empirical setting as follows. First, we aggregate our left-hand-side variable at the country-currency level and compute the aggregate growth rate in cross-border credit by all UK-based banks. Then, we recompute all bank-level variables as the market-share-weighted average of all banks operating within a country-currency market. For this exercise, we employ the full data set without the filters imposed on the data in our baseline specification to allow for a potential substitution across all UK-based banks active in a given market abroad.

Second, to explore the substitution of credit across origination countries we replace the dependent variable by the (exchange rate adjusted) growth rate in total cross-border credit to each country-currency pair. We consider credit originated either out-

headquarters in our sample) can exert influence on their affiliates abroad to access FX funds. This dynamic may further explain the difference in the size of the estimated coefficients.

31. For this exercise, we drop the destination country dimension of our panel given specific data constraints on intragroup liability information. This means we also have to modify our fixed effects structure. See footnote to Table A.12.

side the United Kingdom (“rest of the world”) or in the currency areas corresponding to each of the currencies analyzed. We compute these series using data from the the Bank of International Settlements (BIS) Locational Banking Statistics. In the case of the United Kingdom, system-wide BIS data results from the aggregation of the individual institutions data we rely on for the rest of our analysis, marking a continuity in terms of data used.

In order to operationalize this setting, we run an adjusted version of equation (4) using a panel at the country-currency-quarter level (i.e., losing the bank dimension). This model is formalized in equation (5):

$$\begin{aligned} \Delta L_{j,k,t} = & \alpha + \beta_1 RSF_{j,k,t-5} + \sum_{l=1}^4 \beta_{2,l} \Delta CIP_{k,t-l} * RSF_{j,k,t-5} \\ & + \beta_3 X_{j,t-1} + \gamma_{j,k} + \delta_t + \epsilon_{j,k,t}. \end{aligned} \quad (5)$$

In equation (5), we study the cross-border lending growth rate in country j and currency k during quarter t ($\Delta L_{j,k,t}$). The variable of interest is the interaction between a country-level proxy for the exposure to synthetic funding (RSF) and the deviations in the CIP condition (ΔCIP). We control for country-currency and quarter fixed effects, which can absorb demand shocks that spread similarly across countries and currencies. To ensure consistency, this panel includes the same group of 70 countries as in our previous analysis.

Table 5 reports the results. Column I reports a positive and statistically significant joint coefficient for the interaction term of interest, suggesting that markets relying on UK-based banks largely exposed to synthetic funding experience a drop in aggregate credit from the United Kingdom when synthetic funding shocks occur. We interpret this result as evidence against a potential substitution of credit across UK-based banks.³²

Interestingly, columns II–V show that, in periods of synthetic market strain, aggregate lending from the United Kingdom does not fall in destination markets with a large share of lending originated from UK-based branches (columns II–III) or UK banks with large use of ICM (columns IV–V). This result imply that a larger presence of banks that can undo the effect of synthetic funding shocks moderates the aggregate effect.³³

Next, we reestimate equation (5) by calculating the dependent variable $\Delta L_{j,k,t}$ as the growth rate in cross-border claims from the “rest of the world,” or, alternatively, from the corresponding currency areas of credit flows (i.e., the United States and the Euro Area) using the BIS Locational Banking Statistics. If a substitution across origination countries takes place, we would expect lending from these currency areas

32. Barajas et al. (2020) find similar aggregate results in a cross-country analysis; that is, banking systems with high RSF tend to cut back cross-border lending in the event of funding shocks.

33. For this exercise, we split the sample according to the 75th percentile of the 2008 distribution of the share of claims originated in UK-based branches or banks with a large use of ICM. This latter definition is the same as in Section 3.2. Due to data limitations, this exercise is restricted to the period 2008–16.

