Bank Competition for Wholesale Funding: Evidence from Corporate Deposits*

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ABSTRACT

When banks are faced with a funding shortage in money market wholesale funding, they partly substitute by tapping other wholesale funding sources. Using auction-level data on large corporate deposits, we trace these substitution effects and their implications, which go beyond the balance sheets of banks affected by the funding shortage. Banks which are forced to seek funding sources substitution ("affected" banks) crowd out other initially unaffected banks, which pay substantially more to retain funding. Affected banks achieve funding substitution mostly through an intensive margin adjustment, increasing their share of funding coming from stable funding providers. We document a mechanism to explain this observation, building on the existence of a pecking order of funding in fragmented markets and the matching of banks' and firms' preferences. The crowding-out of initially unaffected banks worsens their pool of funding providers. The stock prices of these banks underperform those of affected banks, while CDS spreads remain broadly unchanged between the two groups. Our results suggest that crowding out in funding markets affect competitiveness on the asset side.

JEL classification: G21, G28
Keywords: global banks, dollar funding, US money market fund reform, corporate deposits

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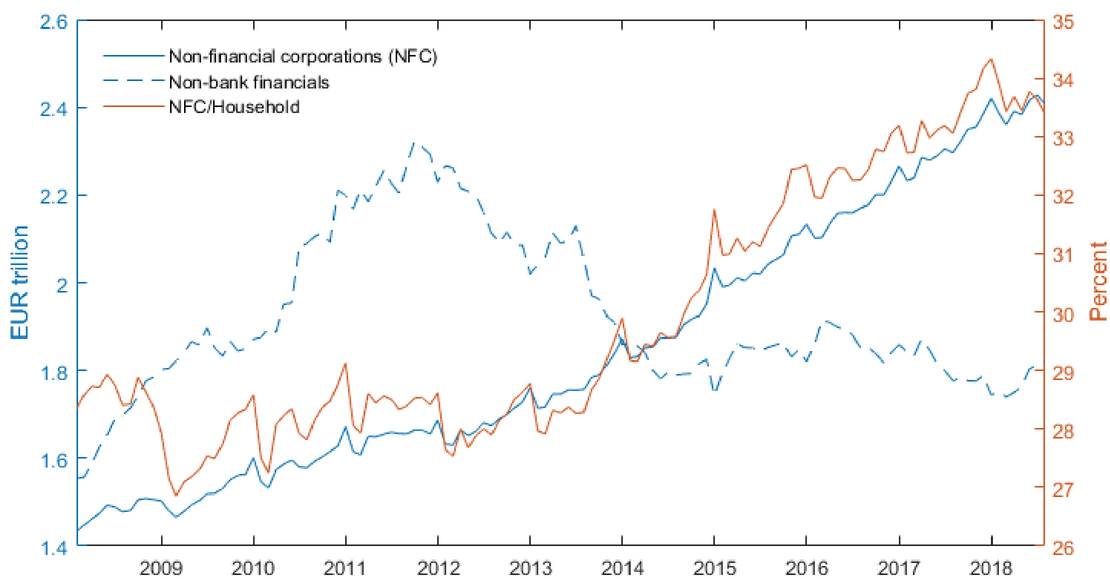
I. Introduction

The liability structure of banks is increasingly recognized as a key reason why banks are special (Drechsler, Savov and Schnabl, 2017; Egan, Lewellen and Sunderam, 2017). While the focus of the literature has been mostly on retail deposits, non-financial corporate deposits represent an increasing share of funding for banks. Figure 1 presents selected liability positions of euro area banks. Over a period of ten years from 2008 to 2018, non-financial corporate deposits have risen substantially by close to 1 trillion euro to about 2.4 trillion euro as of July 2018. Non-financial corporate deposits have not only increased in absolute terms, but have also gained importance relative to household deposits – the largest and most stable source of funding. This rise in importance of non-financial corporate deposits occurred simultaneously with an absolute decline in funding coming from non-bank financial institutions, such as money market funds.

Figure 1

Deposit liabilities of euro area banks



Source: ECB Statistical Data Warehouse, Balance Sheet Items, Euro area counterparties.

In this paper, we use the market for corporate deposits denominated in US dollars to document increasing competition for dollar funding in response to a dollar funding supply shock, and the negative externalities this generates. We present a novel channel showing how a shock to bank funding supply transmits through the banking system via an increase in competition for remaining funding sources. To this end, we employ the US MMF reform of October 2016 as an exogenous negative funding supply shock in a difference-in-difference set-up[1] Banks could respond to such a shock by reducing assets (Ivashina, Scharfstein and Stein, 2015; Chernenko and Sunderam, 2014) or by replacing the loss of MMF funding with other sources of funding.

[1]The reform represented an important loss of unsecured dollar funding available to global banks. We discuss the institutional features and the implementation of the reform in detail in Section II.A.

Using a unique auction-level dataset of corporate deposits, we show how competition for corporate deposit funding intensified after the MMF reform. The auction setup for non-financial corporate deposits (as one important source of alternative wholesale funding) serves as an ideal means to study whether substitution between different sources of funding by one bank has implications beyond its own balance sheet, with spill-overs to funding structure and performance of other banks through competition. The fact that the reform happened during an otherwise tranquil period in financial markets limits the influence of potential confounding factors that may plague inference based on periods of broad financial distress. Furthermore, this renders our results informative for bank behavior more generally.

We identify banks that suffered a loss in dollar funding due to the reform by using detailed, transaction-level information on lending of MMFs to banks gathered from regulatory filings of US MMFs.[2] We match the funding loss information with granular auction-level data from a large corporate deposit trading platform in Europe. The richness of detail of this dataset allows us to investigate the effects of substitution between sources of, and competition for, wholesale funding. We have information on deposits denominated in various currencies, with transactions in dollars, euros, and pounds having a similarly large and diversified sample. In 2016, transactions denominated in dollars, euros, and pounds respectively had a daily turnover of around 1.5 billion dollars, 2.9 billion euros, and 0.8 billion pounds and a median transaction size of about 25 million dollars, 50 million euros, and 16 million pounds. Since the funding shock we investigate originated from the United States, we focus on the dollar segment of our dataset for identification.[3] In 2016, banks directly affected by the MMF reform captured around 75% of this market, whereas unaffected banks accounted for the rest.

The auction mechanism works as follows. Firms offer to deposit their funds to banks, choosing the size and maturity. Banks are invited to provide a quote and decide to bid interest rates. Banks' bids are private information, i.e. one bank does not observe the bids of other banks. Firms have full information on all bids and select the winning bid at their own discretion. In the dataset, we observe the names of the banks and, although we do not observe the names of the deposit offering firms, we have a unique identifier that allows us to follow firms over time. In this way, we can enrich our analysis by classifying firms into different categories, such as stable funding providers, i.e., those firms that are a reliable source of funding by consistently providing deposits for auction.

Combining the two datasets allows us to trace the funding substitution of banks from one market to the other, as we can follow the banks affected by a loss in wholesale funding from MMFs and see how they compete for wholesale funding in the corporate deposit market. We observe that those banks experiencing a strong decline in MMF funding can substitute their funding loss with corporate deposits, while the increasing competition leads to a crowding-out of those banks that

[2]Throughout the paper we refer to the banks affected by the MMF reform as *treated* or *MMF-affected* banks and to the unaffected banks as *non-treated* banks. Treated banks are large, global banks, while non-treated banks tend to be, on average, smaller European banks. However, the sample of non-treated banks also includes global and domestic systemically important banks as per definition of the Financial Stability Board (FSB) or national supervisors.

[3]We use auctions for deposits denominated in other currencies in a placebo test to show that the reform affects only competition for USD deposits.

were not directly affected by the MMF reform. More precisely, we show that banks that were not affected by the reform have to pay higher spreads in order to obtain corporate deposits.

We document that as the MMF reform was implemented, banks experiencing a funding shortage in its wake (*treated banks*) intensified competition for corporate deposits. In particular, we observe that treated banks manage to crowd out banks that did not lose funding from MMFs (*non-treated banks*) from the USD-denominated corporate deposit market: Non-treated banks had to increase their offered deposit rates in order to keep their market share during the implementation of the reform. Our identification strategy would fail if there are different time trends in the general bidding behavior of treated and non-treated banks that are unrelated to the funding shock due to the reform. In order to rule out a general change in bidding behavior, we compare USD-denominated auctions to GBP-denominated auctions. We confirm that the observed difference in deposit spreads shows a dollar-specific effect and thus the impact of a dollar funding shock due to the US MMF reform.

The markets we study are characterized by a degree of fragmentation. Some banks have access to both markets (i.e. MMF and corporate deposits) whereas others have only access to one (i.e. corporate deposits). Furthermore, we argue for, and present evidence of, the existence of a pecking order in terms of the funding preference of those banks with access to both markets, namely a preference for MMF funding due to maturity and volume considerations. Market fragmentation and pecking order interact to affect the matching of banks' and firms' preferences, and the resulting bargaining power of firms and banks. Against this background, we show that (i) banks with access to both MMFs and corporate deposits are also the ones preferred by corporate funding providers, and (ii) banks favor funding providers offering a stable, and also sufficiently large, flow of funding. Therefore, banks preferred by corporate funding providers prefer MMFs as funding source themselves.[4] After the US MMF reform, these banks had to resort to less preferred funding sources, i.e., corporate deposits. As preferred deposit taker, these banks could smoothly substitute MMF funding losses without paying higher prices and thereby forced less preferred banks – i.e. banks without access to MMF funding – to build up new relationships with less stable funding providers and to pay higher prices for deposit funding.

We use the change in banks' lenders composition to document a mechanism of crowding out, which also serves as explanation for the higher price that non-treated banks have to pay. Underpinning this explanation is the existence of a pecking order of preference for funding and market fragmentation as discussed above. Using the long history of firms' deposit provision, we classify firms into two groups depending on the "stability" of their funding provision. We measure the stability of funding provision by the ratio of monthly aggregate notional deposit amounts provided by a firm over the average monthly notional deposit amount of the prior six months in which the firm was active on the platform.

We document that treated banks attract stable funding providers away from non-treated banks. In particular, we show that non-treated banks have a lower probability of winning an auction with

[4] See Section III.A for details on the underlying conceptual framework and Section IV.B for a detailed discussion of banks' and firms' preferences.

stable, and particularly larger, funding providers, despite offering the same bid quote to a firm (using bid*rank fixed effects). They are therefore forced to form new relationships. In the aftermath of the reform, they increasingly obtained funding from firms they had no relationship with on the platform prior to the reform. Non-treated banks are therefore forced to satisfy their funding needs by bidding a higher price for funding from new relationship firms, and also had to pay a substantial premium for funding from existing smaller and less-stable funding providers, which served as a mean to control their funding costs before the US MMF reform. Here, too, we rule out that the two groups differ in their fundamental trends in the success probability for winning an auction, which could be due to, e.g., a change in deposit offering firms' preferences for treated banks. The observed advantage of winning an auction is dollar-specific, as we do not observe a higher chance of winning an auction in GBP for treated banks.

Finally, we focus on the implications of the crowding out in funding markets on banks' risk and performance. We show that over a 3-month horizon, treated banks outperform non-treated banks by a 14-18 percentage points higher stock price growth. This might be due to two potential channels of investor expectations: First, investors might worry about the ability of non-treated banks to access dollar funding, causing some uncertainty about their riskiness and solvency position. Second, given that the access to funding of non-treated banks is lower, they might not be able to easily materialize profitable lending opportunities, affecting the stock prices through the discounting of future cash flows. If the first hypothesis is true, we would expect that the CDS spreads of treated versus non-treated banks diverge. Such a divergence is present, but only over a very short period right after the MMF reform implementation. Taking a slightly longer perspective, however, we find no evidence of material divergence in 5-year CDS spreads. The evidence we present is instead in line with the old theories put forward by Stahl (1988) and Yanelle (1989), suggesting that the nature of competition for liabilities affect the competitiveness of banks on the asset side. The substitution and crowding out effects we uncover using the corporate deposit data are arguably not large enough in absolute terms to single-handedly justify the observed divergence in stock prices. We rather view the corporate deposit platform as a microcosm of a larger development affecting treated and non-treated banks in the aftermath of the MMF reform.

Related literature Our results relate and contribute to several strands of literature. First, our paper builds on the literature on price competition for deposits à la Bertrand, which goes back to the seminal work of Stiglitz and Weiss (1981) and Diamond (1984). Yanelle (1989) and Yanelle (1997) model in two early papers this competition on both sides of the balance sheet: banks can only finance projects if they have sufficient funds available. The importance of the liability side of banks' balance sheet has also been emphasized in recent research. Egan et al. (2017) find that deposit productivity explains the largest share of the cross-section of bank value and is therefore more important than banks' ability to screen and monitor borrowers, whereas synergies between deposit-taking and lending also account for a significant share of value creation by banks. Drechsler et al. (2017) show that an increase in the fed funds rate leads to an increase in the deposit spread (defined as the difference between the Fed funds rate and the deposit rate), to which households respond by reducing their deposits. This "deposit channel of monetary policy" further predicts that the decrease in deposits causes a contraction in lending as banks cannot costless replace deposits with wholesale (non deposit) funding. Importantly, deposit supply is found to be more sensitive to monetary policy in more concentrated deposit markets, i.e., when banks have a high market power. Much of the focus of this literature is on core deposits.[5] Our paper contributes to this literature by studying both substitution between different sources of wholesale funding, as well as the channels and effects that competition for funding has. Furthermore, we show that market power also plays a role in the ability of banks to withstand competitive pressures while keeping constant both market shares and prices they pay for funding.

A well-established literature studies the importance of bank-firm relationships from the perspective of banks as lenders. Elyasiani and Goldberg (2004) conduct a comprehensive literature review on relationship lending and come to the conclusion that relationships between banks and firms increase fund availability and reduce loan rates. Bharath, Dahiya, Saunders and Srinivasan (2011) show that repeated borrowing leads to favorable lending conditions for the borrower and translates into 10-17 bps lower loan spreads. In a deposit auction setting similar to ours, Friedmann, Imbierowicz, Saunders and Steffen (2017) find that stronger relationships significantly increase the probability of winning a deposit auction. However, this benefit seems to come at a cost, as relationship banks bid higher on average during their observation period. We corroborate their findings on the importance of relationship funding.