TABLE 5
MACRO-ECONOMIC DIMENSION—SUBSTITUTION ACROSS UK BANKS

Sample:	Share of UK branches			Share of large	
	Full I	in total claims:		Low IV	High V
		Low II	High III		
Joint $\Delta CIP \times RSF_{t-5}$	1.159** (0.461)	1.326** (0.618)	0.646 (0.936)	1.688* (0.848)	-1.096 (1.181)
RSF_{t-5}	-0.057 (0.037)	-0.099** (0.041)	0.081 (0.065)	-0.110 (0.078)	0.047 (0.095)
Controls:					
$Log\ assets_{t-1}$	0.008 (0.006)	0.007 (0.007)	0.009* (0.005)	0.009 (0.011)	-0.007 (0.014)
$Dep. ratio_{t-1}$	-0.021 (0.036)	-0.059 (0.045)	0.080* (0.046)	-0.019 (0.062)	0.222* (0.114)
$Liq. ratio_{t-1}$	0.244*** (0.066)	0.316*** (0.080)	0.119 (0.106)	0.309** (0.136)	-0.093 (0.137)
$Cap. ratio_{t-1}$	0.434*** (0.151)	0.503*** (0.184)	0.039 (0.204)	0.013 (0.207)	1.185*** (0.279)
Constant	-0.237** (0.102)	-0.227* (0.120)	-0.275** (0.108)	-0.266 (0.196)	-0.157 (0.202)
Obs	6,576	4,896	1,680	2,856	980
R^2	0.036	0.041	0.061	0.038	0.064

NOTE: This table reports the results from estimating equation (5) at the country-currency level. The dependent variable is the quarterly change in log total claims to country j in currency k by all UK-based banks in the original sample ($\Delta L_{j,k,t}$), before including sample filters. The independent variables (with the exception of ΔCIP) are computed as market-share weighted averages of the respective underlying bank-level variables in each country-currency pair. Column I reports the results for the full sample. Columns II and III report a sample split exercise according to the 75th percentile of the precrisis average share of UK-based branches in total claims to each j, k pair. Columns IV and V replicate the sample split exercise according to the 75th percentile of the share of large ICM ratio banks in total claims in each j, k pair. Large ICM ratio banks are those with a ratio of (currency-specific) FX internal liabilities to total assets (ICM ratio) above the 75th percentile of the banks' distribution. All constitutive terms of the interactions are included in the regressions. Regressions include country-currency and quarter fixed effects. Standard errors (in parentheses) are clustered at the currency and quarter level. Variables are winsorized at the 1st and 99th percentiles. *** indicates significance at the 1% level; ** at the 5%; and * at the 10%.

to increase in the face of synthetic funding shocks. We could therefore expect a flipped sign in the joint coefficient of interest.

The results from this analysis are reported in Table 6. In column I, we replicate the exercise on UK-originated lending shown in Table 5, but estimated on BIS data. Reassuringly, results hold and the magnitude of effects is very similar. Column II shows that a substitution of credit does not take place between the United Kingdom and the world considered as a whole. However, when considering only cross-border flows originated in the United States and the Euro Area (column III), the results show a negative and statistically significant coefficient in our interaction of interest. This result indicates some substitution between flows originated in the United Kingdom and in the relevant currency areas.

We also look separately at markets with a high versus low market share of UK-based banks, as a proxy for the exposure to sterling-based synthetic funding shocks (columns IV and V). We find that the increase in flows from the United States and the Euro Area only materializes in markets with a large presence of UK-based banks exposed to synthetic funding, as expected from previous results. This sample split follows the same definition as in Table 4.