By studying the effect that the MMF reform in the US has on the wholesale corporate deposit market in Europe, our paper also relates to the large literature on shock propagation and spillover effects. Typically, this literature focuses on direct spillovers from funding stress in distressed times, as for example the Great Depression (Bernanke, 1983), the land market collapse in Japan (Peek and Rosengren, 1997; Gan, 2007), the Russian sovereign default (Schnabl, 2012) or the financial crisis (Ivashina and Scharfstein, 2010; Aiyar, 2012; De Haas and Van Horen, 2012). However, also monetary policy spillovers (Buch, Bussiere, Goldberg and Hills, 2018) or spillovers in less severe episodes are analyzed (Chernenko and Sunderam, 2014). The novel feature of our paper is the fact that our exogenous shock appears in a very tranquil period regarding funding stress. We show that there are negative spillover effects even in calm times, which affect institutions that were not intended to by targeted by the reform.

Our paper also adds to the literature on the importance of dollar funding. Correa, Sapriza and Zlate (2012), for example, provide evidence for a cross-border bank lending channel. They show that US branches of European banks suffered from a massive deposit withdrawal during the European sovereign debt crisis, which was not driven by bank-specific risk characteristics but rather due to their euro-area affiliation. This liquidity shock, in turn, translated to a cut in lending of these branches to U.S. firms. Similarly, Ivashina et al. (2015) show evidence that US MMFs cut their US dollar exposures to European banks during the Eurozone sovereign crisis. As a result,

[5] A recent paper that looks into wholesale funding in detail is Pérignon, Thesmar and Vuillemey (2018).

dollar lending of European banks fell relative to euro lending, and firms reliant on US dollar from Eurozone banks before the crisis had a more difficult time to borrow USD. Aldasoro, Ehlers and Eren (2018) show that bargaining power and relationships are important determinants for the price global banks pay to obtain dollar funding from MMFs. Aldasoro and Ehlers (2018) document changes in the dollar funding geography of non-US banks, in particular the increased role of dollars raised outside of the US.

Also close to our paper are recent contributions that study how banks scramble for liquidity under severe funding stress. Acharya, Afonso and Kovner (2017) focus on the asset-backed commercial paper market freeze of August 2007, and how global banks coped with this funding shortage. While US banks were able to tap alternative sources of financing, foreign banks had to resort to raising US dollar deposits elsewhere. Using a similar data to ours (but focusing on the liquidity shortage following the great financial crisis period instead), Friedmann (2017) documents how banks bid more often for, and obtain more, unsecured corporate deposits. An important aspect on which our contribution differs from these papers is the focus on a tranquil period in financial markets, and the usage of a natural experiment that allows for clean identification. In our setting, banks are not "scrambling for liquidity", but rather perform adjustments to their funding strategies to cope with a significant, yet far from devastating, loss in dollar funding. Finally, our paper relates to a growing literature on MMFs and the MMF reform[6].

The rest of the paper is organized as follows: Section II provides some background on MMFs, the US MMF reform in 2016 as well as the used data sources. Section III outlines the underlying conceptual framework and the empirical design. Empirical results on wholesale funding substitution are presented in Section IV, while Section V complements empirical results on bank risk and performance. Section VI concludes.

II. Institutional background and data

A. Money market funds and the MMF reform

US MMFs are open-ended mutual funds that invest in money market instruments such as repos, commercial paper (CP), certificates of deposits (CD), and asset-backed commercial paper (ABCP). With around $3 trillion in assets under management, MMFs are an important source of funding for banks, as well as an attractive investment for a range of investors. Since their inception in the 1970s and up to the Global Financial Crisis (GFC), they were perceived as an investment as safe as bank deposits, but able to provide better returns. The ability to keep their net asset values (NAV) at $1 per share was historically an important factor underpinning this perception, since money market fund investments are not insured by the government. However, when the oldest MMF (Reserve Primary Fund) "broke the buck" in the aftermath of the Lehman Brothers collapse, this perception

[6] On MMF themselves and their role in the crisis, see Baba, McCauley and Ramaswamy (2009), Kacperczyk and Schnabl (2013) and Chernenko and Sunderam (2014), among others. For more details on the MMF reform, see Aldasoro, Ehlers, Eren and McCauley (2017) and Aldasoro et al. (2018) among others.

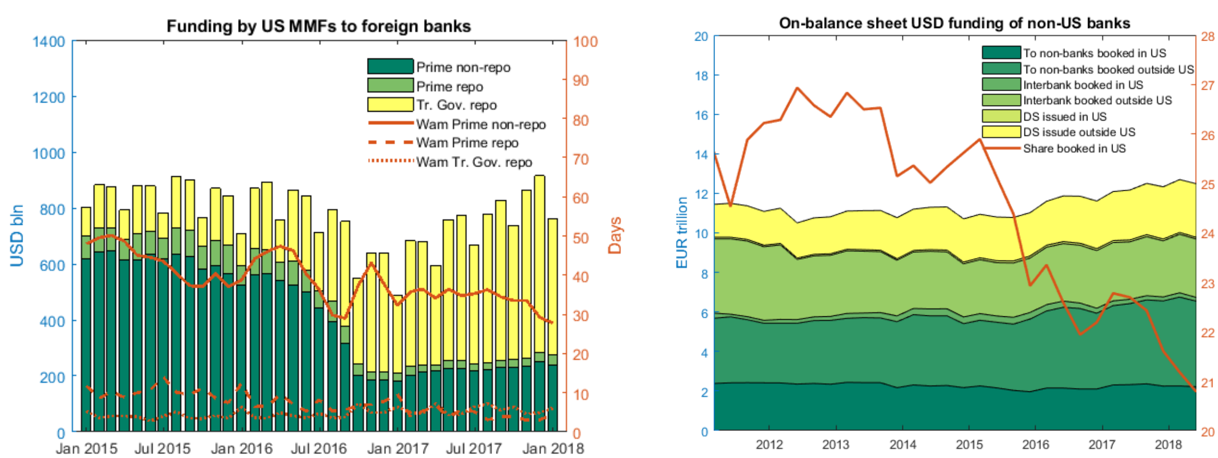
vanished as investors massively ran to redeem their shares, bringing about the collapse of the fund. This in turn led to additional investor redemptions in other funds (Kacperczyk and Schnabl, 2013). The run-prone nature of MMFs was again highlighted during the European sovereign debt crisis (Chernenko and Sunderam, 2014).

The revealed fragility of MMFs prompted the Securities and Exchange Commission (SEC) to respond by adjusting the regulation governing MMFs, known as Rule 2a-7 of the Investment Company act of 1940. After requirements to invest in even higher quality assets with shorter maturities adopted in 2010, an important revision of Rule 2a-7 was approved by the SEC in July 2014. This reform to the rules governing MMFs, which came into effect in October 14, 2016 (but with earlier compliance dates for parts of the reform package starting on April 14, 2016), constitutes the policy event on which our identification strategy builds. With the primary goal of addressing the risk of runs on MMFs, the reform required institutional prime funds and municipal funds to switch from a stable to a floating NAV calculation and introduced redemption gates and fees at the discretion of the fund. This finally led to the conversion of many prime funds to government-only funds, which only invest in secured instruments such as short term repos backed by US Treasury collateral.

The reform represented an important negative dollar funding supply shock to global non-US banks, which heavily relied on MMFs for their dollar funding (Figure 2, left-hand panel). Note that aggregate funding by MMFs hardly change, but there is in particular a shock to the unsecured portion of that funding, given the fund conversion mentioned above. This dollar funding squeeze did not, however, lead to a dollar funding shortage as in the financial crisis (McGuire and von Peter, 2012). As argued in Aldasoro, Ehlers, Eren and McCauley (2017), non-US banks were able to replace the loss of non-bank dollar deposits in the US with non-bank dollar deposits elsewhere (Figure 2, right-hand panel).

Figure 2

The MMF reform and the role of non-bank deposits



Source: Crane data (left-hand panel), BIS consolidated banking statistics (immediate counterparty basis), debt securities statistics and locational banking statistics (right-hand panel)

B. *Data*

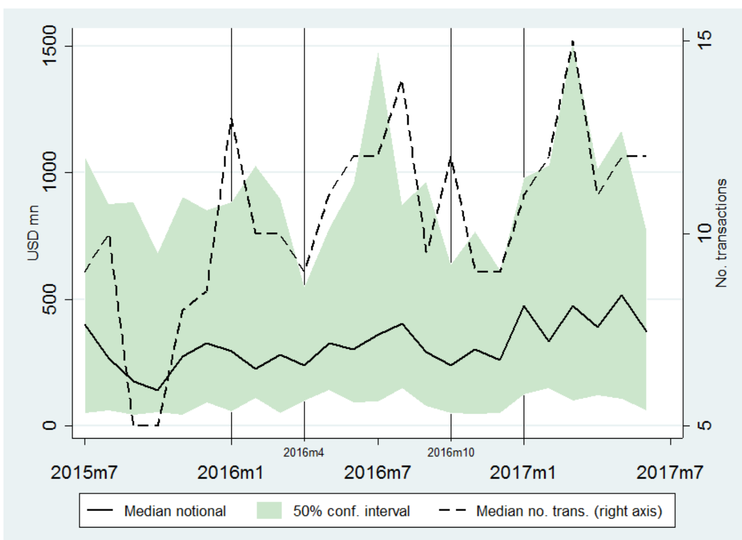
Corporate deposits data

The core of our analysis builds on a comprehensive dataset of corporate deposit auctions on one of the largest electronic trading platforms by volume in Europe.

On this platform, non-financial corporate firms offer their excess liquidity in various currencies as unsecured deposits. There are no restrictions for the deposit-providing firm on deposit amounts or maturities traded on the platform. Banks can trade with firms they have a trading agreement with and can bid in auctions by quoting an interest rate (provided they have been invited to participate by the firm). Interest rates are quoted using an actual/360 day count convention and transactions are settled on the same day. The bidding period lasts for two minutes by default and banks can adjust their bids anytime during this period.[7] Banks cannot see the bids of other banks, hence initial bids and adjustments should not be influenced by the behavior and risk evaluation of other bidders. After the bidding period, firms choose a winning bid out of the last bids of all bidding banks.

Figure 3

Monthly notional deposit amount and number of transactions per bank



Notes: The solid line depicts the median and the green area describes the first and third quartile of monthly notional deposit amounts executed by bank. The dashed line denotes the median number of transactions executed by bank to realize the monthly volumes.

The dataset consists of all bids (including adjustments) placed by different banks during the deposit auctions. Banks participating in auctions are identified by name. Deposit providing firms are anonymous, but have a unique identifier. We focus in our analysis on dollar deposits as the MMF reform represented a negative shock to dollar funding. On average, banks obtain $590 million in dollar funding in 14.64 transactions per month, which aggregates to a monthly average transaction

[7]The length of the bidding period can be individually adjusted by deposit providers as needed.

volume of $28.85 billion and on average 712.5 transactions per month. Note that the platform is less prone to supply-side confounding factors as funding supply is purely determined by excess liquidity. Figure 3 presents the distribution of notional dollar amounts and transactions in USD for our main sample.

MMF data

We classify banks' funding loss from MMFs using the month-end holdings of MMFs as reported in their regulatory filings to the SEC (SEC N-MFP forms), collected by Crane Data. Crane Data reports detailed information on MMFs as well as the instruments they invest in. For every instrument, the reports include information on transaction amounts, prices, remaining maturities and other important contract characteristics. Our focus is on the contract type (CDs, CPs, etc.), transaction amounts, and counterparty name and type.

We restrict the sample to the unsecured funding instruments through which banks borrow from MMFs, namely CDs, CPs and ABCPs, as this is the market that was negatively affected by the reform (Aldasoro, Ehlers and Eren (2018)). We link the contract-level information to the parent institution of the issuer, and aggregate funding from the three instruments at the bank-month level.

Bank characteristics and market data

Additional bank balance sheet and income statement information is added to the corporate deposits dataset from S&P Global Market Intelligence (formerly SNL Financial), which is available on an annual frequency for most banks in the sample. Daily stock prices for listed banks used for the bank performance analysis are also obtained from S&P Global Market Intelligence. Daily pricing data of five-year bank credit default swaps (CDS) on senior unsecured debt are retrieved from Markit.

III. Conceptual framework and descriptive statistics

In this section, we document the characteristics of the different funding markets, in particular with regards to transaction volumes, maturities and prices. We use this to set the conceptual framework we employ to develop our hypotheses. Finally, we lay out our empirical design used to test those hypotheses.

A. Conceptual framework: Market fragmentation and pecking order of funding

Table I describes some key characteristics of the MMF and corporate deposit markets for those banks that are active on both. Funding from MMFs has two desired features for banks. First, the average transaction volume of funding from MMFs is twice as large as that from corporate deposits. Second and more importantly, the average maturity of MMF funding exceeds that of corporate deposits by a very large margin. Banks seem to be willing to pay a price for these desired features, as in terms of absolute rates they pay on average slightly more when obtaining dollars from MMFs than from corporates.

Table I

Key characteristics of markets from 14/01/2016 to 14/04/2016 - All non-repo transactions

	US MMFs	Corporate Deposits
Avg. transaction [USD mn]	85.81	44.91
Avg. maturity [days]	42.90	10.50
Avg. rate [bps]	49.81	39.82

Source: Crane Data and corporate deposit data.

Notes: Only banks active in both the corporate deposit platform and US Money markets considered. In line with corporate deposits characteristics, only unsecured (i.e., non-repo) US MMF products considered.

This points towards a potential pecking order in the preferences of banks. They can obtain larger amounts of funding and lengthen their funding maturity through MMFs. We explore this in more detail in Table II by regressing, at the contract level, the rate paid for unsecured MMF funding and corporate deposits on interactions between contract maturity, size, and whether the funding comes from MMFs or corporate deposits.