TABLE 6
MACRO-ECONOMIC DIMENSION—SUBSTITUTION ACROSS SOURCE COUNTRIES

Claims from:	UK	Rest of world	Home CA Share UK claims:		
	Full I	Full II	Full III	Low IV	High V
Joint $\Delta CIP \times RSF_{t-5}$	1.039** (0.415)	-0.499 (0.403)	-0.959* (0.541)	-0.651 (0.661)	-1.694** (0.769)
RSF_{t-5}	-0.084 (0.052)	-0.048 (0.033)	0.021 (0.041)	-0.041 (0.051)	0.079 (0.069)
Controls:					
$Log\ assets_{t-1}$	0.013** (0.005)	-0.001 (0.002)	0.003 (0.002)	0.002 (0.003)	0.004 (0.006)
$Dep. ratio_{t-1}$	-0.008 (0.087)	-0.006 (0.035)	0.052 (0.074)	0.034 (0.080)	0.035 (0.134)
$Liq. ratio_{t-1}$	0.239*** (0.062)	0.019 (0.033)	0.097* (0.050)	0.119* (0.063)	0.083 (0.086)
$Cap. ratio_{t-1}$	0.434** (0.176)	-0.050 (0.089)	-0.270* (0.141)	-0.290* (0.151)	-0.329 (0.271)
Constant	-0.334*** (0.073)	0.025 (0.032)	-0.072 (0.049)	-0.045 (0.061)	-0.088 (0.103)
Obs	6,546	6,546	5,695	2,999	2,696
R^2	0.039	0.076	0.035	0.043	0.048

NOTE: This table reports the results from estimating equation (5) at the country-currency level. The dependent variable is the quarterly change in log total claims to country j in currency k computed using data from the BIS Locational Banking Statistics ($\Delta L_{j,k,t}$). The independent variables (with the exception of ΔCIP) are computed as market-share weighted averages of the underlying bank-level variables in each country-currency pair. The table reports regressions in which we compute $\Delta L_{j,k,t}$ using flows originated in three regions: UK (column I), all countries different than the United Kingdom (Rest of world, column II); and the United States and the Euro Area as the home currency areas of the currencies in which claims are denominated (Home CA, columns III–V). In columns IV and V, we report a sample split exercise according to the median of the precrisis average share of claims from the United Kingdom in total claims to each j, k market. All constitutive terms of the interactions are included in the regressions. Regressions include country-currency and quarter fixed effects. Standard errors are clustered at the currency and quarter level. Variables are winsorized at the 1st and 99th percentiles. *** indicates significance at the 1% level; ** at the 5%; and * at the 10%.

How large is this cross-country substitution? The answer depends on countries' relative exposure to lending originated in the United Kingdom and in the relevant currency areas. As an illustrative example, we consider two representative jurisdictions: Singapore, which receives around 30% of its U.S. dollar funding from the United Kingdom, and South Africa, for which the share of dollars coming from the United Kingdom is close to 50%. The market-weighted RSF of UK banks active in these markets is very similar, at around 20%. Using the coefficients displayed in Table 6, it can be calculated that, in the face of a seven-basis point CIP shock (i.e., the one observed in the second quarter of 2012), the increase in cross-border lending from the United States offsets around two-thirds of the drop in UK lending for Singapore. However, only around one-third of the drop in UK lending is offset in the case of South Africa.

In sum, our results show that (i) substitution does not take place within the sample of UK-based banks, but (ii) other banks, namely, those based in the United States and the Euro Area, do step in and increase their lending to particularly affected countries. The net effect depends, however, on countries' relative exposure to the United Kingdom and other relevant currency areas.

5. CONCLUSION

This paper documents the existence of a cross-border bank lending channel arising from funding shocks in FX swap markets. By looking at balance sheet data from banks operating in the United Kingdom, we show that banks cut cross-border lending in specific foreign currencies whenever the cost of obtaining funds in these currencies goes up in FX derivatives markets.

While we find evidence that the effect of these funding shocks is alleviated for those banks that have access to on-balance-sheet FX funds coming from abroad via ICM, we document that there is no increase in lending from unaffected UK banks that may substitute the loss of credit in the recipient countries. However, we do see an increase in lending originating from the corresponding currency areas, particularly toward destination countries with initial high reliance on UK lending.

The dynamics uncovered by our findings could have medium-term consequences for banks' operations and organizational structures. In particular, the possibility of sudden spikes in the cost of accessing FX offshore, resulting in a forced cut back in profitable lending, could lead banks to either engage in precautionary front-loading of FX funding and/or the reoptimization of group structures so as to be able to tap FX funding directly (e.g., via the presence of affiliates in the relevant jurisdictions).