Table II

Rates payed across markets

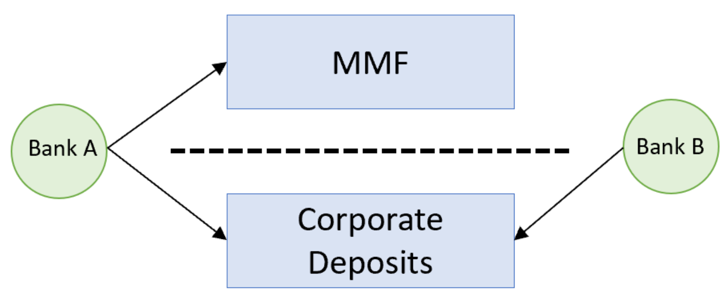
	(1)	(2)
MMF	9.3908***	8.8060***
	(2.8975)	(2.5936)
maturity * transaction size	0.0033***	0.0038***
	(0.0015)	(0.0013)
maturity * transaction size * MMF	-0.0028***	-0.0033**
	(0.0015)	(0.0013)
Constant	38.6460***	
	(2.6944)	
N	34672	34672
R^2	0.0491	0.0925
Bank FE		✓

Notes: OLS regressions at the contract level for the following equation: $Rate_{ijct} = \alpha + MMF_c + maturity_{ijct} * transaction\_size_{ijct} + maturity_{ijct} * transaction\_size_{ijct} * MMF_{ct} + \nu_i + \epsilon_{ijct}$. The dependent variable is the interest rate paid by bank i to either MMF or corporate funding provider j in contract c at time t. $maturity_{ijct}$ and $transactionsize_{ijct}$ denote the maturity and transaction size of the contract respectively. MMF_c is a dummy equal to 1 if the contract is with an MMF, and zero otherwise (i.e. for contracts with corporates). ν_i denotes bank fixed effects. The sample consists of all transactions from 14/01/2016 to 14/04/2016. Standard errors are clustered at the bank level (in parentheses). ***, **, * indicate significance at the 1%, 5% and 10% levels.

Banks pay on average more when transacting with MMFs (around 9 basis points). More interestingly, for longer maturity and larger transaction size, banks can pay less for dollar funding if their counterparties are MMFs. Against the background of the average transaction size and average maturities with US MMFs reported in Table I, the marginal price per dollar per day is lower for US MMF transactions.[8] Thus, banks should have a preference for obtaining funding from MMFs rather than from corporate deposits.

This pecking order is naturally relevant for banks that have access to both markets. The markets in our study are, however, segmented. Figure 4 illustrates this point. *Bank A* is characterized by having access to both markets and broadly maps to *treated banks* in the empirical analysis later; though, as discussed above, they have a preference for one type of funding over the other.[9] *Bank B* largely corresponds to our *non-treated banks* and does not have access to MMFs. When *Bank A* suffers a shock to its preferred source of funding, it will go down its pecking order and attempt to replace the funding lost by tapping its next best option. This will generate competitive pressures on *Bank B*.

Figure 4
Market fragmentation and differential access to funding sources



B. Descriptive statistics

We use bank names from Crane data and hand-match the MMF data with the corporate deposit data. The matched sample allows us to categorize banks active on the platform according to their funding loss from money market funds during the MMF reform implementation. We categorize banks as MMF-affected (*treated*) if they suffered a funding loss in the six months after full reform implementation in October 2016 relative to the six months up to the start of reform implementation in April 2016. The classification of treated banks as such is conditional on these banks having funding exposures to MMFs in the three months prior to April 2016.[10] Banks not fulfilling these

[8]Applying results of column (1) in Table II to an average MMF transaction (i.e., transaction size of 85.81 mn dollars and 42.90 days of maturity) results in an estimated premium of around 1 basis points for corporate deposits.

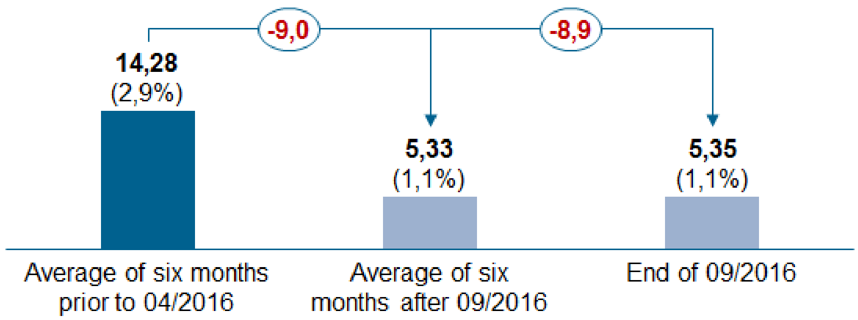
[9]Note that this does not imply that the funding providers in the second-tier market will not prefer this type of banks. Indeed, we present evidence that corporate funding providers have also a preference to trade with treated banks.

[10]One could alternatively use the universe of all banks that were potentially affected by the reform as treated. However, competition for wholesale funding intensified for those banks that actually suffered a loss in dollar funding. The applied definition results in the same classification as using the point in time funding loss as of end of September 2016 – i.e. the last pre-reform implementation observation – except for two banks. Looking into the development of MMF exposures of these banks reveals that this point in time consideration does not correctly reflect the actual funding substitution need and therefore the average of six months after the reform implementation is the better

conditions are classified as MMF-unaffected (*non-treated*). Figure 5 presents descriptive statistics on the funding loss from MMFs for treated banks. Treated banks have an average funding exposure of 14.3 billion dollars in the six months prior to April 2016 (close to 3% of total assets). This amount drops to 5.3 billion dollars in the six months post reform implementation period, which implies an average funding loss of about 9 billion dollars.[11] Non-treated banks have limited interactions with MMFs and, if anything, marginally gain MMF funding post reform.

Figure 5

Treated banks' US MMF funding exposure in USD bn (% of total assets)



Source: authors' calculations using Crane Data for banks active on the corporate deposit trading platform.

Our final sample comprises a total of 58 banks and 94 deposit providing firms executing 4,319 transactions on the platform. Of these banks, 32 are identified as treated and 26 as non-treated banks. From the 26 banks in the non-treated group, 3 are in the MMF sample, but either do not suffer a funding loss or even increase their unsecured funding from MMFs. The main analyses are based on an observation period of three months before the first MMF reform compliance date on April 14, 2016 ("pre" period) and three months after the full implementation of the reform on October 14, 2016 ("post" period).

Table III

Balance sheet characteristics by bank group, pre and post reform

Bank group	Treated		Non-treated	
Period (year-end)	2015	2016	2015	2016
Total assets (USD bn)	1,067	1,091	297	298
Leverage (total assets/equity)	18.0	18.0	15.3	14.9
NII revenue share (%)	54.9	55.6	54.7	47.7
Loans-to-deposits (%)	107.5	108.9	103.6	100.6
Loans-to-total assets (%)	49.0	49.5	47.4	46.4
Deposits-to-total assets (%)	47.2	47.9	50.0	50.8

Source: S&P Global Market Intelligence; authors' calculations.

comparison. Similarly, using three instead of six months before and after the reform implementation for measuring the funding loss only reclassifies one bank and looking into the development of MMF exposures again reveals that the average of six months is the more suitable measure. Moreover, using the six-month window reflects better, in our view, the reliance of banks on funding from MMFs, as well as the loss of funding as a consequence of the MMF reform.

[11]The same number obtains if we were to compute the funding obtained by treated banks in September 2016.

Table III presents balance sheet information for both treated and non-treated banks for the pre- and post-reform period.[12] Treated banks are on average larger, more leveraged, with a larger share of loans and a smaller deposit-to-assets ratio compared to non-treated banks. The most notable changes between the pre and post period are the relative increase (reduction) in loans for treated (non-treated) banks and, in particular, a decline in the net interest income revenue share of non-treated banks.

Table IV

Share of transactions by country of headquarters and bank group (%), pre and post reform

Bank group	Treated		Non-treated	
Period	Pre	Post	Pre	Post
Australia	8	7	-	-
Austria	-	-	8	17
Belgium	-	-	7	8
Canada	4	5	-	-
China	1	1	-	-
Denmark	1	1	-	-
France	25	25	<1	1
Germany	1	2	52	45
Hong Kong	<1	<1	-	-
Italy	-	-	12	5
Japan	17	18	-	-
Luxemburg	-	-	<1	1
Netherlands	16	19	-	-
Spain	<1	<1	2	2
Sweden	2	3	-	-
Switzerland	<1	<1	13	11
Thailand	-	-	3	8
United Kingdom	19	12	2	2
United States	5	9	-	<1

Source: authors' calculations.

To better understand the regional distribution of banks, Table IV presents the share of USD transactions on the corporate deposit platform by treated and non-treated banks in both pre- and post-reform period, split by the nationality of the banks' headquarters. Our sample consists of banks from 19 different countries. Banks within a country are in our sample typically either treated or non-treated, with the exception of those jurisdictions where the largest banks are headquartered (such as France, Germany, Spain, Switzerland and the United Kingdom).

Major summary statistics for dollar-denominated deposit auctions by bank category (treated vs. non-treated) and period (pre vs. post reform) are presented in Table V. Treated banks bid less often, yet secure a larger number of transactions and increase their aggregate market share.[13] The opposite applies to non-treated banks, which bid more often for funds, yet enter in less transactions, pay substantially more for the funds they obtain and lose market share.

The descriptive statistics suggest that the US MMF reform mainly had an adverse impact on

[12] As we only have year-end data, we approximate the pre period as end-2015 and the post period as end-2016.

[13] Aggregate market share refers to the aggregate share of the total USD deposit amount transacted during a certain time period received by the entire bank group.

Table V
Summary statistics dollar denominated auctions

Bank group	Treated banks		Non-treated banks		All banks	
Period	pre	post	pre	post	pre	post
No. bids	4446	4316	1385	1540	5831	5856
No. trans.	1454	1638	645	582	2099	2220
No. banks	30	32	22	22	52	54
No. firms	59	59	47	43	75	75
thereof new	-	*15*	-	*15*	-	*26*
Avg. notional	44.91	41.75	35.79	35.56	42.11	40.13
Avg. maturity	10.50	14.50	9.13	10.44	10.08	13.43
Avg. spread	0.88	0.37	8.69	16.58	3.28	4.62
Market share	73.88	76.76	26.11	23.23	-	-

Notes: Summary statistics for corporate deposit auctions denominated in US dollar. Bank groups three months pre and post periods as specified in Section III.B. *No. bids* is the total number of bids. *No. trans.* is the number of transactions. *No. banks* is the number of banks active in transactions. *No. firms* is the number of deposit providing firms active in transactions. *thereof new* denotes the number of firms having their very first transaction with one of the active banks in the post period. *Avg. notional* is the average notional deposit amount of transactions in 10^6 dollar. *Avg. maturity* is the average maturity of transactions in days. *Avg. spread* is the deposit spread (deposit interest rate - interbank benchmark rate of comparable maturity) in basis points. *Market share* denotes aggregate share of total notional deposit amount on the trading platform in percent for treated and noon-treated banks.

non-treated banks, who did not even suffer from any funding loss from the MMF reform. Albeit non-treated banks pay a substantially higher price in the post period, they somewhat lose on an aggregate level some market share. However, examining the development of market shares at the individual bank level does not confirm a volume change.[14] This analysis, which is shown in Appendix A, documents that non-treated banks have a statistically significant lower market share of around 1 percentage point in the pre-period, but there is no statistically significant difference in market shares between the pre-reform and post-reform periods, neither for treated nor for non-treated banks. Note again that on the platform, funding supply is determined by excess liquidity of firms and thus, rather price inelastic. With a more elastic funding supply, one might expect spillover effects to funding markets in terms of volumes.

IV. Competition and crowding out

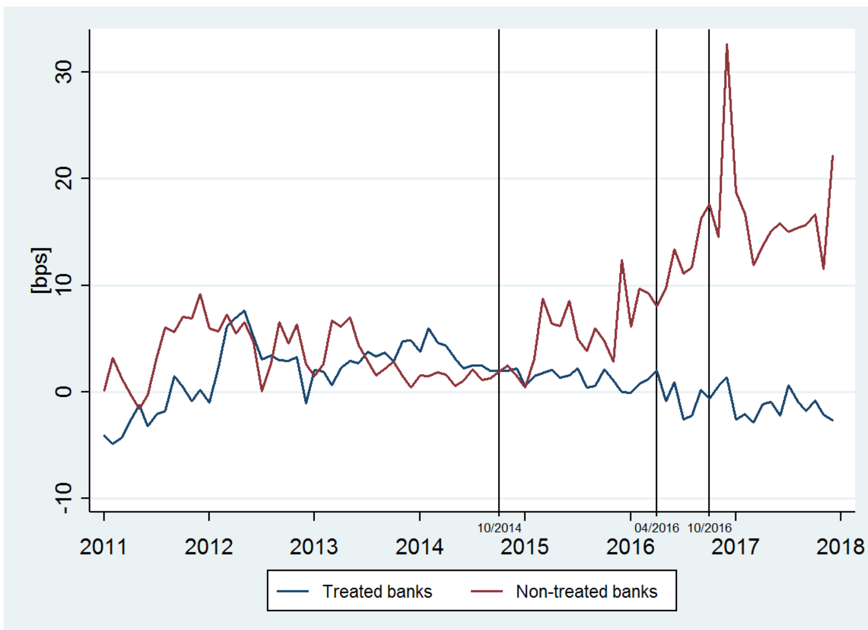
A funding drain, such as the one following the US MMF reform in 2016, is normally expected to exert pressure on affected banks that in turn can respond by cutting the asset side and by paying a premium on less preferred funding markets in order to fulfill their funding need. Our deposit trading platform is one of the potential substitutes for funding losses incurred from US MMFs, and the auction level data allows us to study the increase in competition following thereafter.

[14]Market share at the bank level refers to the share of the total USD deposit amount transacted during a certain time period by a single bank i.

The average deposit spread that treated and non-treated banks have to pay in order to obtain USD deposits is depicted in Figure 6.[15] While there is no systematic difference in the spread prior to the adoption of the MMF reform in October 2014, it starts to diverge slightly thereafter, yet in the opposite direction than expected: While treated banks pay a somewhat decreasing interest spread for receiving dollar denominated deposits, the opposite is true for non-treated banks. After the first compliance date in April 2016 and especially after the full implementation of the reform in October 2016, the price that MMF reform affected and non-affected banks have to pay diverges further and differs substantially.[16] Note that the price difference between affected and non-affected banks does not disappear in the aftermath of the reform but remains persistently at a high level.

Figure 6

Monthly mean deposit spread



Notes: The deposit spread is defined as deposit interest rate minus USD LIBOR rate of comparable maturity in basis points. Shown is the monthly mean deposit spread per bank group, i.e., treated and non-treated banks.