Our results inform policy discussions related to international financial fragmentation and the need for regulatory cooperation to tackle the drivers of fragmentation. Since the outset of the latest financial crises several countries have introduced policies aimed at restricting the ability of domestic banks and foreign bank affiliates to participate in internal (and external) capital markets, including geographic ring-fencing policies.³⁴ Our analysis highlights a potential unintended drawback of this drive: by restricting global banks' capacity to manage internal liquidity on a global scale, these policies may entail the risk of reducing banks' access to FX liquidity, affecting thereby the stability of cross-border banking flows.

More generally, our results also provide direct evidence on the consequences of CIP deviations for (cross-border) credit provision, and therefore help strengthen the case for central bank swap lines. This policy tool has succeeded in two fronts according to some estimates, both in terms of reducing offshore U.S. dollar funding costs (Bahaj and Reis 2019, 2020) and sustaining the flow of U.S. dollar lending by non-U.S. banks (Aldasoro et al. 2020, Barajas et al. 2020, Cetorelli, Goldberg, and Ravazzolo 2020). Exploring the interaction between central banks' FX swap lines and liquidity dry-ups in FX swap markets provides an interesting avenue for future research.

34. Previous studies have argued that these policies may provide a cushion against financial contagion (Anginer, Cerutti, and Martínez Pería 2017) at the cost of increasing banks' capital and liquidity needs (Ilyina et al. 2010). See also Beck et al. (2015).

ACKNOWLEDGEMENTS

Open access funding enabled and organized by Projekt DEAL.

APPENDIX A:

A.1 Variable Definitions

Table A.1 describes the variables used in the analysis. These variables are divided into the following categories: dependent variables, main variables of interest, bank-level controls, and additional variables.

TABLE A.1
VARIABLES DEFINITIONS

Variable	Definition	Source
Dep. vars:		
$\Delta L_{i,j,k,t}$	Exchange-rate adjusted growth rate in cross-border claims of bank i to country j in currency k at time t in percent.	BoE
$\Delta L_{j,k,t}$	Aggregated exchange-rate adjusted growth rate in cross-border claims of all UK banks to country j in currency k at time t in percent. Alternatively, the variable is computed from total cross-border claims originated in the BIS reporting countries from the BIS Locational Banking Statistics.	BoE, BIS
Main vars:		
$\Delta CIP_{k,t-1}$	Quarter-to-quarter change in the cross-currency basis between sterling and currency k .	BBG
$RSF_{i,k,t-1}$	Ratio of synthetic funding in currency k by bank i relative to total liabilities in currency k . Synthetic funding in k is proxied by the difference between total assets and liabilities denominated in currency k .	BoE
Joint $\Delta CIP \times RSF_{t-5}$	Joint coefficient of four-lags of interactions between RSF and CIP for lags $t = -1$ to $t = -4$.	BoE & BBG
Dif_{t-5}	Dummy equal to 1 if the respective claims are denominated in EUR. Alternatively, the variable equals to 1 if ΔCIP is negative.	BBG
Control vars:		
$Log\ assets_{t-1}$	Log of total assets at the UK-bank level (excludes assets of foreign affiliates).	BoE
$Dep.\ ratio_{t-1}$	Ratio of total retail (sight + savings) deposits to total assets at the bank level.	BoE
$Liq.\ ratio_{t-1}$	Ratio of liquid assets (cash + BoE deposits) to total assets at the bank level.	BoE
Variable	Definition	Source
$Cap.\ ratio_{t-1}$	Ratio of total equity to total assets	BoE
$\Delta L_{i,k,t}^{\neq k}$	Average growth rate of bank i 's claims in non- k currencies to all countries but j .	BoE
Additional vars:		
Branch	Dummy variable equal to one if a bank in the sample is a branch of a foreign banking conglomerate operating in the United Kingdom.	C&VH
CA branch	Dummy variable equal to one if a foreign bank branch in the sample is owned by a bank headquartered either in the United States or the Euro Area. These jurisdictions represent the home currency areas (CA) of the currencies in which cross-border claims are denominated (i.e., USD and EUR).	C&VH
Non-CA branch	Dummy variable equal to one if a foreign bank branch in the sample is owned by a bank headquartered outside the United States or the Euro Area. These jurisdictions represent the home currency areas (CA) of the currencies in which cross-border claims are denominated (i.e., USD and EUR).	C&VH
Total FX	Ratio of total on-balance-sheet liabilities in a given FX currency to total bank assets. FX currencies are represented by either USD or EUR. In the analysis, the variable enters the empirical model as a dummy equal to one for banks with a ratio above the 75th percentile, and 0 otherwise.	BoE