A. Identifying spillovers: Evidence from deposit spreads

In order to rule out that the effect in Figure 6 is driven by contaminating factors, we assess the economic and statistical significance of the divergence of deposit spreads for MMF-reform affected banks compared to non-affected banks in a difference-in-differences framework. Importantly for identification is a parallel trend prior to the reform for the two groups, which in Figure 6 clearly shows. We run the following regression based on transaction-level data:

[15]The deposit spread is defined as the deposit interest rate of the transaction minus the interbank benchmark rate, i.e., USD LIBOR rates for dollar denominated transactions of comparable maturities in basis points.

[16]The peak in December 2016 is due to end of year pressure. A similar pattern in smaller magnitude could also be observed in December 2015.

$$\begin{aligned}Spread_{ijat} &= \alpha_{jt} + (\alpha_i +)\beta_1 \cdot nonMMF_i + \beta_2 \cdot nonMMF_i \cdot post_t \\ &\quad + \beta_3 YearEnd_t + \beta_3 YearEnd_t \cdot MMF_i + \gamma \cdot \boldsymbol{X}_a + \delta \cdot \boldsymbol{Y}_{i(t-1)} + \epsilon_{ijat}.\end{aligned} \tag{1}$$

$Spread_{ijat}$ describes the deposit spread paid by bank i to firm j in auction a at time t. $nonMMF_i$ denotes a dummy variable that equals 1 if bank i is not affected by the money market fund reform (non-treated) and 0 otherwise. $post_t$ is a dummy variable equal to 1 if the transaction belongs to the post period and 0 otherwise. $\boldsymbol{X}_a$ is a vector of transaction-specific control variables (maturity and the logarithm of notional amounts). $\boldsymbol{Y}_{i(t-1)}$ is a vector of bank balance sheet control variables lagged by one year, and contains bank size measured as log of total assets, bank leverage defined as total assets over total equity as well as the share of net interest income of total revenues as a business model indicator. As the variation in the regression setting is on transaction-level, we are able to exploit within-bank variation and include bank fixed effects α_i that absorb all observable and unobservable bank-specific time-invariant characteristics. α_{jt} are $firm \times time$ fixed effects that absorb time-varying firm-specific characteristics and all common, time-specific variation.[17] The main coefficient of interest is β_2, capturing the difference-in-differences effect $nonMMF_i \cdot post_t$.

Results of the regression on deposit spreads are documented in Table VI. In column (1), we control for several transaction and bank characteristics and absorb all observed and unobserved $firm \times time$ variation via fixed effects. In the most saturated specifications (columns (2)-(5)), we additionally absorb all time-invariant bank characteristics using fixed effects and gradually add controls for deposit transaction characteristics and time-varying bank factors. Note that the inclusion of $firm \times time$ fixed effects also controls for any supply effects. Our variable of interest is the interaction between the $nonMMF$ and $post$ dummy variables, which compares the difference in the deposit spreads between non-treated banks and treated banks before the reform and after the reform. In line with Figure 6, we find no significant difference in the deposit spread that treated banks have to pay compared to non-treated banks prior to the reform conditional on the included controls. However, we observe a strong premium for non-treated banks after the reform: Non-treated banks have to pay between 6 and 9 bps more to obtain dollar funding compared to treated banks, which is not only statistically highly significant, but also economically large.

One potential concern could be that there is a selection of firm-bank pairs, i.e., some firms that demand a higher spread trade only with non-MMF banks and non-MMF banks are not able to trade with low spread-demanding firms. In order rule out this concern of selection, we rerun our regressions on a reduced sample, where we only consider firms that interact at least once with a bank from either group of treated and non-treated banks. The results for the most saturated specification similar to the specification in column (5) are shown in column (6) of Table VI and document that selection is not driving our results. The point estimate as well as the standard error of the interaction variable in the reduced sample model are virtually unchanged.

Another potential concern regarding our identification could be that non-treated banks had a

[17] We also control for potential confounding year-end pricing effects.

Table VI

Regression on deposit spread

	(1)	(2)	(3)	(4)	(5)	(6)
non-MMF	2.3300					
	(1.9341)					
non-MMF * post	6.3915**	9.0707***	9.2814***	9.2835***	9.0837***	9.1492***
	(2.6514)	(2.5512)	(2.4269)	(2.4301)	(2.4280)	(2.3868)
Year-end	61.6957	63.4259	63.4527	63.4516	63.4420	83.6079
	(65.0094)	(65.4161)	(65.4100)	(65.4142)	(65.4286)	(81.6813)
Year-end * non-MMF	92.8995	87.4791	87.5183	87.5200	87.6138	98.5622
	(93.6102)	(91.9163)	(91.8718)	(91.8829)	(91.9790)	(104.4960)
log(notional)			0.5137	0.5136	0.4926	2.7950
			(0.3472)	(0.3473)	(0.3482)	(15.2796)
Maturity(days)			0.0774**	0.0775**	0.0767**	0.4158
			(0.0336)	(0.0336)	(0.0334)	(0.3963)
log(total assets)	-1.1534	6.3037	3.4321	4.2004	1.1976	0.0782**
	(0.9409)	(10.9721)	(10.6480)	(13.9782)	(13.5662)	(0.0322)
Leverage				-0.0675	-0.0849	0.0209
				(0.7350)	(0.5518)	(0.6223)
NII revenue share					-0.4495*	-0.3938
					(0.2402)	(0.2658)
N	3996	3994	3994	3994	3994	3258
R^2	0.7268	0.7576	0.7595	0.7595	0.7597	0.5561
Firm-month FE	✓	✓	✓	✓	✓	✓
Bank FE		✓	✓	✓	✓	✓

Notes: OLS regressions for Equation 1. The dependent variable is the deposit spread $Spread_{ijt}$ defined as deposit interest rate minus USD LIBOR rate of comparable maturity in basis points. non-MMF is a dummy variable equal to 1, if a bank is non-treated and post a dummy variable equal to 1 in the post period. log(notional) stands for the logarithm of the notional deposit amount, Maturity(days) for the remaining time (in days) until the funding matures, log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity, NII revenue share for the share of net interest income of bank's total revenue. In column (6), we use only a reduced sample of firms that interact at least once with banks from either group of MMF affected non-MMF-affected banks. *SE* are clustered at the bank level and given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

general increase in their funding rates from corporate deposits, i.e., there was a general increase in spreads for non-treated banks, which is not related to the MMF reform. To rule out this concern, we compare the dollar results to currencies that are not impacted by the US MMF reform. The platform provides us with a similarly diversified dataset in terms of participating treated and non-treated banks as well as sufficiently many transactions for EUR- and GBP-denominated auctions. As EUR-denominated money market products are strongly influenced by negative deposit facility rates and extensive quantitative easing programs by the European Central Bank over the observation period, only GBP-denominated auctions remain as a suitable control currency.[18] Therefore, we add GBP denominated deposit auctions to the sample and interact our main variables of interest in Equation 1 with a dollar dummy variable to measure the differential effect of the US MMF reform on dollar-denominated transactions relative to GBP-denominated transactions. If the effect that we identify in Table VI originates from the US MMF reform, GBP-denominated auctions would not

[18] The Brexit referendum in June 2016 has a strong impact on GBP money market products, which does not leave our platform unaffected either. However, those effects follow directly on the date of the referendum and were washed out already before the full implementation date of the US MMF reform and the beginning of the post period on October 14, 2016.

be affected and we should observe a significantly different effect between dollar-denominated and GBP-denominated transactions in the aftermath of the MMF reform. We estimate the following difference-in-differences-in-differences equation:

$$
\begin{aligned}
Spread_{ijact} = {} & \alpha_c + \alpha_{jt} + (\alpha_i + \alpha_{ct}+)\beta_1 \cdot nonMMF_i + \beta_2 \cdot nonMMF_i \cdot USD_a \\
& + \beta_3 \cdot nonMMF_i * post_t + \beta_4 \cdot nonMMF_i \cdot post_t \cdot USD_a \\
& + \gamma \cdot \boldsymbol{X}_a + \delta \cdot \boldsymbol{Y}_{i(t-1year)} + \epsilon_{ijat}
\end{aligned} \tag{2}
$$

The dependent and control variables remain the same as in Equation 1.[19] The $nonMMF$ dummy variable is additionally interacted with a dummy variable USD, which is equal to 1 for transactions denominated in dollars and 0 for transactions in GBP.

Table VII presents the results. We start with the most saturated specification from Table VI including additionally currency fixed effects (α_c) and add in the following specifications *currency* $\times$ *time* (α_{ct}) fixed effects to control for time-constant and time-varying characteristics of currencies, respectively. We do not observe any significant trend in the difference between the funding costs for treated and non-treated banks in GBP denominated transactions. However, non-treated banks pay a statistically significant and economically large premium after the US MMF reform implementation for USD transactions compared to GBP transactions. The premium of around 7.5 to over 12 bps is even higher than the premium in the within-currency analysis of dollar transactions only. This finding underscores the notion that the results in Table VI reflect the causal effect of intensified competition for wholesale dollar funding arising from the US MMF reform.

B. *Stable funding providers and bank-firm relationships*

In order to understand the mechanism behind the findings from the previous section, we next document that the premium for non-treated banks is driven by several firm-specific factors determining their quality as funding provider as well as bank-firm relationships. In doing so, we exploit the richness of detail down to all last bids placed by banks during an auction.[20]

On the one hand, we are interested in whether treated banks manage to acquire funds from new firm relationships (the extensive margin) or whether they win more often auctions with existing bank-firm relationships (the intensive margin). To this end, we introduce a measure of *new relationship* as a dummy variable that is equal to 1 if the first transaction (determined considering all currencies traded on the platform) between a bank i and firm j takes place after April 2016.

On the other hand, we want to better understand preferences and relationships between banks and firms. We categorize firms along two dimensions (i) stability of funding provision and (ii) lot sizes offered. For the first dimension, we introduce an indicator measuring the stability of firms' funding flows on the platform. We define the indicator as the ratio of monthly aggregate notional

[19] We exclude the year-end controls from Equation 2 for notational simplicity.

[20] Banks can adjust their bids during an auction. Firms make their decision between the last bids of all participating banks. Therefore, bid adjustments are not relevant for this analysis of banks' bidding success.

Table VII
Regression on deposit spread - USD vs. GBP comparison

	(1)	(2)	(3)
non-MMF	-3.8469**	-3.0151*	
	(1.7505)	(1.7170)	
non-MMF * USD	7.4013***	5.6168***	6.0838***
	(1.7642)	(2.0019)	(1.6719)
non-MMF * post	-1.5658	-3.2947	-3.0393
	(3.3498)	(3.5568)	(3.1291)
non-MMF * post * USD	7.5030*	10.8448**	12.2362***
	(3.9573)	(4.3281)	(3.9594)
Year-end	-0.0043	-0.3816	-1.2861
	(1.8175)	(1.6763)	(2.1689)
Year-end * USD	59.4933	60.0835	61.2866
	(61.6031)	(61.8869)	(62.8396)
Year-end * non-MMF	0.0354	0.2618	3.2284
	(12.1891)	(12.1518)	(9.0310)
Year-end * non-MMF * USD	99.5129	99.0228	93.8415
	(98.0615)	(97.9751)	(94.9512)
log(notional)	0.3573*	0.3466*	0.3996*
	(0.1832)	(0.1882)	(0.2140)
Maturity(days)	0.0691**	0.0688**	0.0733***
	(0.0262)	(0.0264)	(0.0260)
log(total assets)	-0.9728**	-0.9907**	-4.3934
	(0.3901)	(0.3917)	(14.5407)
Leverage	0.3734***	0.3691***	0.2713
	(0.1014)	(0.1015)	(0.5321)
NII revenue share	-0.0515	-0.0494	-0.1280
	(0.0329)	(0.0332)	(0.1321)
N	7329	7329	7326
R^2	0.7703	0.7710	0.7865
Firm-month FE	✓	✓	✓
Bank FE			✓
Currency FE	✓		
Currency-month FE		✓	✓

Notes: OLS regressions for Equation 2. The dependent variable is the deposit spread $Spread_{ijt}$ defined as deposit interest rate minus LIBOR rate of comparable maturity and respective transaction currency, i.e., USD or GBP, in basis points. non-MMF is a dummy variable equal to 1, if a bank is non-treated, post a dummy variable equal to 1 in the post period and USD a dummy variable that equals 1 for dollar denominated transactions. log(notional) stands for the logarithm of the notional deposit amount, Maturity(days) for the remaining time (in days) until the funding matures, log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity, NII revenue share for the share of net interest income of bank's total revenue. *SE* are clustered at the bank level and given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

deposit amount provided by a firm over the average monthly notional deposit amount of the prior six months in which the firm was active on the platform.[21] Firms are then categorized as stable funding providers if their average indicator score during the observation period is larger than or equal to 1, or above the median of all firms. For the second dimension, we divide firms into big

[21] The denominator calculation excludes months without activity in order to compare the current month to an average active month.

and small lot size providers to proxy the size of a firm.[22] A firm is classified as big if its average transaction size is above the median of all firms' average transaction volumes.[23]

The idea behind these dimensions is based on banks' presumed preferences. As rational agents, we expect banks to prefer lower funding costs to higher funding costs. The deposit spread should therefore be an important part of banks' preference structure for firms' deposits. However, direct costs, such as the deposit spread, do not paint the full picture. If low deposit spreads were achieved only by firms providing funding on an irregular basis, the direct cost advantage of lower deposit spreads would quickly turn into a cost disadvantage due to costs of constantly finding alternative funding providers. Hence, we assume banks to prefer reliable (or stable) funding providers that regularly provide the required amount of funding. As any transaction effort is costly, we further expect big funding providers to be preferred by banks as interacting with these firms will reduce banks' transaction number. Firms as counterparties, too, follow a preference order. On the one hand, they want to achieve the highest possible interest rate.[24] At the same time, firms are aware of the full extent of bank-firm relationships, since the same banks bidding for their deposits are typically also providers of other required financial services. Having beneficial loan conditions or preferred access to international trade finance services might be more important for firms than maximizing deposit conditions on a stand-alone basis. Therefore, funding providers should have a preference to deposit their excess liquidity at the bank that can best fulfill their overall need for financial services. As treated banks are on average bigger and have access to more international markets, one can assume that they are preferred by deposit providing firms in this regard. The degree to which the individual preferences can be achieved depends on the individual bargaining power. In particular, firms and banks with aforementioned eligible properties are assumed to have higher bargaining power than banks and firms without such properties. Therefore, treated banks and (large) stable firms should be able to better achieve their preferences than other banks and firms, respectively. After the US MMF reform, treated banks lost a big part of funding from a market higher in their pecking order and increasingly resorted to corporate deposits. This led to more opportunities for (big) stable funding providers to achieve their preferences. At the same time, non-treated banks had to face more competition from potentially preferred treated banks.Figure 7 show the average deposit spread per transaction and the number of executed transactions by firm type and bank group, and thus provide descriptive evidence for this hypothesis.

Figure 7 shows a clear segmentation already in the pre-period. Stable funding providers show a clear preference for treated banks who can capitalize on their resulting high bargaining power by paying significantly less than non-treated banks for the big and stable funding providers (left-hand side). In order to trade with this most preferred firm type, i.e., big and stable, non-treated banks pay substantially more in the pre period. Opposed to that, non-treated banks can still manage to keep average costs low with the smaller funding providers. As treated banks flood the corporate

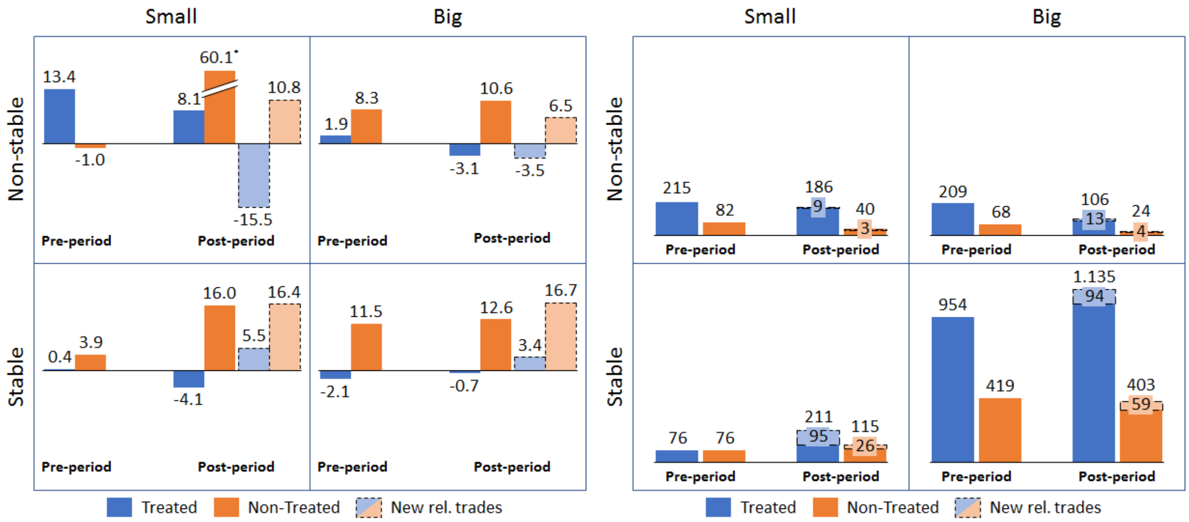
[22]As we do not know the firms, we cannot resort to firms' balance sheet information.

[23]Firms' average transaction sizes are calculated using all currencies on the platform. To ensure comparability across currencies, transactions were first translated using daily exchange rate to the same currency.

[24]See Friedmann et al. (2017) who show that the highest quote is most often selected by deposit providers.

Figure 7

Average deposit spread [bps] (left) and Number of transactions (right) by firm type



Notes: Only transactions with the respective firm type according to the two dimensions transaction size (small vs. big) and stableness of funding provision (stable vs. non-stable) considered in each quadrant. The post period averages distinguish further between trades out of existing and new (i.e., first trade after April 2016) firm-bank relationships. *) Result driven by 27 transactions of one bank. Excluding this bank leads to a reduced deposit spread of 2.50bps.

deposit platform after the US MMF reform, however, even these sources of lower prices are gone for non-treated banks. Non-treated banks have to pay across the board significantly more for stable funding providers and only few non-stable funding providers offer slightly better conditions. The right-hand side of Figure 7 further shows that treated banks substitute non-stable by stable funding providers and additionally build-up new relationships with stable funding providers, while paying substantially less than non-treated banks. Non-treated banks can only maintain the overall level of transactions with stable funding providers by offering massively higher deposit spreads. In this way, non-treated banks are crowded out on the corporate deposit platform through increased competition by more preferred non-treated banks.

In order to rule out that the results from this simple graphical visualization are driven by other confounding factors, we rerun our difference-in-differences regressions to analyze the impact of the US MMF reform on the chances of winning a deposit auction by bank type (treated and non-treated) in the pre- compared to the post-reform period. While the descriptive statistics in Table V indicate that treated banks increase the number of successful transactions from the pre- to post-reform period (unlike non-treated banks), we now analyze whether the three factors discussed above (bank-firm relationship, firms' stability of deposit provision and firms' deposit volumes) coherently impact the probability of winning an auction for treated banks versus non-treated banks.

In particular, we estimate the following equation at the *auction quote* level:

$$
\begin{aligned}
WinningBid_{ijabt} = \alpha_{jt} + (\alpha_i + \alpha_{abt} +)\beta_1 \cdot nonMMF_i + \beta_2 \cdot nonMMF_i \cdot post_t \\
+ \beta_3 \cdot newReln_{ij} + \beta_4 \cdot newReln_{ij} \cdot nonMMF_i \\
+ \beta_5 \cdot stable_j + \beta_6 \cdot stable_j \cdot nonMMF_i \\
+ \beta_7 \cdot stable_j \cdot big_j + \beta_8 \cdot stable_j \cdot big_j \cdot nonMMF_i \\
+ \beta_9 \cdot highestQuote_{abt} + \gamma \cdot \boldsymbol{X}_{at} + \delta \cdot \boldsymbol{Y}_{i(t-1year)} + \epsilon_{ijabt}
\end{aligned}
\tag{3}
$$

where $WinningBid_{ijabt}$ is a dummy variable that equals 1 if bank i wins the deposit offered by firm j in auction a with bid quote rank b at time t. Equal quotes are allocated to the same bid quote rank resulting in equally many bid quote ranks as distinct quotes in an auction. We again use the $nonMMF_i$ dummy variable to flag non-treated banks, i.e., banks not directly affected by the US MMF reform. $newReln_{ij}$ is a dummy variable for new relationships which is equal to 1 if the first transaction (determined considering all currencies traded on the platform) between a bank i and firm j takes place after April 2016. Thus this variable discriminates between transactions stemming from "old" relationships from those of "new" relationships. Transactions from new relationships can by definition only take place in the post-reform period, so that the variable can be interpreted as if it was interacted with the post-reform period dummy. $stable_j$ is equal to one if firm j offering the deposit is a stable funding provider according to the aforementioned definition. big_j is equal to 1 if the average transactions size of firm j is larger or equal to the median of average transaction sizes of all other firms. $highestQuote_{ab}$ is a dummy variable equal to 1 if bid b contains the highest quote in auction a. In the most saturated specification, we include bid quote rank fixed effects and employ only the variation within the same auction bid quote. This allows us to compare - within an auction - the success probability of winning for two banks offering the *same* quote, where one bank is affected by the MMF reform while the other is not. This, however, restricts our sample to those auctions where at least two banks offer the same quote to a firm. The other variables remain the same as in previous regressions.

We present results in Table VIII (excluding bid quote rank fixed effects) and Table IX (including bid quote rank fixed effects).[25] In line with Friedmann et al. (2017), we find that the highest quote is consistently an important driver of winning a deposit auction, across both bank groups and periods, as documented in Table VIII. Beyond this expected result, we find that non-treated banks manage to win on average more auctions from new relationship firms, as column (1) and column (2) document. These new relationship firms that deposit with non-treated banks, however, are on average the non-stable funding providers (columns (3) and (4)). In addition, there is evidence that those stable firms with whom non-treated banks manage to win the auction with a higher probability are smaller depositors. Overall, Table VIII documents a composition effect and explains the higher deposit spread that non-treated banks have to pay: Once treated banks were forced to step down in their pecking order and intensified competition for deposits, they crowded-out non-treated banks

[25] In order to analyze a short run effect, we provide similar tables with post period lengths of one and two months in the appendix.

from stable, large deposit providing firms. In order to keep funding volume, smaller banks had to form new relationships with less stable funding providers and smaller firms, and had to pay a premium for both building up new relations and keeping in place existing relationships.

Table VIII

Regression on winning bid

	(1)	(2)	(3)	(4)	(5)	(6)
non-MMF	0.0467		-0.0303		-0.0417	
	(0.0380)		(0.0760)		(0.0623)	
non-MMF * post	-0.0554	-0.0637	-0.2856	-0.2646	0.0399	0.0420
	(0.0449)	(0.0432)	(0.1744)	(0.1636)	(0.0726)	(0.0651)
non-MMF * post * New rel.	0.1558***	0.1825***	0.8256***	0.7767**	0.3449**	0.4507**
	(0.0366)	(0.0541)	(0.3059)	(0.3051)	(0.1617)	(0.1809)
non-MMF * stable			0.1091*	0.1319*		
			(0.0640)	(0.0721)		
non-MMF * stable * post			0.2209	0.1865		
			(0.1720)	(0.1682)		
non-MMF * stable * post * New rel.			-0.7115**	-0.6481**		
			(0.2980)	(0.2925)		
non-MMF * stable * big					0.1405***	0.1676***
					(0.0506)	(0.0617)
non-MMF * stable * big * post					-0.1468**	-0.1659**
					(0.0665)	(0.0713)
non-MMF * stable * big * post * New rel.					-0.2154	-0.2994*
					(0.1526)	(0.1675)
Highest quote	0.7644***	0.7480***	0.7653***	0.7494***	0.7649***	0.7495***
	(0.0246)	(0.0274)	(0.0243)	(0.0271)	(0.0245)	(0.0271)
N	6004	6003	6004	6003	6004	6003
R^2	0.6567	0.6699	0.6595	0.6727	0.6583	0.6720
Transaction & bank controls	✓	✓	✓	✓	✓	✓
Bank FE		✓		✓		✓
Firm-month FE	✓	✓	✓	✓	✓	✓
Bid quote rank FE						

Notes: OLS regressions for Equation 3. The dependent variable is $WinningBid_{ijabt}$ defined as a dummy variable that equals 1 if bank i wins the deposit offered by firm j in auction a with bid b at time t. non-MMF is a dummy variable equal to 1, if a bank is non-treated and post a dummy variable equal to 1 in the post period. New relationship is a dummy variable equal to 1 if the first transaction (determined considering all currencies traded on the platform) between a bank i and firm j takes place after April 2016. $stable_j$ is equal to one if firm j offering the deposit is a stable funding provider according to the aforementioned definition. big_j is equal to 1 if the average transactions size of firm j is larger or equal to the median of average transaction sizes of all other firms. Highest quote is a dummy variable equal to 1 if bid b contains the highest quote in auction a. log(notional) stands for the logarithm of the notional deposit amount, Maturity(days) for the remaining time (in days) until the funding matures, log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity. *SE* are clustered at the bank level and given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

Using only within auction bid quote rank variation in Table IX documents this mechanism in more detail. We show that, while there is no difference in winning an auction in the direct comparison of equally high quotes for treated and non-treated banks on average (columns (1) and (2)), there is some important heterogeneity. In particular, non-treated banks have a disadvantage in winning dollar-denominated auctions from non-stable existing firm relations (columns (3) and (4)). This disadvantage, however, does not disappear or even worsens (although not significantly) for stable funding providing firms. The lower probability of winning an auction does also not disappear by building new relationship with unstable firms.[26] For stable (and in particular big) funding providing firms with an existing relationship, the disadvantage of winning an auction is somewhat reduced. This provides evidence that existing relationships matter also for non-treated banks. Large, stable funding providers seem to honor relationships with non-treated banks in the direct quote comparison at least for a sufficiently high quote, as we know from Figure 7.

Table IX

Regression on winning bid including bid quote rank fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)
non-MMF	0.0892		0.0446		0.0450	
	(0.0634)		(0.1019)		(0.0991)	
non-MMF * post	-0.1154	-0.1634	-0.5085*	-0.7648***	-0.1623	-0.7496***
	(0.0768)	(0.0985)	(0.3023)	(0.2659)	(0.1565)	(0.2131)
non-MMF * post * New rel.	0.1556	0.1344	0.1306	0.0851	0.2643*	
	(0.1479)	(0.2093)	(0.1453)	(0.2074)	(0.1546)	
non-MMF * stable			0.0659	-0.0218		
			(0.1296)	(0.1625)		
non-MMF * stable * post			0.3984	0.6469**		
			(0.3307)	(0.2976)		
non-MMF * stable * post * New rel.			(-)	(-)		
			(-)	(-)		
non-MMF * stable * big					0.0676	-0.0186
					(0.1268)	(0.1495)
non-MMF * stable * big * post					0.0394	0.6455**
					(0.2116)	(0.2521)
non-MMF * stable * big * post * New rel.					-0.1259	0.0602
					(0.2017)	(0.2086)
Highest quote	(-)	(-)	(-)	(-)	(-)	(-)
	(-)	(-)	(-)	(-)	(-)	(-)
N	958	948	958	948	958	948
R^2	0.4284	0.5050	0.4306	0.5081	0.4290	0.5091
Transaction & bank controls	✓	✓	✓	✓	✓	✓
Bank FE		✓		✓		✓
Firm-month FE	✓	✓	✓	✓	✓	✓
Bid quote rank FE	✓	✓	✓	✓	✓	✓

Notes: OLS regressions for Equation 3. The dependent variable is $WinningBid_{ijabt}$ defined as a dummy variable that equals 1 if bank i wins the deposit offered by firm j in auction a with bid b at time t. non-MMF is a dummy variable equal to 1, if a bank is non-treated and post a dummy variable equal to 1 in the post period. New relationship is a dummy variable equal to 1 if the first transaction (determined considering all currencies traded on the platform) between a bank i and firm j takes place after April 2016. $stable_j$ is equal to one if firm j offering the deposit is a stable funding provider according to the aforementioned definition. big_j is equal to 1 if the average transactions size of firm j is larger or equal to the median of average transaction sizes of all other firms. Highest quote is a dummy variable equal to 1 if bid b contains the highest quote in auction a. log(notional) stands for the logarithm of the notional deposit amount, Maturity(days) for the remaining time (in days) until the funding matures, log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity. Note that we cannot estimate the coefficient of the interaction $non-MMF*stable*post*Newrel$ due to perfect multicollinearity with the interaction $non-MMF*post*Newrel$. *SE* are clustered at the bank level and given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