(Continued)

TABLE A.1
(CONTINUED)

Variable	Definition	Source
ICM ratio	Ratio of foreign internal liabilities in a given FX currency to total bank assets. FX currencies are represented by either USD or EUR. Internal liabilities represent liabilities vis-à-vis correspondent entities within the same banking conglomerate located outside the United Kingdom. In the analysis, the variable enters the empirical model as a dummy equal to one for banks with a ratio above the 75th percentile, and 0 otherwise. This variable is only available for the period 2008–16.	BoE
Non-ICM ratio	Ratio of non-ICM liabilities in a given FX currency to total bank assets. FX currencies are represented by either USD or EUR. Non-ICM liabilities correspond to total on-balance-sheet liabilities minus ICM liabilities as described in the variable ICM ratio. In the analysis, the variable enters the empirical model as a dummy equal to one for banks with a ratio above the 75th percentile, and 0 otherwise. This variable is only available for the period 2008–16.	BoE
Rest of World	Dummy variable equal to one for countries different than the United Kingdom, and 0 otherwise.	Own
Home CA	Dummy variable equal to one for the United States and the Euro Area countries, and 0 otherwise. These countries represent the home currency area (CA) of the currencies in which cross-border claims are denominated (i.e., USD and EUR).	Own
Share of UK branches	Average pre-2008 (2003–07) share of UK branches in total claims from banks operating in the United Kingdom to a given country-currency market i, j . In the analysis, the variable is used as a dummy equal to one for markets with a share above the 75th percentile of the distribution, and 0 otherwise.	BoE
Share of large ICM rat.	Share of large ICM ratio banks in total claims from banks operating in the United Kingdom to a given country-currency market i, j . Large ICM ratio banks are banks with a ratio of internal liabilities from abroad (ICM) to assets above the 75th percentile of the variable's distribution. The share is computed as of 2008Q1, the first available observation. In the analysis, the variable is used as a dummy equal to one for markets with a share above the 75th percentile of the distribution, and 0 otherwise.	BoE
Share of UK claims	Average 2003–07 share of UK-originated cross-border claims in total claims to a given country-currency market i, j originated in the BIS reporting countries. In the analysis, the variable is used as a dummy equal to one for markets with a share above the sample median, and 0 otherwise.	BIS

NOTE: This table reports the definitions and sources of the variables used in the analysis. The sources include the Bank of England (BoE), Bloomberg (BBG), the Claessens and van Horen (2014) Bank Ownership Database (C&VH), the Locational Banking Statistics reported by the Bank of International Settlements (BIS), and the authors' own construction (own).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Figure A.1 Share of EUR liabilities by instrument (average across banks)

Figure A.2 Distribution of internal capital markets’ funding

Table A.1 Preliminary test - Regressing RSF on bank variables

Table A.2 Preliminary Test - Regressing RSF on Δ CIP

Table A.3 Robustness tests - Empirical setting

Table A.4 Robustness tests - Alternative FE specifications

Table A.5 Robustness tests - Horse-race against RSF

Table A.6 Extension - Currency and Δ CIP sign

Table A.7 Robustness tests - Excluding relevant observations

Table A.8 Robustness tests - Effect on assets and RSF definition

Table A.9 Robustness tests - GBP-denominated claims

Table A.10 Robustness tests - Changes to econometric setting

Table A.11 FX funding ratios by bank type

Table A.12 Access to FX funding: Internal funding growth

Table A.13 Descriptive statistics of country-level regressions