We again rule out that non-treated banks had a general decrease in their bidding success that is not related to the MMF reform by comparing the results of dollar auctions with GBP-denominated auctions as a suitable control currency. Our main variables of interest in Equation 3 are again

[26] Note that in the post period, all new relationship trades are with non-stable firms, such that the coefficient of the interaction *non-MMF * stable * post * New rel.* cannot be estimated.

additionally interacted with a dollar dummy variable to measure the differential effect of the US MMF reform on dollar-denominated transactions relative to GBP-denominated transactions. If the effect that we identify in Table VIII originates from the US MMF reform, we should observe a significantly different effect between dollar-denominated and GBP-denominated transactions. We estimate the following bid level difference-in-differences-in-differences equation:

$$
\begin{aligned}
WinningBid_{ijabct} = {} & \alpha_{ct} + \alpha_{jt} + (\alpha_i +)\beta_1 \cdot MMF_i + \beta_2 \cdot MMF_i \cdot post_t \\
& + \beta_3 \cdot nonMMF_i \cdot USD_a + \beta_4 \cdot nonMMF_i \cdot post_t \cdot USD_a \\
& + \beta_5 \cdot newReln_{ij} + \beta_6 \cdot newReln_{ij} \cdot MMF_i \\
& + \beta_7 \cdot newReln_{ij} \cdot USD_a + \beta_8 \cdot newReln_{ij} \cdot MMF_i \cdot USD_a \\
& + \beta_9 \cdot stable_j + \beta_{10} \cdot stable_j \cdot nonMMF_i \\
& + \beta_{11} \cdot stable_j \cdot USD_a + \beta_{12} \cdot stable_j \cdot nonMMF_i \cdot USD_a \\
& + \beta_{13} \cdot stable_j \cdot big_j + \beta_{14} \cdot stable_j \cdot big_j \cdot nonMMF_i \\
& + \beta_{15} \cdot stable_j \cdot big_j \cdot USD_a + \beta_{16} \cdot stable_j \cdot big_j \cdot nonMMF_i \cdot USD_a \\
& + \beta_{17} \cdot highestQuote_{ab} + \gamma \cdot \boldsymbol{X}_a + \delta \cdot \boldsymbol{Y}_{i(t-1year)} + \epsilon_{ijabt}
\end{aligned} \tag{4}
$$

The dependent and control variables remain the same as in Equation 3. USD_a is a dummy variable that discriminates USD transactions from GPB transactions. The results are shown in Table X and document that MMF affected banks had only a higher probability in winning USD denominated auctions, but not auctions denominated in GBP. This result points to an increased competition after the MMF reform for dollar funding only, i.e., not present in other currencies.

Table X
Regression on winning bid - USD vs. GBP comparison

	(1)	(2)	(3)	(4)	(5)	(6)
non-MMF	0.0083		0.0013		-0.0019	
	(0.0349)		(0.0538)		(0.0511)	
non-MMF * USD	0.0173	-0.0002	-0.0434	-0.1209	-0.0468	-0.1120*
	(0.0372)	(0.0316)	(0.0901)	(0.0775)	(0.0705)	(0.0603)
non-MMF * post	0.0029	-0.0066	-0.0013	-0.0101	0.0302	0.0167
	(0.0355)	(0.0354)	(0.1024)	(0.1116)	(0.0889)	(0.0973)
non-MMF * post * USD	-0.0357	-0.0330	-0.2482	-0.1946	0.0173	0.0460
	(0.0457)	(0.0440)	(0.1587)	(0.1517)	(0.1041)	(0.0994)
non-MMF * post * New rel.	-0.0612	0.0054	-0.0136	0.1190	-0.0409	0.1027
	(0.0680)	(0.0484)	(0.1511)	(0.1219)	(0.1422)	(0.1074)
non-MMF * post * New rel. * USD	0.2042***	0.1618**	0.8097***	0.6427**	0.3721*	0.3549*
	(0.0642)	(0.0640)	(0.2808)	(0.2848)	(0.1940)	(0.1977)
non-MMF * stable			0.0223	-0.0306		
			(0.0713)	(0.0527)		
non-MMF * stable * USD			0.0708	0.1538**		
			(0.0875)	(0.0747)		
non-MMF * stable * post			-0.0003	0.0100		
			(0.1156)	(0.1238)		
non-MMF * stable * post * USD			0.2116	0.1430		
			(0.1541)	(0.1473)		
non-MMF * stable * post * New rel.			-0.0793	-0.2015		
			(0.1499)	(0.1380)		
non-MMF * stable * post * New rel. * USD			-0.6134**	-0.4449		
			(0.2929)	(0.2960)		
non-MMF * stable * big					0.0307	-0.0125
					(0.0705)	(0.0544)
non-MMF * stable * big * USD					0.0835	0.1539**
					(0.0706)	(0.0625)
non-MMF * stable * big * post					-0.0541	-0.0415
					(0.1035)	(0.1126)
non-MMF * stable * big * post * USD					-0.0669	-0.1114
					(0.1078)	(0.1053)
non-MMF * stable * big * post * New rel.					-0.0391	-0.1697
					(0.1458)	(0.1293)
non-MMF * stable * big * post * New rel. * USD					-0.1735	-0.1501
					(0.2136)	(0.2184)
Highest quote	0.7687***	0.7568***	0.7689***	0.7574***	0.7689***	0.7573***
	(0.0195)	(0.0213)	(0.0195)	(0.0211)	(0.0195)	(0.0211)
N	10641	10639	10641	10639	10641	10639
R^2	0.6562	0.6671	0.6577	0.6688	0.6569	0.6684
Bank FE		✓		✓		✓
Currency-month FE	✓	✓	✓	✓	✓	✓
Firm-month FE	✓	✓	✓	✓	✓	✓

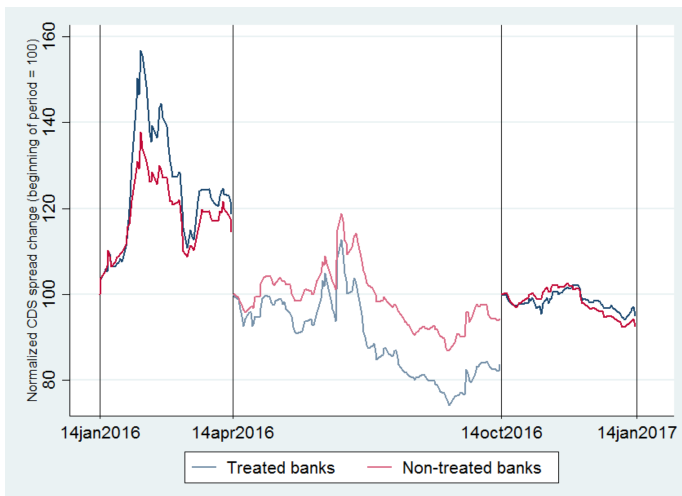
Notes: OLS regressions for Equation 3. The dependent variable is $WinningBid_{ijabt}$ defined as a dummy variable that equals 1 if bank i wins the deposit offered by firm j in auction a with bid b at time t. non-MMF is a dummy variable equal to 1, if a bank is non-treated and post a dummy variable equal to 1 in the post period and USD a dummy variable that equals 1 for dollar denominated transactions. New relationship is a dummy variable equal to 1 if the first transaction (determined considering all currencies traded on the platform) between a bank i and firm j takes place after April 2016. $stable_j$ is equal to one if firm j offering the deposit is a stable funding provider according to the aforementioned definition. big_j is equal to 1 if the average transactions size of firm j is larger or equal to the median of average transaction sizes of all other firms. Highest quote is a dummy variable equal to 1 if bid b contains the highest quote in auction a. log(notional) stands for the logarithm of the notional deposit amount, Maturity(days) for the remaining time (in days) until the funding matures, log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity. SE are clustered at the bank level and given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

V. Effects on bank performance

After showing that non-treated banks are crowded out from deposit markets by intensified competition (with substantial impact on their funding cost, funding availability and reliability of funding sources), we investigate whether this also has implications for banks' health and performance.[27]

The rise in dollar funding costs and the deterioration in the pool of funding providers that non-treated banks experience due to the competition for wholesale dollar funding could in principle make the default of these banks more likely, all else equal. In such a scenario, we should observe a divergence between the CDS spreads of treated and non-treated banks. Figure 8 shows that CDS spreads slightly diverge during the first weeks after reform implementation, but this trend reverses after a few weeks.

Figure 8
Average CDS spread change



Notes: Daily CDS spread changes normalized to the beginning of each sub-period (=100). US banks excluded.

We investigate this more formally by estimating the following regression:

$$CumCDSspreadChange_{ikt} = \alpha_{kt} + (\alpha_i +)\beta_1 \cdot nonMMF_i + \beta_2 \cdot nonMMF_i \cdot post_t + \gamma \cdot Brexit + \delta \cdot \boldsymbol{Y}_{i(t-1year)} + \epsilon_{it} \tag{5}$$

The dependent variable $CumCDSspreadChange_{ikt}$ describes the cumulative CDS spread change of bank i domiciled in country k in period t, i.e., the pre- or post-reform period. To control for recovery effects after Brexit referendum on June 23, 2016, we include a *Brexit* variable, which is defined as the CDS spread change in percentage points two trading days after the referendum (i.e., the increase until close of business on Monday, June 27, 2016) for observations in the post-period

[27]Note that we exclude US banks for this analysis as US banks, while affecting the above discussed competition for corporate deposits, can raise dollar funding at any time from the Federal Reserve.

and equal to 0 for observations in the pre-period. The dummy variables $nonMMF_i$ and $post_t$ are defined similarly to previous regression models. In order to account for the overall development of CDS markets as well as differences across countries over time, we add $country \cdot time$ fixed effects. The main variable of interest is again the interaction between the non-treatment dummy and the post-reform period dummy. In order to differentiate between short term and medium term effects, specifications in columns (1)-(3) estimate the equation for a pre- and post-period length of one month and specifications in columns (4)-(6) for a pre- and post-period length of three months. The regression results in Table XI confirm a statistically significant short term effect one month after the reform. The divergence vanishes when expanding the analysis up to three months after US MMF reform implementation. These results suggest that the market does not expect the crowding out in deposit markets to lead to a smaller distance to default or accordingly, a higher probability of default for non-treated banks.

Table XI

Regression on CDS spread changes

	(1)	(2)	(3)	(4)	(5)	(6)
Lenght of pre and post periods:	*(1 month)*	*(1 month)*	*(1 month)*	*(3 months)*	*(3 months)*	*(3 months)*
non-MMF	-5.2431	-4.8272		4.1687	4.8031	
	(4.5450)	(4.9663)		(12.9308)	(14.6972)	
non-MMF * post	11.9739**	11.9708**	12.5803*	0.5959	0.5067	1.2733
	(5.4345)	(5.4727)	(6.2666)	(13.0171)	(13.2972)	(12.5014)
Brexit	-0.1812**	-0.1790**	-0.6136***	-0.3454**	-0.3472**	-0.8362
	(0.0712)	(0.0721)	(0.1431)	(0.1563)	(0.1689)	(0.6071)
log(total assets)	1.7166	1.6829		1.3808	1.2644	-21.6964
	(1.6966)	(1.6845)		(4.1455)	(4.0114)	(50.5653)
Leverage		0.0470			0.0287	-0.5788
		(0.1629)			(0.3928)	(1.5248)
NII revenue share		-0.0198			-0.0550	-0.2669
		(0.0796)			(0.1693)	(0.7799)
N	100	100	100	98	98	98
R^2	0.7875	0.7881	0.9076	0.7821	0.7825	0.8921
Country-period FE	✓	✓	✓	✓	✓	✓
Bank FE		✓	✓		✓	✓

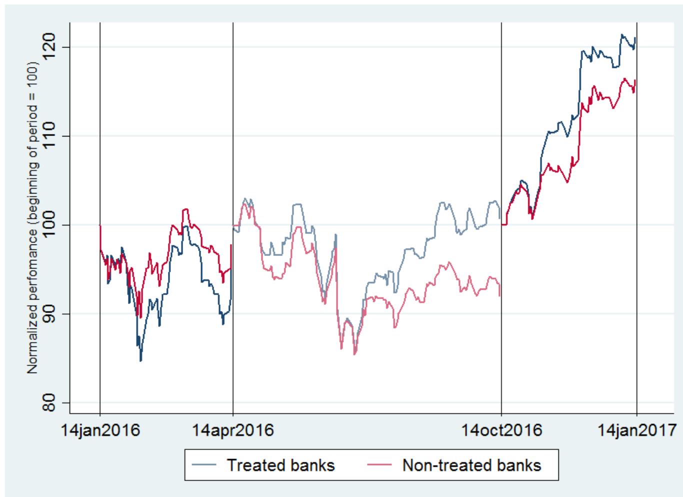
Notes: OLS regressions for Equation 5. The dependent variable is $CumCDSspreadChange_{ikt}$ defined as cumulative CDS spread change of bank i from country k in pre or post period. non-MMF is a dummy variable equal to 1, if a bank is non-treated and post a dummy variable equal to 1 in the post period. Brexit is defined as the CDS spread change in percentage points two trading days after the referendum and is equal to 0 for observations in pre-period. log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity. Robust *SE* are given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

While the distance to default of non-treated banks remains on average largely unaffected, the relatively weaker position of these banks could impair their ability to capitalize potentially profitable lending opportunities - in addition to the higher costs these banks have to pay. Figure 9 plots the stock price performance of publicly listed treated and non-treated banks. It depicts a parallel trend of treated and non-treated banks' performance before Brexit referendum and also during the US MMF reform implementation. The post-reform period takes place during a global bull market[28]

[28]Over the post period (October 14, 2016 to January 13, 2017) the MSCI World index increased by around 5%,

and the recovery of banks stocks from a stock price drop after the Brexit referendum, which both also drives the stock prices of banks in the sample. Although on average all banks on the trading platform are able to participate in this bull market, the descriptive analysis in Figure 9 reveals that treated banks increase their stock prices on average by around 5 percentage point more than non-treated banks.

Figure 9
Average stock price performance



Notes: Daily stock price performance normalized to the beginning of each sub-period (=100). US banks excluded.

To rule out potentially confounding factors, we run a difference-in-differences regression where we focus on comparing the development of daily stock prices of all publicly listed banks active on the platform during our observation period.[29] In particular, we run the following regression model:

$$\begin{aligned} CumStockReturn_{ikt} = \alpha_{kt} + (\alpha_i +)\beta_1 \cdot nonMMF_i + \beta_2 \cdot nonMMF_i \cdot post_t \\ + \gamma \cdot Brexit + \delta \cdot \mathbf{Y}_{i(t-1year)} + \epsilon_{ikt} \end{aligned} \tag{6}$$

The dependent variable $CumStockReturn_{ikt}$ describes the three-month cumulative stock return of bank i from country k in period t, i.e., pre- or post-period. To control for recovery effects of the stock prices drop after Brexit referendum on June 23, 2016, we include a $Brexit$ variable, which is defined as the stock price drop in percentage points two trading days after the referendum (i.e., the drop until close of business on Monday, June 27, 2016) for observations in the post-period and equal to 0 for observations in the pre-period. The dummy variables $nonMMF_i$ and $post_t$ are defined similarly to previous regression models and we also control for the overall development of stock markets as well as differences across countries over time by adding $country \cdot time$ fixed effects.

while important bank indices such as the S&P 500 Banks and the Stoxx Europe 600 Banks even increased by around 30% and 25%, respectively.

[29]Excluding US banks.

The main variable of interest remains the interaction between the non-treatment dummy and the post-reform period dummy.

Table XII presents the results, which indicate a statistically significant and economically even more substantial effect than suggested by Figure 9: Treated banks exhibit 14-18 additional percentage points stock price growth after controlling for $country \cdot time$, $bank$ specific factors, and a potential Brexit recovery impact. Hence, the regression results confirm that treated banks clearly outperform non-treated banks on stock markets.[30] Moreover, the stock performance seems to confirm that the results from the deposit trading platform are representative for a general detrimental effect of the US MMF reform on non-treated banks' competitiveness in alternative short term USD funding markets. As hypothesized earlier, the effect in other wholesale funding markets even seems to go beyond the price and portfolio impact, we observe under relatively inelastic supply conditions on the deposit trading platform.[31]

Table XII
Regression on stock price performance

	(1)	(2)	(3)
non-MMF	1.3442		
	(7.4493)		
non-MMF * post	-18.3626**	-15.1154**	-14.5818***
	(6.8770)	(7.0940)	(3.8928)
Brexit	0.9030***	1.3190***	1.6294***
	(0.1573)	(0.3205)	(0.1986)
log(total assets)	-4.2339**	-36.0351	-46.7583
	(1.6242)	(36.6920)	(43.0531)
Leverage			0.3546
			(2.0769)
NII revenue share			1.5604***
			(0.3638)
N	82	82	82
R^2	0.8858	0.9397	0.9607
Country-period FE	✓	✓	✓
Bank FE		✓	✓

Notes: OLS regressions for Equation 6. The dependent variable is $CumStockReturn_{ikt}$ defined as the three months cumulative stock return of bank i from country k in pre or post period. non-MMF is a dummy variable equal to 1, if a bank is non-treated and post a dummy variable equal to 1 in the post period. Brexit is defined as the stock price drop in percentage points two trading days after the referendum and is equal to 0 for observations in pre-period. log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity. Robust SE are given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

The shortage of dollar funding for crowded-out banks can affect their stock prices via two

[30] The Brexit referendum in June 2016 could potentially drive stock price divergence between treated and non-treated banks, as the treatment group contains more UK headquartered banks than the control group. Assuming that the positive Brexit referendum has a larger negative impact on UK banks than on non-UK banks, our results would even underestimate the impact of the US MMF reform. However, taking out all UK banks of the analysis hardly change our results.

[31] As the deposit trading platform is only one puzzle piece of banks' funding substitution, the observed magnitude of stock price results needs to be driven by an overall effect of wholesale funding substitution on banks competitiveness.

potential channels of investor expectations: On the one hand, the market might expect that non-treated banks will continue having difficulties in finding sufficient dollar funding, which might finally result in funding stress and affect bank's health. This would substantially increase the riskiness of the bank, thus eventually resulting in a lower stock price performance, other things being equal. On the other hand, investors could expect that crowded-out banks, due to lower access to dollar-denominated funding, will miss out on potential profitable lending opportunities. Other things equal, this would decrease future cash flows, yet not influence the overall riskiness of the bank.

The results from Tables XI and XII lend support to the second hypothesis: We do not observe a sustained impact on CDS spreads, but we do find that stock prices diverge significantly. Non-treated banks are not judged to be closer to insolvency, but their market value deteriorates in relative terms.

VI. Conclusion

In this paper, we study how banks substitute different sources of wholesale funding as well as the broader effects this has through competition. We present evidence that substitution between different sources of funding by one bank has implications beyond its own balance sheet, and spills over to the funding structure and performance of other banks due to competition.

We merge two unique datasets and provide evidence that banks that suffered a negative funding shock in USD after the 2016 MMF reform in the US crowd-out other banks that were not affected by the MMF reform in the market for dollar-denominated corporate deposits. In particular, non-treated banks had to increase their offered deposit rates in order to keep their market share during the implementation of the reform. We confirm that the observed difference in deposit spreads is dollar-specific, as there is no price change difference for GBP-denominated deposits between treated and non-treated banks.

We use the change in banks' lender composition to document a mechanism of crowding out, which also serves as explanation for the higher credit price that non-treated banks have to pay. Underpinning this explanation is the existence of a pecking order of funding, whereby banks with access to both MMFs and corporate deposits have a preference for the former, driven by volume and maturity considerations. Together with the existence of funding market fragmentation (i.e., not all banks have access to both markets), this pecking order shapes how banks' and firms' preferences are matched. Using the long history of firms' deposit provision, we classify firms into two groups depending on the "stability" of their funding provision. We measure the stability of funding provision by the ratio of monthly aggregate notional deposit amounts provided by a firm over the average monthly notional deposit amount of the prior six months in which the firm was active on the platform.

We document that treated banks attract stable funding providers away from non-treated banks. In particular, we show that non-treated banks have a lower probability of winning an auction with stable, and particularly larger, funding providers, despite offering the same bid quote to a firm and are therefore forced to form new relationships. In the aftermath of the reform, they increasingly obtained funding from firms they had no relationship with on the platform prior to the reform. Non-treated banks are therefore forced to satisfy their funding needs by bidding a higher price for funding from new relationship firms, and also had to pay a substantial premium for funding from existing smaller and less-stable funding providers. Here, too, we rule out that the two groups do not differ in their fundamental trends in the success probability for winning an auction, which could be due to, e.g., a change in deposit offering firms' preferences for treated banks. The observed advantage of winning an auction is dollar-specific, as we do not observe a higher chance to win an auction in GBP for treated banks.

We further show that non-treated banks exhibit a 14-18 percentage points lower stock price growth during the post reform implementation period, relative to their treated competitors. At the same time the CDS spread, a measure of the riskiness of non-treated banks, only shortly diverges from the CDS of treated banks, and returns to around the initial levels shortly thereafter. As we observe a substantially lower performance of non-treated banks without a sustained increase in perceived risk, investors seem to assume that non-treated banks will have more difficulties in materializing profitable lending opportunities, but do not judge that banks are closer to default than their treated peers. A plausible interpretation of this result is that investors seem to expect that the crowding out in funding markets potentially leads to a crowding out in lending markets.

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Appendix

Appendix A. Competition and Market Shares

We have examined to which extent the crowding-out of non-treated banks is reflected by market share and volume effects. To compare the aggregate market share in terms of transaction volume of bank i in the pre- and post-reform periods, we run the following regression at the *bank* level with pre and post period lengths varying from one to three months to differentiate between short-run versus longer term effects:

$$\begin{aligned} MarketShare_{it} &= \alpha + \beta_1 \cdot nonMMF_i + \beta_2 \cdot post_t + \beta_3 \cdot nonMMF_i \cdot post_t \\ &+ \gamma \cdot mat_i + \delta \cdot \boldsymbol{Y}_{i(t-1year)} + \epsilon_{it} \end{aligned} \tag{7}$$

$MarketShare_{it}$ is the aggregate market share of bank i in period t, i.e., in the pre or post period. As we want to explain the crowding-out of non-treated banks, the dummy variable $nonMMF_i$ that is equal to 1 if bank i is non-treated, and 0 otherwise is used again. $post_t$ remains a dummy variable equal to 1 if the observation belongs to the post period, and 0 otherwise. Our main variable of interest is the interaction of $nonMMF_i$ and $post_t$, the difference-in-differences variable, which is equal to 1 for non-treated banks in the post period and thus describes the differential effect on non-treated banks compared to treated banks from the pre- to post-reform period. With mat_i we control for the average maturity of deposits (in days) contained in market share of bank i as a transaction specific control variable. $\boldsymbol{Y}_{i(t-1year)}$ is the same vector of bank balance sheet control variables lagged by one year as in previous regressions.

The regression results are shown in Table XIII and partly confirm the message from the descriptive statistics in Table V. Regardless of the bank-specific control variables, non-treated banks have a statistically significant lower market share of around 1 percentage point in the pre-period on individual bank level. However, there is no statistically significant difference in market shares between the pre-reform and post-reform periods on individual bank level, neither for treated nor for non-treated banks. Hence, while the group of treated banks increase their share, this effect is not observable at the individual bank level. Comparing market shares at the individual bank level, non-treated banks do not consistently lose market share, though the negative point estimate of the difference-in-differences variable in the longer run indicates a negative trend for non-treated banks.

To complement the market share picture by notional deposit amount changes in absolute terms, we compare the transaction notional amount of bank i in the three months prior to the MMF reform with the notional amount of the same bank in the one to three months post-reform. We estimate the following transaction-level regression:

$$\begin{aligned} Notional_{ijat} &= \alpha_{jt} + (\alpha_i +)\beta_1 \cdot nonMMF_i + \beta_2 \cdot nonMMF_i \cdot post_t \\ &+ \gamma \cdot mat_a + \delta \cdot \boldsymbol{Y}_{i(t-1year)} + \epsilon_{ijat} \end{aligned} \tag{8}$$

Table XIII

Regression on aggregate bank market shares

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lenght of pre and post periods:	*(3 months)*	*(3 months)*	*(3 months)*	*(2 months)*	*(2 months)*	*(2 months)*	*(1 month)*	*(1 month)*	*(1 month)*
non-MMF	-1.0583	-0.8792	-0.6096	-1.0169	-0.8629	-0.5855	-0.9394	-0.7789	-0.5533
	(0.6532)	(0.6569)	(0.6804)	(0.6466)	(0.6537)	(0.6772)	(0.6935)	(0.7013)	(0.7289)
post	0.0723	0.1061	0.1385	0.0493	0.0661	0.1070	-0.1230	-0.1297	-0.0760
	(0.9189)	(0.9212)	(0.9189)	(0.9443)	(0.9466)	(0.9435)	(0.9491)	(0.9504)	(0.9450)
non-MMF * post	-0.2063	-0.4096	-0.3578	-0.1239	-0.3268	-0.2548	0.3908	0.1756	0.2562
	(0.9845)	(1.0036)	(0.9969)	(1.0209)	(1.0507)	(1.0375)	(1.1117)	(1.1354)	(1.1393)
log(total assets)	0.2298*	0.2344*	0.3139*	0.2623**	0.2601**	0.3359*	0.3491**	0.3503**	0.4098**
	(0.1204)	(0.1211)	(0.1790)	(0.1201)	(0.1199)	(0.1806)	(0.1366)	(0.1368)	(0.1898)
Maturity(days)		-0.0086**	-0.0058		-0.0081**	-0.0046		-0.0079*	-0.0045
		(0.0035)	(0.0042)		(0.0039)	(0.0043)		(0.0040)	(0.0047)
Leverage			0.0940			0.1040			0.1059
			(0.0588)			(0.0659)			(0.0777)
NII revenue share			-0.0111			-0.0090			-0.0045
			(0.0165)			(0.0167)			(0.0157)
Constant	-2.3726	-2.3473	-5.1183	-3.0380	-2.8811	-5.8876	-4.6802*	-4.5812*	-7.5441*
	(2.4794)	(2.4750)	(3.6988)	(2.4181)	(2.4007)	(3.8056)	(2.6734)	(2.6624)	(4.2201)
N	114	114	114	114	114	114	104	104	104
R^2	0.0830	0.0946	0.1164	0.0785	0.0873	0.1100	0.0698	0.0779	0.0985

Notes: OLS regressions for Equation 7. The dependent variable is $MarketShare_{it}$ defined as the aggregate market share of bank i in the pre- or post-reform periods. non-MMF is a dummy variable equal to 1, if a bank is non-treated and post a dummy variable equal to 1 in the post period. Maturity(days) stands for the average remaining time (in days) until the funding matures (for all transactions of bank i in period t), log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity. Robust SE are given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

where $Notional_{ijat}$ is the notional deposit amount transacted between bank i and firm j at time t in transaction a. With mat_a we control for the maturity of deposits (in days) in transaction a as a transaction specific control variable. The remaining variables are defined as before.

Table XIV

Regression on notional deposit amounts

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	*(3m/3m)*	*(3m/3m)*	*(3m/2m)*	*(3m/2m)*	*(3m/1m)*	*(3m/1m)*
non-MMF	0.2810		0.8468		-0.2720	
	(6.4589)		(6.1580)		(5.3206)	
non-MMF * post	-9.3871	-2.8681	-16.0320	-6.9050	-15.9121	-0.5039
	(9.1223)	(5.4935)	(12.7831)	(6.4419)	(14.9478)	(10.9715)
Maturity(days)	-0.4296	-0.3796*	-0.4183	-0.3744	-0.2549	-0.2604
	(0.2597)	(0.2172)	(0.2728)	(0.2275)	(0.1822)	(0.1596)
log(total assets)	-0.2825	49.8091	0.0164		-2.0744	
	(3.2301)	(41.4296)	(3.0424)		(2.1267)	
Leverage	1.6565**	-2.5359	1.6900**		1.5585**	
	(0.8018)	(2.4754)	(0.8379)		(0.7153)	
NII revenue share	-0.7315**	0.2096	-0.6390*		-0.3769	
	(0.3526)	(0.5779)	(0.3347)		(0.2320)	
N	3996	3994	3335	3334	2629	2622
R^2	0.5011	0.5646	0.5083	0.5666	0.5570	0.5950
Bank FE		✓		✓		✓
Firm-month FE	✓	✓	✓	✓	✓	✓

Notes: OLS regressions for Equation 8. The dependent variable is $Notional_{ijat}$, defined as the notional deposit amount transacted between bank i and firm j at time t in auction a. non-MMF is a dummy variable equal to 1, if a bank is non-treated and post a dummy variable equal to 1 in the post period. Maturity(days) stands for the remaining time (in days) until the funding matures, log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity. The sample name describes the length of pre and post periods in months, e.g., *(3m/1m)* stands for three months pre and one month post period length. *SE* are clustered at the bank level and given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

Our results (cf. Table XIV) provide only weak evidence that non-treated banks lost volume relative to treated banks at transaction level. The decrease in average notional deposit amount per transaction for non-treated banks in the post-reform period is only observable once we do not control for time-invariant bank characteristics.

Appendix B. Robustness regarding different lengths of post period

Table XV and Table XVI estimate Equation 3 for 2 months and 1 month lenght of post period, respectively.

Table XV

Regression on winning bid - Robustness 2 months post-period

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	*(3m/2m)*	*(3m/2m)*	*(3m/2m)*	*(3m/2m)*	*(3m/2m)*	*(3m/2m)*
non-MMF	0.0480		-0.0266		-0.0400	
	(0.0389)		(0.0768)		(0.0633)	
non-MMF * post	-0.0835	-0.0923*	-0.5473**	-0.5175**	-0.0273	-0.0052
	(0.0526)	(0.0509)	(0.2353)	(0.2274)	(0.0824)	(0.0832)
non-MMF * post * New rel.	0.2456***	0.2684***	1.1340***	1.0829***	0.6361***	0.6252***
	(0.0541)	(0.0750)	(0.3353)	(0.3358)	(0.1459)	(0.1648)
non-MMF * stable			0.1064	0.1240*		
			(0.0644)	(0.0727)		
non-MMF * stable * post			0.4661*	0.4238*		
			(0.2346)	(0.2320)		
non-MMF * stable * post * New rel.			-0.9458***	-0.8871***		
			(0.3258)	(0.3219)		
non-MMF * stable * big					0.1390***	0.1595**
					(0.0507)	(0.0620)
non-MMF * stable * big * post					-0.0956	-0.1401
					(0.0787)	(0.0909)
non-MMF * stable * big * post * New rel.					-0.4415***	-0.4033***
					(0.1306)	(0.1482)
Highest quote	0.7581***	0.7362***	0.7595***	0.7387***	0.7580***	0.7383***
	(0.0267)	(0.0290)	(0.0263)	(0.0287)	(0.0265)	(0.0287)
N	5209	5209	5209	5209	5209	5209
R^2	0.6534	0.6680	0.6578	0.6721	0.6557	0.6703
Transaction & bank controls	✓	✓	✓	✓	✓	✓
Bank FE		✓		✓		✓
Firm-month FE	✓	✓	✓	✓	✓	✓

Notes: OLS regressions for Equation 3. The dependent variable is $WinningBid_{ijabt}$ defined as a dummy variable that equals 1 if bank i wins the deposit offered by firm j in auction a with bid b at time t. non-MMF is a dummy variable equal to 1, if a bank is non-treated and post a dummy variable equal to 1 in the post period. New relationship is a dummy variable equal to 1 if the first transaction (determined considering all currencies traded on the platform) between a bank i and firm j takes place after April 2016. $stable_j$ is equal to one if firm j offering the deposit is a stable funding provider according to the aforementioned definition. big_j is equal to 1 if the average transactions size of firm j is larger or equal to the median of average transaction sizes of all other firms. Highest quote is a dummy variable equal to 1 if bid b contains the highest quote in auction a. log(notional) stands for the logarithm of the notional deposit amount, Maturity(days) for the remaining time (in days) until the funding matures, log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity. New relationship is additionally interacted with the treatment group indicator (MMF) and the post period indicator (post). The sample name describes the length of pre and post periods in months, e.g., *(3m/1m)* stands for three months pre and one month post period lengths. *SE* are clustered at the bank level and given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

Table XVI

Regression on winning bid - Robustness 1 month post-period

Sample	(1) *(3m/1m)*	(2) *(3m/1m)*	(3) *(3m/1m)*	(4) *(3m/1m)*	(5) *(3m/1m)*	(6) *(3m/1m)*
non-MMF	0.0467		-0.0308		-0.0422	
	(0.0385)		(0.0751)		(0.0625)	
non-MMF * post	-0.0627	-0.0761	-0.3655	-0.3272	0.0133	0.0305
	(0.0487)	(0.0468)	(0.2810)	(0.2720)	(0.0964)	(0.0896)
non-MMF * post * New rel.	0.3414***	0.3658***	0.6169**	0.6416**	0.4669***	0.3443***
	(0.0559)	(0.0780)	(0.2809)	(0.2883)	(0.1142)	(0.1076)
non-MMF * stable			0.1101*	0.1364*		
			(0.0633)	(0.0713)		
non-MMF * stable * post			0.2876	0.2301		
			(0.2836)	(0.2781)		
non-MMF * stable * post * New rel.			-0.2848	-0.2952		
			(0.2775)	(0.2765)		
non-MMF * stable * big					0.1402***	0.1633**
					(0.0505)	(0.0626)
non-MMF * stable * big * post					-0.1240	-0.1650
					(0.0974)	(0.1002)
non-MMF * stable * big * post * New rel.					-0.1382	0.0132
					(0.1230)	(0.1078)
Highest quote	0.7666***	0.7409***	0.7693***	0.7442***	0.7677***	0.7440***
	(0.0291)	(0.0310)	(0.0288)	(0.0309)	(0.0288)	(0.0309)
N	4269	4269	4269	4269	4269	4269
R^2	0.6680	0.6853	0.6698	0.6871	0.6699	0.6873
Transaction & bank controls	✓	✓	✓	✓	✓	✓
Bank FE		✓		✓		✓
Firm-month FE	✓	✓	✓	✓	✓	✓

Notes: OLS regressions for Equation 3. The dependent variable is $WinningBid_{ijabt}$ defined as a dummy variable that equals 1 if bank i wins the deposit offered by firm j in auction a with bid b at time t. non-MMF is a dummy variable equal to 1, if a bank is non-treated and post a dummy variable equal to 1 in the post period. New relationship is a dummy variable equal to 1 if the first transaction (determined considering all currencies traded on the platform) between a bank i and firm j takes place after April 2016. $stable_j$ is equal to one if firm j offering the deposit is a stable funding provider according to the aforementioned definition. big_j is equal to 1 if the average transactions size of firm j is larger or equal to the median of average transaction sizes of all other firms. Highest quote is a dummy variable equal to 1 if bid b contains the highest quote in auction a. log(notional) stands for the logarithm of the notional deposit amount, Maturity(days) for the remaining time (in days) until the funding matures, log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity. New relationship is additionally interacted with the treatment group indicator (MMF) and the post period indicator (post). The sample name describes the length of pre and post periods in months, e.g., *(3m/1m)* stands for three months pre and one month post period lengths. *SE* are clustered at the bank level and given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

Appendix C. Robustness regarding cross-currency confounding factors

Results of cross-currency robustness check for aggregate market shares analysis by estimating the following equation are shown in Table XVII:

$$\begin{aligned} MarketShare_{ict} = {} & \alpha_c + \beta_1 \cdot nonMMF_i + \beta_2 \cdot post_t + \beta_3 \cdot nonMMF_i \cdot post_t \\ & + \beta_4 \cdot nonMMF_i \cdot USD_c + \beta_5 \cdot post_t \cdot USD_c \\ & + \beta_6 \cdot nonMMF_i \cdot post_t \cdot USD_c + \gamma \cdot mat_i + \delta \cdot \mathbf{Y}_{i(t-1year)} + \epsilon_{it} \end{aligned} \tag{9}$$

Results of cross-currency robustness check for transaction notional amount analysis by estimating the following equation are shown in Table XVIII:

$$\begin{aligned} Notional_{ijact} = {} & \alpha_{ct} + \alpha_{jt} + (\alpha_i +)\beta_1 \cdot nonMMF_i + \beta_2 \cdot nonMMF_i \cdot post_t \\ & + \beta_3 \cdot nonMMF_i \cdot USD_a + \beta_4 \cdot nonMMF_i \cdot post_t \cdot USD_a \\ & + \gamma \cdot mat_a + \delta \cdot \mathbf{Y}_{i(t-1year)} + \epsilon_{ijat} \end{aligned} \tag{10}$$

Table XVII

Regression on aggregate bank market shares - USD vs. GBP comparison

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lenght of pre and post periods:	*(3 months)*	*(3 months)*	*(3 months)*	*(2 months)*	*(2 months)*	*(2 months)*	*(1 month)*	*(1 month)*	*(1 month)*
non-MMF	-2.7794***	-2.6909**	-3.1958***	-2.9617**	-2.9552**	-3.1842**	-2.3443*	-2.3474*	-2.6805*
	(1.0647)	(1.0666)	(1.2110)	(1.2040)	(1.2058)	(1.2974)	(1.3388)	(1.3392)	(1.4443)
non-MMF * USD	1.6375	1.6566	2.1991*	1.7871	1.9633	2.3150*	1.2609	1.4463	1.7581
	(1.1578)	(1.1612)	(1.2841)	(1.2762)	(1.2802)	(1.3578)	(1.4132)	(1.4124)	(1.5108)
post	-0.4623	-0.4481	-0.6603	-0.6116	-0.6107	-0.4375	-0.3325	-0.3326	-0.3317
	(1.2659)	(1.2665)	(1.4211)	(1.3877)	(1.3899)	(1.5044)	(1.4556)	(1.4591)	(1.5707)
post * USD	0.5345	0.5436	0.5905	0.6607	0.6791	0.3418	0.2093	0.2019	0.1063
	(1.5641)	(1.5644)	(1.7024)	(1.6794)	(1.6812)	(1.7807)	(1.7390)	(1.7411)	(1.8382)
non-MMF * post	0.6201	0.5404	0.8357	0.8861	0.8928	0.8780	0.4568	0.4569	0.4521
	(1.3176)	(1.3192)	(1.4908)	(1.5036)	(1.5050)	(1.6704)	(1.7099)	(1.7124)	(1.8612)
non-MMF * post * USD	-0.8270	-0.8878	-0.8920	-1.0110	-1.2510	-0.9646	-0.0672	-0.3079	-0.0406
	(1.6452)	(1.6502)	(1.8105)	(1.8187)	(1.8399)	(1.9925)	(2.0406)	(2.0591)	(2.2033)
log(total assets)	0.1774	0.1706	0.2315	0.1634	0.1644	0.2519	0.2615**	0.2646**	0.2888*
	(0.1151)	(0.1147)	(0.1657)	(0.1244)	(0.1250)	(0.1768)	(0.1299)	(0.1305)	(0.1704)
Maturity(days)		-0.0059**	-0.0068		-0.0093**	-0.0108*		-0.0088**	-0.0096*
		(0.0028)	(0.0043)		(0.0041)	(0.0057)		(0.0042)	(0.0050)
Leverage			0.0229			0.0338			0.0202
			(0.0504)			(0.0569)			(0.0648)
NII revenue share			-0.0166			-0.0152			-0.0059
			(0.0154)			(0.0161)			(0.0156)
N	208	208	182	200	200	178	180	180	168
R^2	0.1231	0.1278	0.1489	0.1120	0.1175	0.1319	0.0891	0.0937	0.1030
Currency FE	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes: OLS regressions for Equation 9. The dependent variable is $MarketShare_{it}$ defined as the aggregate market share of bank i in the pre- or post-reform periods. non-MMF is a dummy variable equal to 1, if a bank is non-treated, post a dummy variable equal to 1 in the post period and USD a dummy variable that equals 1 for dollar denominated transactions. Maturity(days) stands for the average remaining time (in days) until the funding matures (for all transactions of bank i in period t), log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity. Robust SE are given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.

Table XVIII

Regression on notional deposit amounts - USD vs. GBP comparison

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	*(3m/3m)*	*(3m/3m)*	*(3m/2m)*	*(3m/2m)*	*(3m/1m)*	*(3m/1m)*
non-MMF	6.0598		5.8401		4.0379	
	(4.7927)		(4.4444)		(3.7365)	
non-MMF * USD	2.6551	3.4649	2.8973	2.9890	3.5713	2.0768
	(3.4835)	(3.6564)	(3.4585)	(3.6554)	(3.3031)	(3.6322)
non-MMF * post	-18.7344***	-22.5789***	-16.4917***	-22.0312***	-15.5438*	-16.5875*
	(5.2540)	(5.9490)	(5.1893)	(6.1814)	(8.3938)	(8.8967)
non-MMF * post * USD	14.4556**	17.6858***	11.5993	15.9335**	12.2520	17.0060*
	(6.3251)	(5.8724)	(7.3343)	(6.0262)	(9.8444)	(8.9116)
Maturity(days)	-0.2945	-0.2674	-0.2593	-0.2369	-0.1411	-0.1472
	(0.1866)	(0.1601)	(0.1781)	(0.1529)	(0.1029)	(0.0901)
log(total assets)	-0.0962	67.7328	-0.1083		-1.3382	
	(1.8189)	(58.2872)	(1.6534)		(1.3685)	
Leverage	1.2338**	-3.4907	1.2577***		1.1347***	
	(0.4697)	(3.4779)	(0.4689)		(0.3731)	
NII revenue share	-0.3480**	-0.0915	-0.2994*		-0.1652	
	(0.1714)	(0.4703)	(0.1535)		(0.1044)	
N	7329	7326	6207	6205	5020	5013
R^2	0.4674	0.4965	0.4727	0.4992	0.5105	0.5307
Bank FE		✓		✓		✓
Currency-month FE	✓	✓	✓	✓	✓	✓
Firm-month FE	✓	✓	✓	✓	✓	✓

Notes: OLS regressions for Equation 10. The dependent variable is $Notional_{ijat}$, defined as the notional deposit amount transacted between bank i and firm j at time t in auction a. non-MMF is a dummy variable equal to 1, if a bank is non-treated, post a dummy variable equal to 1 in the post period and USD a dummy variable that equals 1 for dollar denominated transactions. Maturity(days) stands for the remaining time (in days) until the funding matures, log(total assets) stands for the logarithm of bank total assets, Leverage for total assets over equity. The sample name describes the length of pre and post periods in months, e.g., *(3m/1m)* stands for three months pre and one month post period length. *SE* are clustered at the bank level and given in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels.