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Cross-border transmission of emergency liquidity ⋆

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Abstract

We show that emergency liquidity provision by the Federal Reserve transmitted to non-U.S. banking markets. Based on manually collected holding company structures, we identify banks in Germany with access to U.S. facilities. Using detailed interest rate data reported to the German central bank, we compare lending and borrowing rates of banks with and without such access. U.S. liquidity shocks cause a significant decrease in the short-term funding costs of the average German bank with access. This reduction is mitigated for banks with more vulnerable balance sheets prior to the inception of emergency liquidity. We also find a significant pass-through in terms of lower corporate credit rates charged for banks with the lowest pre-crisis leverage, US-dollar funding needs, and liquidity buffers. Spillover effects from U.S. emergency liquidity provision are generally confined to short-term rates.

Key words: cross-border policy transmission, emergency liquidity, internal capital markets, interest rates
JEL: E52; E58; F23; F38; G01; G21

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1 Introduction

What are the cross-border implications of the pervasive provision of emergency liquidity facilities by central banks for corporate loan and deposit rates? By the end of 2008, the federal funds rate was at the zero-lower bound, rendering conventional monetary policy unavailable. Figure 1 shows that the U.S. Federal Reserve distributed up to 1.2 trillion USD by means of emergency lending facilities to financial institutions with a U.S. banking charter to alleviate continuing funding pressure. The cost of these facilities was well below those charged by the European Central Bank (ECB) (see Figure C.1 in the Online Appendix). Accordingly, more than half of the distributed volume was used by foreign bank affiliates (Benmelech, 2012; Shin, 2012; Acharya et al., 2014). We test if U.S. emergency liquidity was re-allocated via the internal capital markets of international (non-U.S.) bank holding companies (IBHC) and affected banks' funding and lending terms *outside* the U.S. economy.

– Figure 1 around here –

Investigating the effects of liquidity assistance is particularly relevant because Bernanke and Gertler (1992, 1995) and Kashyap and Stein (2000) emphasize that banks already fail to fully transmit conventional monetary policy when facing funding constraints and uncertainty about liquidity access (see also Freixas et al., 2011), a limitation aggravated at the zero-lower bound (Adam and Billi, 2007). The empirical evidence for the U.S. emergency liquidity provision suggests that it mitigated banks' funding pressure in severely stressed federal fund markets fairly well (Afonso et al., 2011; Wu, 2011). [1] Emergency liquidity facilities effectively substituted conventional

[1] The Term Auction Facility (TAF) and the Term Securities Lending Facility (TSLF) mitigated liquidity shortages of banks (Fleming et al., 2010), but did not reduce their borrowing costs relative to the London Interbank Overnight Rate (LIBOR) (Kuo et al., 2012). Duygan-Bump et al. (2013) find that the Asset-Backed Commercial Paper (ABCP) Money Market Mutual Funds Liquidity Facility (AMLF) significantly reduced ABCP yields and prevented fund outflows.

monetary policy in terms of employment and output responses (Gambacorta et al., 2014). When short-term funding pressure mounted, lending volumes contracted and lending rates increased due to the crisis (Santos, 2010; Ivashina and Scharfstein, 2010). Emergency liquidity lines mitigated domestic lending contraction in particular by large banks (Berger et al., 2017). The potential downside was, in turn, that weak banks could use emergency liquidity, thereby increasing expectations of bailouts "through the backdoor" (Helwege et al., 2017; Hett and Schmidt, 2017).

Our focus is to shed light on the consequences of unconventional U.S. monetary policy for credit and funding cost *outside* the U.S., which remain uncharted so far. Contrary to the effects of U.S. emergency lending on U.S. banks, we test for the cross-border impact of these facilities. We expect three phenomena to emerge under the null hypotheses of effective cross-border policy transmission. First, if spill-overs of U.S. policies exist, the funding cost of banks on German soil with access should decline relative to those of banks without access to Fed facilities. Second, if Fed policies transmit also to corporates outside the U.S., credit rates charged to the customers of German banks with access to U.S. liquidity should decline. Third, if there are similar "bailout through the backdoor" concerns at work for non-U.S. banks, we expect that banks on German soil with already weak balance sheets exhibit amplified interest rate effects regarding funding and lending.

Most analyses of cross-border responses to the financial crisis pertain to lending and funding volumes rather then pricing. Crisis-ridden banks reduced foreign lending significantly (De Haas and Van Lelyveld, 2010; Giannetti and Laeven, 2012a,b; Schnabl, 2012; De Haas and Van Horen, 2012). Withdrawals from foreign credit and funding markets are not homogeneous because internal capital markets of IBHCs are managed actively, re-allocate financial funds globally (see Cetorelli and Goldberg, 2012a,b; Galema et al., 2016), and because the financial resilience of IBHC to withstand arriving

shocks differs (Devereux and Yetman, 2010). We complement these studies by investigating the role of emergency liquidity transmission in terms of pricing, thereby testing more directly the implications for banks' cost of funding and corporates' cost of bank debt.

Contrary to prior studies on the pass-through of policy and shocks via internal capital markets of nationally active banks, [2] we use a unique setting with three main advantages to cast more light on the international transmission of monetary policy. Our approach combines granular micro data about the use of U.S. liquidity, manually collected internal capital market connections of IBHCs outside the U.S., and supervisory information on interest rate setting for new credit and funding by banks in Germany. Thereby, we contribute to the few studies on cross-border policy transmission through global banks in these markets (e.g., Cetorelli and Goldberg, 2012a,b; Buch et al., 2018).

A first important challenge that we overcome is that emergency liquidity usage is conventionally unobservable to avoid stigmatization (Armantier et al., 2015) and self-fulfilling prophecies of bank distress due to a deterioration of banks' market values (Cyree et al., 2013). We benefit from the public release of detailed data on the identity of all banks that used any of the six different U.S. emergency facilities or the Discount Window, which had to be released in 2011 under the Freedom of Information Act (FOIA, New York Southern District Court, 2008) by Bloomberg. The data provide the names, the timing, and the volume of Fed liquidity used by both U.S. and non-U.S. banks on each day between December 2007 and April 2010.

Second, the identification of an exogenous policy shock is notoriously difficult due to the simultaneity between banking system health and the policy stance. We identify the exogenous effect of emergency liquidity provision by comparing banks on German soil that have access to U.S. liquidity facilities

[2] See, e.g., Campello (2002) (U.S.), Cremers et al. (2011) (Netherlands), or Frey and Kerl (2015) (Germany).

via their affiliates to those banks on German soil that have no such access. To this end, we manually identify 23 IBHCs with which the "Bloomberg banks" are associated and that operate in Germany. German banks were heavy users of U.S. emergency liquidity, tapping up to 100 billion EUR in September 2008 (see Figures C.2 and C.3 in the Online Appendix). This magnitude corresponds to 10% of the entire volume of the U.S. facilities at the time and roughly equals the size Germany's financial system contribution to Gross Domestic Product (GDP).

Third, transmitted liquidity shocks should affect *new* rather than outstanding stocks of loans and borrowed funds, to which previous studies are conventionally confined. We, in turn, use detailed interest rate data on new business reported each month by a representative sample of 217 banks in Germany to Deutsche Bundesbank, which we complement with annual report information of all IBHCs. Contrary to syndicated loan (Giannetti and Laeven, 2012a) or corporate funding auction platform data (Acharya et al., 2015), we thus investigate interest rates charged and offered on the margin.

Our results show that short-term funding costs of German banks vis-à-vis corporate depositors declined significantly in response to U.S. liquidity assistance. For each percent of emergency funding per total IBHC assets, short-term deposit rates offered to German corporates by banks with access to the U.S. emergency facilities are 2.3 basis points lower. Increasing the use of emergency lending by one standard deviation reduces banks' short-term funding costs by 1%. This effect is statistically significant for lags up to two months. Thus, we find cross-border spillovers of U.S. policies to reduce short-term funding pressure, albeit at a small magnitude and in the very short run only. Short-term corporate loan rates only exhibit a statistically significant reduction for a lag of exactly three quarters. Neither long-run lending nor funding interest rates exhibit significant differential effects. Likewise, both lending and deposit volumes do not respond significantly. These results

confirm that liquidity emergency policies might have eased pressure on the short end of the yield curve, but could not reduce longer term risk premia.

We also test if weak banks responded differently to emergency liquidity. To this end, we interact liquidity usage with four pre-policy stress indicators, which reveals four noteworthy results. First, the total marginal effect of emergency liquidity usage reduces short-term funding and lending rates significantly across most measures of stress. That is, once we account explicitly for differences in financial resilience of banks' balance sheets in 2007, we find robust evidence of both funding pressure relief as well as interest rate pass-through to a non-U.S. banking market. Second, loan rate reductions are largest for well-capitalized banks and those with the lowest exposure to ABCP prior to the freeze of the Fed funds market. At the same time, banks with the lowest liquidity buffers also exhibit significant credit rate reductions. Third, we also find that the reduction in funding cost is in particular significant for those banks on German soil that were least levered and least exposed to dollar funding needs in the form of ABCP holdings prior to 2007. Finally, the indirect effects of U.S. liquidity assistance routed to banks on German soil via internal capital markets is completely neutralized if banks also received direct support from their national governments in the form of equity injections or asset guarantees. While the resulting funding cost reduction is around three times as large compared to the indirect effects, we also document that bailed out banks actually charge higher loan rates.

Our results are robust towards a number of robustness checks in terms of measurement of both observable and unobservable variation, treatment definitions, and specification choices.

2 Identification and Methodology

2.1 IBHC networks

We distinguish three cases when banks that report interest rates to the German central bank are possibly exposed to a positive U.S. liquidity shock. First, German banks that are a member of an IBHC with a U.S. affiliate. Second, German branches and subsidiaries of U.S. IBHCs that had access via their internal capital markets. And third, German affiliates of non-U.S., non-German IBHCs, that also operated affiliates in the U.S. [3]

Banks are considered members of a IBHC whenever the latter has an equity share or voting rights of more than 50%. We gather these information from public sources and annual reports of IBHCs that are associated with banks revealed on the Bloomberg list. An exception are German savings banks, which are government-owned without free-floating equity. They exhibit a two-tiered network structure that consists of multiple regional savings banks, which are each tied to exactly one so-called Landesbank. To classify local savings banks with and without access, we follow Puri et al. (2011). A savings bank has access to U.S. emergency liquidity if it is connected to a Landesbank with an U.S. affiliate. [4]

Figure A.1 in the appendix shows that this approach identifies 139 out of the 217 banks in our sample as members of an IBHC with access to Federal Reserve funding facilities. These 139 banks belong to 22 non-U.S. IBHCs, of which all operated their branches or subsidiaries already in 2004, which is the first year when we observe the interest rate statistics, up and until today with one exception. [5] This persistent internationalization pattern is

[3] See Figure C.4 in the Online Appendix for a graphical illustration.

[4] We exclude DekaBank, the investment bank of the German savings bank group.

[5] The exception is WestLB, which failed and eventually exited the German, the U.S., and all other markets. In addition, Citigroup operated in Germany and used U.S. emergency facilities, see Figure C.2 in the Online Ap-

consistent with earlier evidence (see, e.g., Buch et al., 2018). A systematic self-selection of (large) banks into the U.S. market in anticipation of future emergency liquidity provision therefore seems unlikely. [6]

2.2 *Specification of emergency facility effects*

Based on this identification of IBHCs' access to U.S. liquidity facilities, we estimate the effects on interest rates set in Germany in two ways. First, we specify a difference-in-differences model that compares interest rate differentials between banks with and without an U.S. $AFFILIATE$ prior to December 2007 to interest rate differentials between banks of these two groups after the facilities were abandoned in May 2010:

$$r_{i,m} = \alpha_m + \alpha_{it} + \beta AFFILIATE_i \times POST_m + \gamma X_{i,m-1} + \varepsilon_{i,m}. \quad (1)$$

The dependent variables $r_{i,m}$ are different lending and funding interest rates of bank i in month m, $AFFILIATE_i$ is a dummy variable equal to one if a bank has access to emergency funding through a U.S. affiliate in its IBHC network, and $POST$ indicates the period after the liquidity treatment stopped, ranging from June 2010 until December 2014. $X_{i,m-1}$ is a vector of control variables lagged by one month. All variables are defined in Table 1 and we discuss and describe them in more detail below.

– Table 1 around here –

Month-fixed effects α_m capture business cycle effects and any effect due to the mere existence of the emergency facilities rather than its actual usage. α_{it} is a bank×semi-annual-fixed effect to account for unobserved bank-specific characteristics, which may vary over time. This specification minimizes

pendix.

[6] Alternative access definitions are shown in Figure A.1, for which we report results in the Online Appendix.

concerns about confounding policy measures, such as unobserved liquidity facilities provided by the ECB (see, e.g., Acharya et al., 2015). Controlling for such unobservables per bank-term in addition to observed monthly liquidity indicators from prudential data aids the identification of the effect of U.S. facilities on interest rates in Germany. Furthermore, this time-varying bank-fixed effect also allows us to control for possible changes in the bank's client base composition over time, as well as credit demand during a given 6-month period. [7]

In this specification the direct effect of an $AFFILIATE_i$ is subsumed by the bank$\times$semi-annual-fixed effect because the U.S. presence of IBHCs did not change during the sample period. Likewise, the direct term for $POST_m$ is subsumed by the monthly fixed effects. Whereas such a difference-in-differences approach therefore permits the exact identification of the presence of affiliates, it does suffer from two limitations. First, it neglects the intensity with which IBHCs have tapped the facilities, thereby camouflaging cross-sectional heterogeneity across banks' actual usage of favorable U.S. funding conditions. Indeed, the data show significant changes in the amount of borrowed funds, both across IBHCs and time. [8] Second, although the establishment of liquidity facilities signals a possible change in the policy stance – and may therefore be a permanent shock to banks with access – some liquidity effects will be short-lived rather than yielding a long-term and sustained reduction of banks' funding costs, which may or may not be passed on to corporate credit customers in the form of lower loan rates.

As a second approach, we therefore take a closer look at the dynamics during the "*treatment period*". We estimate a reduced form to explain observed interest rates during the lifetime of the facilities with observed bank-specific usage of these facilities per IBHC. Contrary to the first approach, we thus

[7] We scrutinize the results for various regional demand controls in Tables C.6 to C.8 in the Online Appendix.

[8] Figures C.2 and C.3 in the Online Appendix show the identities as well as the average and cumulative facility usage of IBHCs included in the sample.

focus on the months between December 2007 and May 2010 when the facilities were in place to gauge any possible short-term rate-setting effects. We therefore examine the effect of emergency funding based on the different amounts in facility usage, rather than changes in the access structure. On a monthly basis, we estimate the impact on offered interest rates by a bank in Germany with a fixed effect regression framework:

$$r_{i,m} = \alpha_m + \alpha_{it} + \beta USAGE_{i,m} + \gamma X_{i,m-1} + \varepsilon_{i,m}, \quad (2)$$

where $USAGE_{i,m}$ is the IBHC's outstanding balance across all emergency facilities and the Discount Window as a share of total assets. We compute monthly balances outstanding as the average daily balance across all facilities and the Discount Window. The USD balances are converted to EUR using the respective average monthly ECB reference rate. *USAGE* is a variable that equals the average monthly balance divided by the total assets of the IBHC, multiplied by 100. Total assets of the IBHC are the consolidated balance sheet totals of the highest ranking bank of the network in the sample, i.e. the highest available consolidation level in our dataset.[9] *USAGE* thus gauges obtained funds in percentages of IBHC size.

3 Data sources and treatment validity

3.1 Emergency facilities

Starting in December 2007, the Federal Reserve established six funding facilities in addition to the reluctantly used Discount Window (Armantier et al., 2015) as a response to severe stress in the federal funds market (Afonso

[9] For German IBHCs, this equals the total assets of the IBHC head company, which is always included in the sample. For non-German IBHCs, this equals the total assets of the largest affiliate bank in the sample. We scrutinize the robustness of results when excluding these banks in one alternative treatment definitions.

et al., 2011). Detailed information on the amounts received from the Federal Reserve System by individual IBHCs were made public by Bloomberg and through the Federal Reserve's website on grounds of the Freedom of Information Act (FOIA) in 2011 that Bloomberg L.P. had successfully filed against the Board of the Federal Reserve in November 2008. The dataset provides a complete account of all funds granted for each of the facilities and the Discount Window. Balances vis-à-vis the Federal Reserve are stated bank-by-bank during the entire lifetime of each facility for each day.

The facilities were created to alleviate liquidity shortages in the financial market in general. [10] TAF was established in December 2007 and provided short-term credit up to 84 days through bi-weekly auctions to deposit-taking financial institutions against a wide range of collateral until March 2010. As of March 2008, the Primary Dealer Credit Facility (PDCF) and Term Securities Lending Facility (TSLF) provided overnight loans and exchange various types of collateral against Treasury collateral. The ABCP Money Market Mutual Funds Liquidity Facility (AMLF) helped institutions to finance purchases of high-quality ABCP from mutual funds from September 2008 onward. The Commercial Paper Funding Facility (CPFF), established only one month later, supported the market for commercial paper in general. Primary dealers were provided with liquidity through single-tranche open market operations (STOMO) between March and December 2008. All facilities except TAF were abolished on February 1, 2010. [11]

By the end of 2008, the size of the facilities amounted to 8% of total annual U.S. GDP and to 135% of annual U.S. financial sector output (see Figure 1). All financial institutions with a U.S. banking charter had access, i.e. also affiliates of non-U.S. IBHCs. Table 2 reports the average monthly balance of all IBHCs that are associated with banks on German soil in the sample.

[10] See Section C.3 in the Online Appendix for more details of the facilities' mechanisms and terms.
[11] The Term Auction Facility formally remained active, but ceased to conduct auctions in February 2010.

These volumes are derived from the individual facility usage reported in the Bloomberg data between December 2007 and May 2010. All banks with access in the sample used the various Fed lines at some point in time during the lifetime of the emergency facilities. No bank gained or lost access due to a change in the IBHC structure.

– Table 2 around here –

Table 2 shows that the average liquidity uptake from the different facilities reflects the aggregate usage by German banks shown in Figure C.3 in the Online Appendix. The 23 IBHC with connections to local banks on German soil that we identified in the Bloomberg data, used the TAF and the TSLF most intensively, averaging volumes of 1.5 and 0.5 billion USD over the period December 2007 and April 2019, respectively. The data confirm the dominance of these two facilities relative to the conventional monetary policy instrument, the Discount Window, which exhibit an average usage of 0.4 billion USD. These proportions are fairly stable over time. Likewise, the number of participating IBHC remains fairly stable, too. The remaining facilities are used less, corresponding to their smaller aggregate volumes. Consistent with the evidence shown in Helwege et al. (2017), the number of IBHC that use the facilities might be small. Note, however, that these funds are distributed to many more local banks associated with these IBHC via internal capital markets: 134 out 217 in the case of Germany.

3.2 Interest rates

We obtain monthly interest rates and new business volumes from the interest rate report (*Zinsstatistik*) of Deutsche Bundesbank between January 2004 and December 2014. This mandatory report of interest rates and business volumes comprises a representative sample of approximately 200 banks

from all three sectors of the German banking system: commercial, savings, and cooperative banks. The sample gauges around 10% of all banks and covers more than 75% of aggregate banking assets in Germany.

The complete report differentiates more than 50 categories of deposit and credit products. To represent an important share of overall banking activity, we focus on the most frequently reported asset and liability items pertaining to non-financial corporate clients, for short-term (< 1 year) and long-term (> 2 or 5 years) maturities.[12] Table 1 defines these variables in detail. Reported interest rates are averages across new contracts originated during the reporting month. All rates are reported in percentages.

3.3 Control variables

We construct control variables from the monthly balance sheet report of Deutsche Bundesbank (*Bilanzstatistik*), which are defined in Table 1.[13] *Bank Size* is defined as the log of total assets and captures the differences in institution size. To account for differences in funding, we specify *Wholesale Funding* as the share of securitized debt on the balance sheet. The *Leverage Ratio* is the share of total nominal equity and gauges differences in capitalization. *Latent Liabilities* capture the exposure to irrevocable credit commitments as a share of total assets. We also control for monthly variation in available liquidity of each bank, which is crucial in our setting. *Liquidity* is the share of net liquidity balances relative to total assets. The former is obtained from prudential accounts in which banks indicate details about their assets and liabilities with a maturity of up to 30 days. In addition, we specify *Central Bank Liabilities* as net liabilities with the central bank of up to one year in maturity to control for cross-sectional differences among banks in the use

[12] Medium-term interest rates and volumes exhibit no effects throughout.
[13] All variables are winsorized at the 1st and 99th percentile to control for outliers.

of unobserved liquidity provision other than the U.S. facilities investigated here. The latter concern is further mitigated by the fact that the interest rates charged on U.S. liquidity facilities were lower compared to the marginal lending facility of the ECB (see Figure C.1 in the Online Appendix). Since we hypothesize that emergency liquidity is routed via internal capital markets, we also control for *Interbank Borrowing*. Ideally, we would observe bilateral exposures between headquarters and affiliates. These data is unfortunately not directly observed by the central bank, but subsumed in aggregate interbank loans and borrowing reported in the monthly balance sheet statistic (Frey and Kerl, 2015). We specify net interbank assets relative to total assets as a proxy for each German banks intensity of using interbank funds.

3.4 Descriptive statistics and treatment validity

Overall, our final sample comprises monthly data for 217 individual banks in Germany between January 2004 and December 2014 (132 months). Table 3 shows summary statistics for our two main estimation specifications as presented in Section 2.2, separately for banks with a U.S. affiliation (*"treatment group"*) and without U.S. affiliation (*"control group"*).

– Table 3 around here –

Panel A1 includes monthly observations between 2004 and 2014, excluding the *"treatment period"* between December 2007 and April 2010, which form the sample used in the difference-in-differences specification according to Equation (1). The statistics suggest that before and after the emergency facilities were in place, banks in the control and the treatment group offered on average significantly different rates for corporate deposits and loans. Banks without U.S. affiliates earn a lower spread between short-term credit rates and short-term deposit rates and offer on average lower rates for long-term

products. In both groups of banks, there are noticeably fewer observations for long-term deposits, a type of product which is less frequently used by corporate customers as it seems. The two groups of banks also exhibit differences in terms of bank characteristics. Banks in the control group are on average smaller, less reliant on wholesale funding, and exhibit a higher net liquidity balance. Differences in means are shown and tested in the three rightmost columns of the table. Their statistical significance is indicated by standard errors for the t-test for equality of means (SE) and the normalized difference tests according to Imbens and Wooldridge (2009) (ND).

In Panel A2, all observations are restricted to the treatment period between December 2007 and April 2010, which we take a closer look at in Equation (2). During this period we no longer find differences between the two groups for average rates on short-term credits. Furthermore, while the emergency facilities were in place, banks without U.S. affiliation rely more strongly on central bank financing.

The observed differences of mean dependent variables according to either approach bodes, because it indicates that deposit and loan interest rates indeed differed significantly between banks with and without access to U.S. emergency liquidity. However, since observable traits of banks from these two groups are significantly different as well, we are concerned whether any interest rate differential can be validly attributed to the existence of U.S. emergency liquidity or rather represents a spurious correlation between banks that have been systematically different to begin with.

It is important to realize in this context that any differences in the *level* of observables that are fairly time-invariant, such as the sheer size of IBHC relative to purely domestic banks without U.S. liquidity access for example, is fortunately gauged by the rich set of fixed effects specified in both Equations (1) and (2). To ensure that banks from both groups are not exhibiting

a systematically different dynamic development of both dependent variables and covariates, we test the common trend assumption required in our difference-in-difference specification more formally in Panel B.

Specifically, we test wether monthly *changes* of dependent and control variables were different before the introduction of the facilities in Panel B of Table 3. We can see that *prior* to the inception of U.S. emergency facility lines, bank traits did not develop significantly differently. Moreover, short-term rates also developed similarly, while long-term rates only exhibit comparatively small differences in trends. This parallel development of observable bank traits bodes well for our objective to identify the effect of the policy rather than confounding it with observable systematic differences already in place before the policy. The normalized differences test proposed by Imbens and Wooldridge (2009) confirms this finding. We later on confirm our results on a matched sample to further address a potential sampling bias.

– Figure 2 around here –

In our reduced form specification we later on investigate the developments of interest rates in interaction with different bank health characteristics. We take a closer look at the dynamics of interest rates over time dependent on bank stress in Figure 2 to ensure that our findings are not driven by underlying differences in dynamics between stressed and non-stressed banks. Among all banks using the U.S. facilities, we distinguish between banks that at some point during our sample period receive capital injections or asset support (*"stressed banks"*) and those that do not receive support (*"non-stressed banks"*). The left panel in Figure 2 shows the medians of the respective rates for the two groups, which exhibit hardly any differences between 2004 and 2014. This is also confirmed by the right panel, which presents the differences in means together with 95% confidence bands.

4 Results

4.1 Main results

Table 4 reports the baseline estimation results according to Equation (1) in columns (I)-(IV) and according to Equation (2) in columns (V)-(VIII). Consider first short-term rate effects, the primary target of unconventional monetary policy in the form of providing additional liquidity lines, according to the difference-in-differences approach. Column (I) exhibits a significantly negative effect of emergency facility access on short-term deposit rates. The differential impact on the short-term funding cost of banks in Germany with access to U.S. liquidity via the internal capital market of the IBHC amounts to 13.7 basis points. The sample's average short-term interest rate equals 1.6%. Thus, the relative decrease in short-term funding costs is 8.5%, which is economically meaningful.

– Table 4 around here –

This effect is confirmed for the sample that considers responses gauging the intensity of $USAGE$ during the disbursement period in Column (V). The reduction of short-term funding cost of banks in Germany with access to U.S. liquidity via the internal capital market of their IBHC amounts to 2.3 basis points for each percent of emergency funding per total IBHC assets. Given average short-term interest rates on the order of 2.5%, an increase in the reliance on Fed facilities by one standard deviation of $USAGE$ induces a relative reduction in short-term funding costs of around 1% in this sample covering the disbursement period of emergency liquidity. [14]

[14] Distributional moments of estimation samples are provided in the bottom panel of all results tables. Here, we calculate -0.023 $\times$ 1.133 = -0.026/2.533 = 1.03%.

Therefore, German banks with access to Fed liquidity facilities benefited from reduced funding cost both when comparing pre- and post-facility periods as well as during crisis times when the facilities were active. The magnitude of the former effect is economically substantial whereas it is smaller, yet reasonable for the sample covering the disbursement period itself. Irrespective of their size, these statistically significant effects are remarkable as they provide clear evidence for the international transmission of unorthodox monetary policy on the cost of borrowing. Thereby, our micro evidence complements macroeconomic studies concerning the domestic transmission of monetary policy on the cost of borrowing (see, e.g., Gilchrist et al., 2015) as well as bank-level studies documenting the effects of loan volume responses via international banks (as in Cetorelli and Goldberg, 2012a; Schnabl, 2012). [15]

Ideally, the reduction of funding costs of banks should also ease credit terms to corporate customers, an objective presumably more important than easing the funding pressure of banks. Columns (II) and (VI) show insignificant effects on short-term credit rates for those banks with access to U.S. liquidity facilities. This result is in line with Cycon and Koetter (2015), who find that the reduction of internal funding cost of a large commercial bank in response to the ECB's Security Markets Program (SMP) was only partly passed on to customer rates. Instead, they show that interest margins earned by the bank increase.

Columns (III), (IV), (VII), and (VIII) in Table 4 show that banks with access to U.S. facilities do not exhibit significantly different instantaneous long-term loan and deposit rate responses. This result suggests that the emergency facilities in the U.S. were able to relieve short-term pressure in funding markets as intended. But they had no differential effect on the long end of the yield curve faced by banks operating in Germany. As such, internal

[15] We also specified the volumes of marginal lending and funding products that correspond to the interest rates discussed here in the main body of the paper. We find consistently no significant volume responses. Selected results are available in Table C.1 in the Online Appendix.

capital markets of IBHCs appear to be of relevance to transmit monetary policy internationally. But possibly unintended consequences abroad for long-term financing decisions seem to be limited, at least in other developed economies such as the German one.

Since especially the short-run responses to emergency liquidity provisions appear to be robust towards either identification scheme, we focus henceforth on the specification in Equation (2) to investigate interest rate responses also during the disbursement period between May 2007 and December 2010.

4.2 Lagged pass-through

The effect of access to U.S. liquidity facilities on funding and lending rates discussed above assumes that any potential pass-through via internal capital markets of IBHCs occurs swiftly since we specify the contemporaneous usage. However, recent studies investigating the effects of other unorthodox monetary policy on interest rates in variants of a Vector Autoregression setting, such as Boeckx et al. (2017) for the Eurozone, document lagged effects on interest rates in response to quantitative easing of up to four quarters.

– Figure 3 around here –

Therefore, Figure 3 shows estimated coefficients for *USAGE* according to Equation (2) when we specify the scaled amount of used liquidity of each bank's IBHC with up to 12 lags, i.e. one year. The negative effect on deposit rates by banks in Germany with access to U.S. liquidity remains significant up and until one quarter. Short-term customer credit rates, in turn, exhibit an economically significant reduction due to access to U.S. liquidity that is significantly different from zero exactly after three months.

This result might indicate that unorthodox liquidity provision in the U.S. represented a funding advantage to internationally active banks in the very short run. The result for eased credit terms to German corporates after three months is plausible since the renegotiation of terms by banks with their corporate customers likely occurs with some delay. The magnitudes of these effects are not statistically different from each other. On average, funding advantages of banks that are a member of an IBHC with internal capital market access to the U.S. did not result in a competitive advantage in terms of larger markups earned. This result contradicts Berger and Roman (2015), who find that U.S. banks receiving government support (TARP) also gained market power. The absence of competitive distortions due to differential liquidity assistance might reflect that we consider only a part of banks' activities, namely short-term corporate lending. Another reason is that both quantitative easing considered in Cycon and Koetter (2015) and Boeckx et al. (2017) as well as outright equity support of banks as in Berger and Roman (2015) affect banks pricing policies differently compared to liquidity assistance, which we investigate here.

The two graphs in the bottom panels of Figure 3 confirm, in turn, the absence of significant long-run deposit and credit rate responses of corporate customers in Germany. We therefore concentrate henceforth on short-term deposit and credit rates and relegate all corresponding long-term rate regressions to the Online Appendix (Tables C.2 to C.5).

4.3 Bank stress and emergency liquidity

The previous results indicate that the Federal Reserve emergency facilities were successful in lowering short-term funding costs, and thus alleviated funding constraints in times of financial turmoil. But did the significant amount of emergency funds reduce funding constraints for those banks

which were particularly affected by the crisis? And against the backdrop of concerns regarding "bailouts through the backdoor", do we see potentially unintended responses towards larger liquidity uptakes by weaker banks? To analyze if liquidity assistance access exerted differential effects on the rate-setting behavior of more or less stressed banks during the disbursement period, we interact the scaled $USAGE$ of U.S. emergency liquidity with four indicators of pre-policy bank stress and show according results Table 5. [16]

– Table 5 around here –

First, we test in in columns (I) and (II) if rate responses were larger for banks with large pre-crisis ABCP exposure, which indicates a larger need for USD-funding. For these banks U.S. monetary policy should have a potentially larger impact. Quite a few German banks were significantly exposed to the ABCP market, which was one of the first and most severely affected ones during the crisis. Data on end-of-2006 exposure to ABCP and the bank's corresponding end-of-2006 total equity, both measured in billions of USD, are obtained from Acharya et al. (2014). The variable $ABCP$ equals the group's total ABCP balance scaled by group total equity such that we gauge the group's exposure in 1000 USD of ABCP per 1 USD of group equity.

Estimates of the constituent $USAGE$ term corroborate that banks in Germany with access to U.S. liquidity facilities exhibit significantly lower deposit rates. We also find a contemporaneous negative effect on short-term loans of corporates. [17] The interaction term between $USAGE$ and $ABCP$ is significantly positive. To assess the economic magnitude, consider in the two top panels of in Figure 5 the conditional marginal effects of $USAGE$ with respect to short-term deposit and loan rates conditional on the distribution of ABCP exposures across banks in Germany prior to the crisis.

[16] Results for long-term interest rate responses are shown in Table C.2 in the Online Appendix.
[17] Constituent terms of pre-crisis exposure to the ABCP market are absorbed by bank-time fixed effects.

– Figure 4 around here –

The distribution of the ABCP variable is very skewed. The vast majority of IBHC members in Germany had less than 1000 USD of ABCP exposure as a group per 1 USD of group equity. Only a handful of banks were engaged more heavily in this market, which highlights the importance to draw inference not only based on coefficients estimated at the mean of the data. The upper left panel of Figure 4 confirms that short-term deposit rates are significantly reduced across almost the entire ABCP distribution. This reduction of funding cost, however, is no longer different from zero for those member banks of IBHC that were exposed the most to this form of USD-denominated funding. The reduction in short-term credit rates is not significantly different from zero across the entire ABCP distribution. As such, the U.S. facilities helped to reduce short-term funding cost of German banks without extreme USD-funding needs. But corporate bank customers of the most crisis-affected banks did not benefit from U.S. policy.

Second, emergency facilities aimed primarily at easing the funding pressure for banks with an eminent shortage of liquidity. Therefore, we specify in columns (III) and (IV) of Table 5 interaction models with liquidity indicators that we observe at year-end 2007. The point estimates of the constituent terms univocally support the notion that a more intensive use of US liquidity reduced both short-term funding cost of banks and corporates alike. But the interaction terms for deposit and loan rates exhibit contrasting (negative and positive) effects. Consider therefore the total marginal effects conditional on the distribution of net liquid assets relative to total assets before the crisis in the two middle panels of Figure 4. Most banks are in the far left tail of the liquidity distribution. Low liquidity buffers do not indicate bank stress in and of itself – after all, holding relatively few low-yield assets implies more degrees of freedom for the bank to generate income from less liquid assets. The effect of more intensive emergency facility usage on short-term deposit

rates is consistently negative across a wide range of the liquidity distribution. Interestingly, those banks with the least binding liquidity constraints reduced deposit rates the most, indicating a substitution of funding from corporate customers with cheaper funds from U.S. emergency facilities. Indeed, a comparison of ECB liquidity facilities with similar maturities compared to those U.S. facilities investigated here shows that the cost of the former were lower throughout the entire sample period (see Figure C.1). Only for banks with extremely large liquidity buffers, the funding cost reduction due to U.S. facility usage vanishes to differ significantly from zero. Short-term credit rates, in turn, are not significantly reduced.

Our third gauge of bank distress relies on end-of-2007 capitalization levels of banks. The lower panels in Figure 4 corroborate that only the least capitalized banks exhibit the significantly negative effect of U.S. liquidity access on short-term rates. Consistent with the results in Jiménez et al. (2014), additional liquidity appears to be routed to the corporate sector in particular by the weakest banks in the system in terms of lower rates charged on loans. This effect is driven by the least capitalized banks that benefit also the most from emergency liquidity in terms of funding cost reductions.

However, also low levels of capitalization may merely indicate more efficiently managed financial institutions rather than bank stress. As a fourth check, we therefore specify an alternative stress indicator. We use an indicator variable whether and when capital support measures that banks received from their respective governments occurred. Bosma et al. (2017) collect both occurrence and timing of outright equity injections as well as asset support – such as guarantees – received by large European banks. Out of the total of 37 banking groups considered in our sample, we identify on this basis 12 that have received support at some stage during our sample period. These groups are, in turn, associated with 67 out of the 216 banks in our sample, thus also accounting for a sizable share of observations. Columns (VII) and (VIII) in

Table 5 show the according results from these interaction models. These regressions confirm a significant and substantial direct effect of $USAGE$ on the short-term funding cost of banks in Germany of a very similar magnitude as before. Note, that we can now also estimate the constituent terms since the occurrence of support measures varies over time. The total effect of liquidity usage in this specification is then almost entirely mitigated. However, the occurrence of support implies a massive reduction of bank's funding cost by almost one percentage point. The result thus supports the intuition that any direct support of a banking group by its own government reduces funding cost by more than indirect liquidity support from the U.S. via internal capital markets. We interpret the significantly positive interaction terms for both deposit and loan interest rates in sum as an indication that global support in terms of both equity bailouts and liquidity provisioning might significantly reduce funding costs of global banks. However, the lending terms charged to customers of bailed out banks are worse compared to non-rescued banks. This finding casts doubt on the effectiveness of joint equity and liquidity support policies to ease financing conditions for the real economy.

4.4 Treatment validity

4.4.1 Matched control group

Valid inference in our empirical set-up requires, first, that we compare interest rates of banks with and without access to U.S. liquidity that are otherwise sufficiently similar to each other. Second, we want to mitigate the effect of confounding factors other than (U.S.) emergency liquidity that also determine interest rates, e.g. other policies that occurred at the same time.

The former concern is relevant because earlier studies for the German banking sector provide evidence that banks do not enter foreign markets ran-

domly. Only few, fairly larger, productive, and profitable banks set up subsidiaries and branches abroad (see, e.g., Buch et al., 2018). Besides concerns about significantly different observable traits of banks with and without access, there might exist important unobservable differences prior to the policies. For example, banks with affiliates in the U.S. might not only be large, but also more connected in opaque interbank or derivative markets. Such banks might be (perceived) as too-connected-to-fail and enjoy accordingly implicit bail-out guarantees during crisis times (Gatev et al., 2009; Bosma et al., 2017). Such expectations might induce additional inflows of deposits that are responsible for observing lower deposit interest rates.

To address concerns about systematically different samples, we therefore apply propensity score matching as described in Caliendo and Kopeinig (2008) to generate a control group. We match each bank in the treatment group with its nearest neighbor in terms of observables. Using the bank control variables shown in Table 3, we estimate the likelihood to classify a certain bank as having access to U.S. emergency liquidity using a probit model. Thereby, we identify those banks that meet the so-called common support assumption, that is those banks without access to U.S. liquidity that are not significantly different in terms of observables from those with access. We apply the most conservative nearest-neighbor matching. Put differently, we match each treated bank with exactly one bank that is not treated. Subsequently, we re-estimate Equation (2) for the matched sample and report according results in columns (I) and (II) of Table 6.

– Table 6 around here –

To conserve on space, we only show the coefficient for the aggregate $USAGE$ of these facilities. The main result of a decrease in short-term deposit rates remains significant at the 1% level and increases considerably in magnitude. The result suggests a 12 basis point decrease per one percent in facility usage,

which is a six-fold magnitude compared to the baseline results. Hence, once we limit the sample of banks with and without access to U.S. emergency liquidity that are very similar to each other, the effect during the disbursement period of the policy exhibits an economically significant short-term deposit funding cost improvement. Also note that this much more restrictive sample implies that we are able to obtain more precise point estimates of the negative effect of emergency facility $USAGE$ on the rates charged on newly originated short-term loans. This estimate of 10 basis points is only significantly different from zero at the 10%-level of confidence. Yet, it indicates only a partial pass-through of funding cost reductions enjoyed by banks with access to emergency liquidity facilities, which is in line with the micro evidence provided by Cycon and Koetter (2015).

4.4.2 Placebo tests

Next, we address the second issue of potentially confounding factors. To this end, we conduct two falsification tests. Specifically, we re-define two so-called placebo treatments and expect that these non-events contain no statistically significant explanatory power for the observed cross-section of interest rates.

The first placebo treatment pertains to the time dimension of emergency facilities. We hold the identity of IBHCs that are ultimately taking advantage of the policy constant, but pre-date the timing of liquidity facilities by three years. The results pretending an identical cross-sectional distribution across banks in terms of intensity between December 2004 and May 2007 instead of December 2007 and May 2010 is shown in columns (III) and (IV) of Table 6. The results are not significantly different from zero. This outcome supports the inference that the estimated negative relationship of short-term interest rates and the usage of bank i of a U.S. facility in month m is not spurious.

But as Figure 1 illustrates the intensity of usage changed over time. Since it also exhibits considerably variation across banks at any given moment in time, we assign as a second placebo test the observed volumes of used facilities randomly across banks during the time of treatment. The according results are shown in columns (V) and (VI) of Table 6 and confirm as well the absence of differential effects on both short- and long-term interest rates between banks in Germany with versus banks without access to U.S. liquidity facilities.

In sum, these results strongly support the validity of our approach to use a reduced form estimation. Likewise, Table C.3 in the Online Appendix confirm the robustness of (non-)results for long-term interest rates.

4.5 Alternative treatment definitions

We consider alternative differential effects, for which we present results in the Appendix in Tables B.1 and B.2. The different subsamples used in these regressions are illustrated in Figure A.1.

The presence of government-owned savings banks is a fairly specific feature of the German banking industry. Therefore, we scrutinize first how alternative treatment definitions of networks between savings banks and Landesbanken determine our headline reported results. Contrary to the baseline identification, we therefore treat all savings banks in our sample as independent from their Landesbank's IBHC and assume that regional savings banks have no longer access to U.S. funding facilities and are thus part of the control group.

The results in columns (I) and (II) of Table B.1 clearly illustrate that our results are not driven by the large number of regional savings banks, which we consider as supported by U.S. liquidity facilities via their Landesbank.

We continue to estimate a contemporaneous reduction of deposit rates in response to the usage of U.S. facilities by 2.2 basis points, which is very close to the estimated baseline effect.

In columns (III) and (IV) we tackle concerns that local cooperative banks might also be subject to implicit or even explicit liquidity backstops by the central head institutions, which in turn might have routed tapped U.S. liquidity. The result clearly shows that all effects remain intact even when treating all cooperative banks as supported.

Besides the head institutions of the savings and cooperative banking sector, our sample features some very large commercial banks. These banks are exposed to numerous policy in Germany, the U.S., but also elsewhere given their global reach. Given the particular challenge to identify the effect of any single policy for such mega-banks, we exclude these very large banks in columns (V) and (VI) of Table B.1. The coefficient of interest remains significantly negative for short-term deposits and is virtually identical in size compared to the baseline findings. Likewise, the effects for short-term credit rates as well as any long-term responses (see Table C.4 in the Online Appendix) remain insignificant.

These results together therefore strongly suggest that internal capital markets are an important channel through which in particular smaller banks might benefit from additional liquidity tapped by U.S. members of the IBHC.

4.5.1 Effect on German IBHC banks and IBHC heads

Figure A.1 highlights the numerous possible alternatives how to define IBHC and thus access to U.S. liquidity via internal capital markets. Our previous results were obtained under the assumption that both affiliates of German IBHCs and affiliates of non-German IBHCs were equally affected by

transfers of supporting funds through internal capital markets. But De Haas and Van Horen (2012) provide evidence of a pronounced home-country bias in the internal capital market allocation considerations of global banks. Therefore, foreign banks on German soil with access to funding may not be affected in the same way as German banks that are headquartered in this market. Therefore, we exclude banks in Germany that are part of non-German IBHC (that is subsamples *(c)* and *(d)*) in Figure A.1) from the sample. The results in columns (I) and (II) in *Panel A* of Table B.2 confirm the baseline reduction of short-term deposit rates. [18]

We further show the differential impact between German and non-German IBHC banks within the subsample of banks with access to the U.S. emergency funding support (subsamples *(b)*, *(c)*, and *(d)* in Figure A.1) in columns (III) and (IV) in *Panel A* of Table B.2. Using the original baseline regression approach, we redefine our treatment variable *USAGE* to represent the scale of funding received for German IBHC banks only, and zero for all other banks. The estimated coefficient for short-term deposits exhibits virtually identical results compared to the baseline. The exclusion of two affiliates of U.S. IBHCs and seven affiliates of other than German or U.S. IBHCs do not impair the precise estimation of our liquidity shock effect.

U.S. funding support possibly had an even stronger effect on head companies of German IBHCs with an affiliate in the U.S. Unlike the other banks in the IBHC, they have direct control over the U.S. affiliate, and therefore a more direct access to the provided liquidity. We therefore re-define access to emergency liquidity only for the heads of German IBHCs (subsample *(e)* in Figure A.1) and analyze the effect compared to the original control group in *Panel B*, columns (I) and (II) of Table B.2. The results once more corroborate the baseline findings, with both increased significance and magnitude for short-term rates. The heads of German IBHC lowered their short-term de-

[18] Results for long-term interest rate responses are shown in Table C.5 in the Online Appendix.

posit rates and short-term rates by more than their respective subsidiaries, indicating that they exert more control over the received liquidity. Also note that for the comparison of heads of IHBC with access to U.S. liquidity to any bank without access (Column(II) in *Panel B*) we confirm again a statistically significant reduction of short-term loan rates as well. As before, the magnitude of this effect is slightly smaller than the deposit rate response. This outcome points towards partial policy transmission of reduced funding funding cost to the real economy, which we also found for the baseline comparison in the matched sample before.

In analogy, we restrict our sample in columns (III) and (IV) of *Panel B* to all banks of German IBHCs with affiliates in the U.S. to analyze the difference in impact between direct funding access (heads) and indirect access (subsidiaries). The new sample consists of subsamples *(e)* and *(f)* in Figure A.1. The variable *USAGE* in this context remains the share of funds obtained for head companies, and is zero for subsidiaries. The coefficient of interest is then significantly negative, indicating that direct access to U.S. facilities relative to indirect access yields statistically significant responses in terms of corporate deposit rates. Possibly, internal capital markets are less efficient in re-allocating liquidity compared to the possibility of more direct transfers.

4.6 Further robustness tests

The definition which banks had access to U.S. emergency facilities is crucial. Therefore, we conducted a number of further robustness tests that are available in the Online Appendix, Tables C.6 to C.11. Three main issues arise.

First, we provide further tests for differences in credit demand and deposit supply across the regional markets faced by banks. We therefore also specified regional unemployment, state×quarter fixed effects, and both at the

same time in Tables C.6 through C.8 to gauge both observable and unobservable factors. Results remain qualitatively identical.

Second, in addition to excluding all large banks from each of the three German banking sectors – commercial, savings, and cooperative – as before, we also estimated specifications where we drop each sector one-by-one as well as all combinations of pairs. Tables C.9 and C.10 report the associated results, which are qualitatively identical.

Finally, we scale the amount of $USAGE$ by an individual bank's size relative to the IBHC headquarter size to gauge the relative importance of the bank using emergency facility support within the group in Table C.11. Again, results remain qualitatively unaffected.

5 Conclusions

We test whether access to U.S. emergency liquidity, which was available between December 2007 until April 2010 to domestic financial institutions and affiliates of non-U.S. banks alike, transmitted via internal capital markets of international bank holding companies (IBHC). We ask specifically, whether the usage of such emergency liquidity affected interest rate setting outside the U.S. banking market. To track this international interest rate transmission, we first identify banks that used U.S. liquidity assistance and trace their connections via IBHCs to affiliates that operate in Germany. For this market, we observe detailed monthly pricing of new lending and deposit taking reported by a representative sample of banks to the German central bank since January 2004.

We use two empirical approaches to test for interest rate setting responses. First, we employ a difference-in-differences set-up to compare deposit and

loan rates set by banks with access to U.S. liquidity through the internal capital markets of their IBHC to those set by banks without such access after the liquidity programs stopped in April 2010. Second, we assess whether the intensity of using emergency liquidity during the disbursement period to estimate whether the (scaled) volume of used liquidity also reduced the funding cost of banks and subsequently the credit cost to corporate borrowers outside the U.S..

Both approaches univocally suggest a significant reduction of short-term deposit rates both during and after the U.S. emergency facilities were active. The economic magnitude of this effect is relatively small though. Our preferred point estimates imply that an increase in the intensity of using U.S. emergency liquidity by one standard deviation reduced the short-term funding cost of connected German banks by 1%. This effect is statistically significant for up to a quarter after usage of U.S. emergency liquidity. Short-term credit rates, in turn, do not decline contemporaneously. But we do find evidence of a similar mild decline with a lag of exactly one quarter. Thus, unorthodox U.S. monetary policy did not only succeed in reducing funding pressure in the U.S., but also helped to alleviate such constraints abroad in a large, developed banking system like Germany.

We do not find any evidence of a response in long-term rates, neither on deposits from nor loans demanded by German corporate customers. This result indicates that U.S. liquidity assistance did not reduce long-term risk premia outside the home market. Likewise, we do not find evidence for any significant volume response of German banks in response to U.S. emergency liquidity.

We also tackle expressed concerns that liquidity programs to support banks were used especially by the weakest institutions, thereby representing possibly "bailouts through the backdoor". Therefore, we test whether banks

that either exhibited potential indications of stress just prior to the start of the programs or actually received government support after the collapse of Lehman Brothers 2008 showed signs of significantly different interest rate responses. The main upshot from these tests is that across all measures of possible ex-ante indications of stress the reduction of funding cost and (partial) transmission to reduced lending rates is confirmed.

These findings are robust to the construction of control groups of banks that have no access to U.S. emergency liquidity with matching techniques or falsification exercises. A range of alternative definitions of access to U.S. liquidity based on different sampling and treatment of IBHC structures leaves our main findings intact, too.

In sum, our results support the view that unorthodox monetary policy in the form of emergency liquidity assistance in the U.S. also transmitted via internal capital markets of IBHCs to other developed markets, and helped to alleviate short-term funding pressure.

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Figures

Figure 1. **Total size of funding facilities**
The area shows the total balance outstanding of all six Federal Reserve funding facilities (TAF, PDCF, TSLF, AMLF, CPFF, STOMO) and the Discount Window in billion USD (left scale) from December 2007 to April 2010. Lines indicate the balance in % of annual total U.S. GDP and U.S. financial sector GDP, respectively (right scale). GDP data source: OECD.

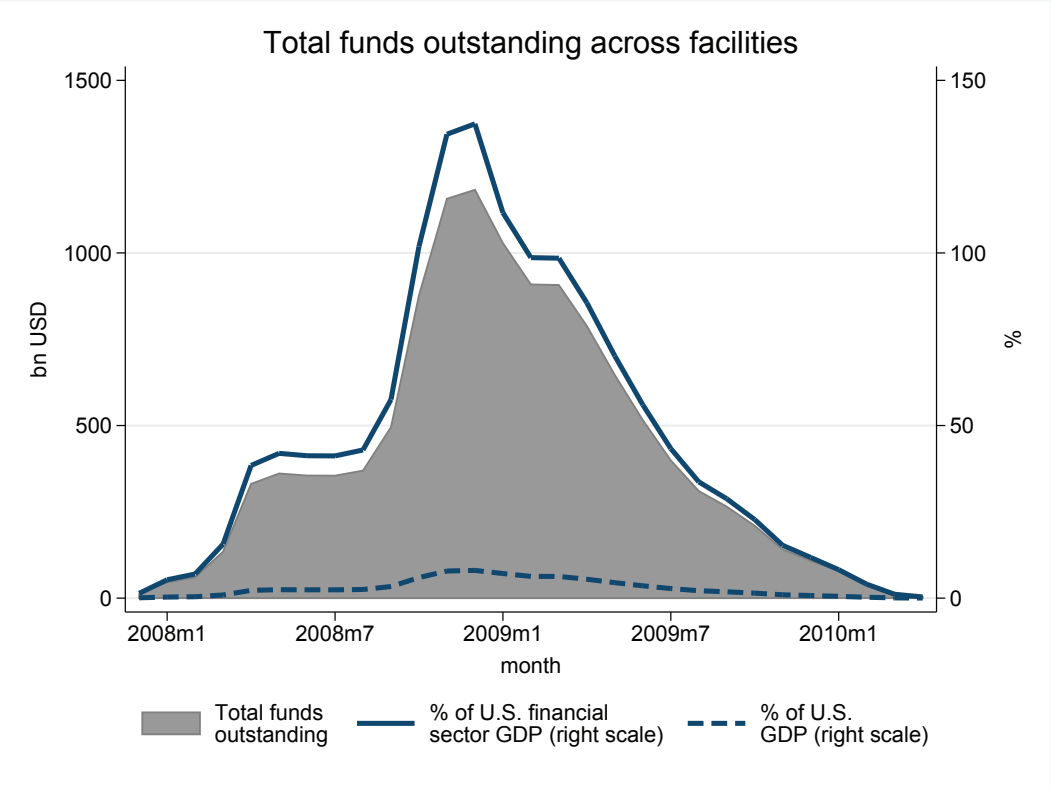


Figure 2. **Development of interest rates for stressed and non-stressed banks with U.S. affiliation**
The left panels show the development of the respective median interest rates separately for stressed and non-stressed banks with U.S. affiliation. A bank is defined as stressed, whenever it received capital injections or asset support at some point in time during our sample period. The corresponding right panels show the difference in means together with the 95% confidence bands. All values in percentage points.

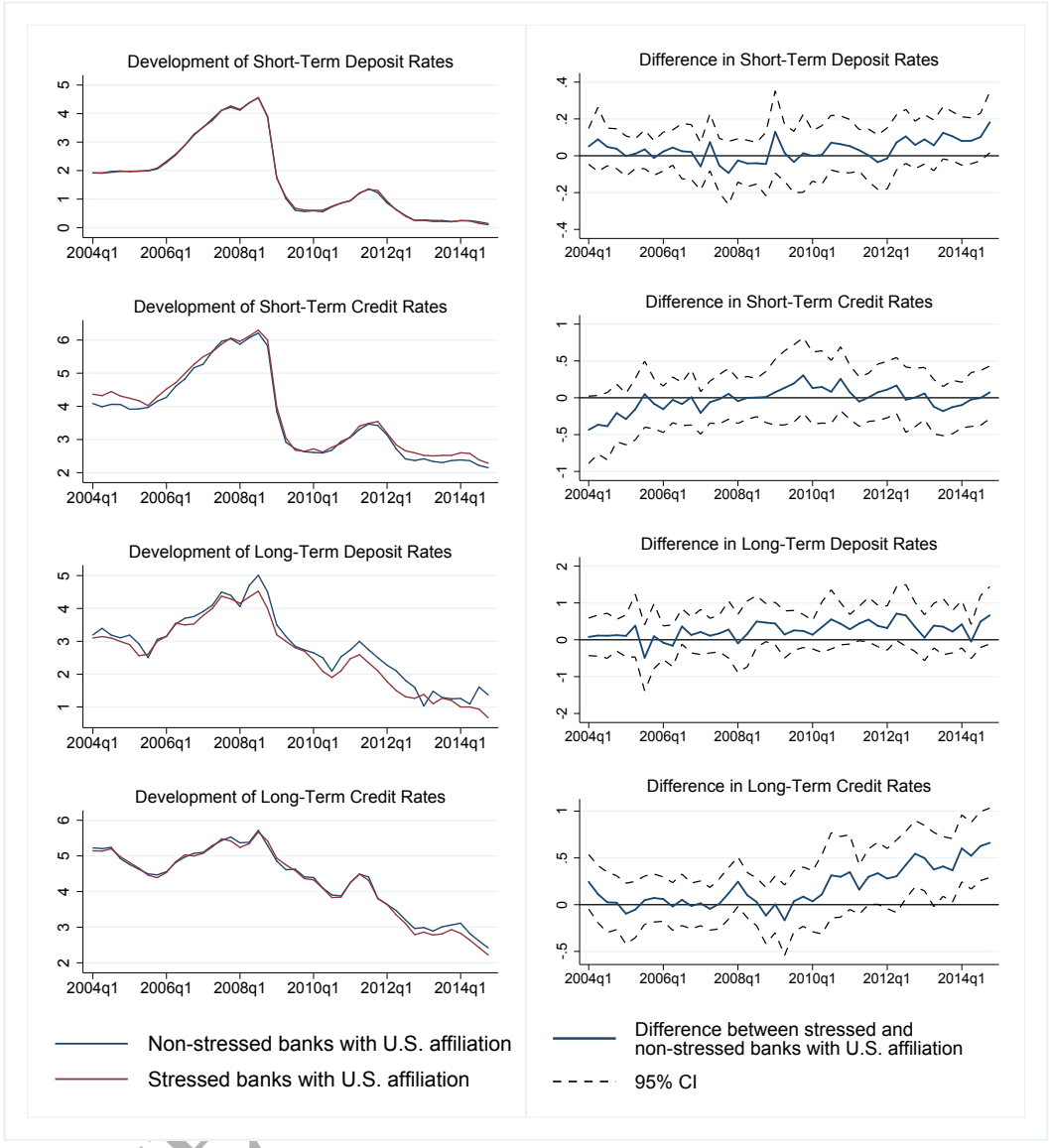


Figure 3. **Lagged effects of access to funding facilities on corporate products**
Graphs illustrate the regression coefficient and the 95% confidence intervals for different time lags of *USAGE*. Coefficients are obtained from OLS regressions on the complete sample of 217 banks, with the treatment variable *USAGE* lagged between 1 and 12 months. All regressions include control variables lagged by one additional month and winsorized at 1% on both ends, as well as bank × semi-annual fixed effects and month fixed effects. Confidence intervals are based on two-way clustered standard errors by bank and month. Rates are reported in %.

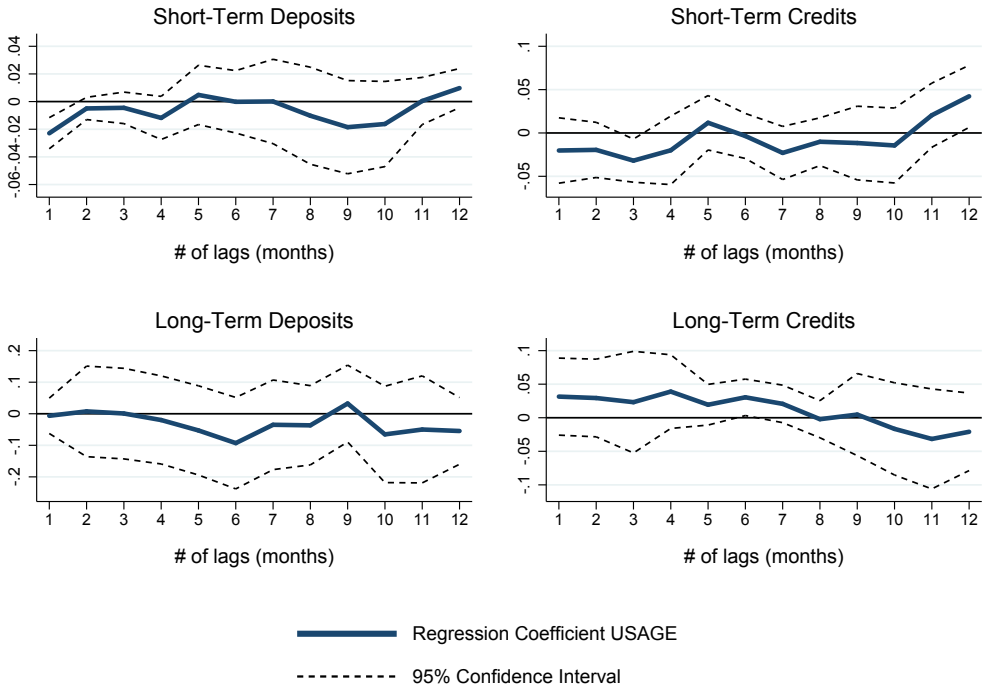
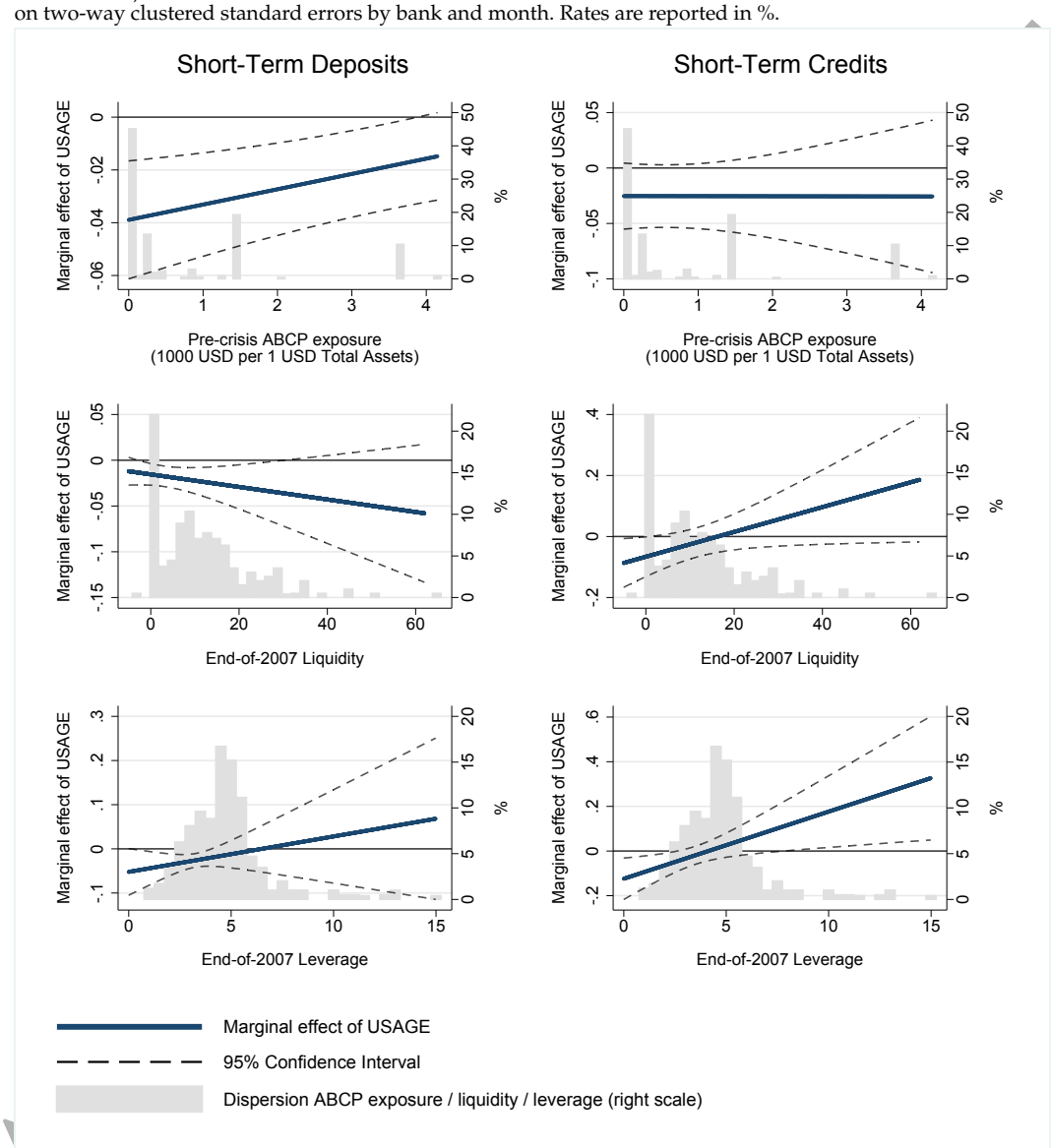


Figure 4. **Effects of facility funds on corporate products conditional on bank stress characteristics**
Graphs illustrate the marginal effect of the treatment variable *USAGE* conditional on pre-crisis ABCP exposure, end-of-2007 liquidity, and end-of-2007 leverage. Marginal effects are calculated based on the OLS regression results presented in Table 5. The regression includes control variables lagged by one month and winsorized at 1% on both ends, as well as bank × semi-annual fixed effects and month fixed effects. Confidence intervals are based on two-way clustered standard errors by bank and month. Rates are reported in %.



Tables

Table 1
Description of variables
Dependent variables are monthly interest rates reported by individual banks to Deutsche Bundesbank's *Zinsstatistik* (interest rate report). All rates are in % and calculated as averages of the total respective month's newly generated business. Control variables are constructed form Deutsche Bundesbank's monthly balance sheet and liquidity reports.

Variable	Description
Dependent Variables	
Short-Term Deposits	Short-term deposits from non-financial corporations, with maturities < 1 year
Short-Term Credits	Short-term credit to non-financial corporations of up to one million EUR with maturities < 1 year
Long-Term Deposits	Long-term deposits from non-financial corporations with maturities > 2 years
Long-Term Credits	Long-term credit to non-financial corporations up to one million EUR with maturities > 5 years
Treatment and Interaction Variables	
AFFILIATE	Dummy equal to 1 for all banks with an affiliated bank in the U.S.
POST	Dummy equal to 1 during the period after emergency facilities have been active (after April 2010)
USAGE	Federal Reserve funds outstanding across all emergency facilities in percent of total IBHC group assets
ABCP	End-of-2006 balance of ABCPs in thousands of EUR over total total IBHC group equity
LIQUIDITY 2007	End-of-2007 Liquidity (as defined below)
LEVERAGE 2007	End-of-2007 Leverage Ratio (as defined below)
SUPPORT	Dummy equal to 1 for banks receiving capital injections or asset support during the month or after support was received
Control Variables	
Bank Size	ln(Total Assets)
Wholesale Funding	(Securitized Liabilities)/(Total Assets) $\times$ 100
Leverage Ratio	(Total Equity)/(Total Assets) $\times$ 100
Latent Liabilities	(Latent Liabilities)/(Total Assets) $\times$ 100
Liquidity	(30-day Net Liquidity Balance)/(Total Assets) $\times$ 100 The numerator equals the difference between the sum of all assets and liabilities with a maturity of up to 30 days. The following assets and liabilities are only included in part: non-market-valued securities (80-90%), money market funds (90%), daily available deposits from non-bank clients (10%), daily available deposits from other banks (40%), savings accounts (20%), liabilities to savings or cooperative banks (20%), latent liabilities (5-20%), approved loans (12-20%).
Central Bank Liabilities	(Net Central Bank Liabilities)/(Total Assets) $\times$ 100 The numerator equals central bank liabilities of up to 1 year maturity less central bank deposits.
Interbank Borrowing	(Net Liabilities to Other Financial Institutions)/(Total Assets) $\times$ 100

Table 2

Funds received from individual facilities

Overview of the average monthly balance outstanding to the different Federal Reserve funding facilities and the Discount Window between December 2007 and April 2010 (29 months) in million EUR. *USAGE* is measured as Federal Reserve funds outstanding in percent of group total assets. The sample includes only IBHCs with headquarters and/or affiliates in Germany, i.e. funds having a link to banks in Germany. In the column labelled *Users*, we show the average number of IBHCs that use the facility during any given month.

Facility	N	Users	Mean	SD	p5	p50	p95
Term Auction Facility (TAF)	667	13.55	1,536.82	2,680.31	0.00	239.21	7,394.44
Commercial Paper Funding Facility (CPFF)	667	4.21	347.70	1,398.78	0.00	0.00	1,853.03
Single Tranche Open Market Operations (STOMO)	667	0.83	108.19	936.44	0.00	0.00	0.00
Term Securities Lending Facility (TSLF)	667	1.55	519.37	2,757.93	0.00	0.00	191.57
Primary Dealer Credit Facility (PDCF)	667	0.41	112.06	1,050.63	0.00	0.00	0.00
ABCP Money Market Mutual Fund Liq. Facility (AMLF)	667	0.45	3.57	37.65	0.00	0.00	0.00
Discount Window (DW)	667	2.62	415.09	2,276.29	0.00	0.00	1,374.47
Total Balance	667	16.03	3,042.80	6,956.12	0.00	674.93	13,261.58
USAGE	667	21.48	7.10	17.90	0.00	1.12	46.12

Table 3. **Summary statistics**

The table presents summary statistics of dependent variables and control variables for banks with access to Federal Reserve funding facilities ('treatment group') and without access ('control group'), as well as the respective differences in means. The sample is composed of monthly data ranging from January 2004 to December 2014 (132 months) and contains up to 217 individual banks. *Panel A1* excludes the 29 months in which the facilities were in operation (December 2007 to April 2010), *Panel A2* shows summary statistics for the treatment period only (December 2007 to April 2010). *Panel A1* thus corresponds to the sample of the regressions in columns (I) to (IV) in Table 4 and *Panel A2* corresponds to those in in columns (V) to (VIII) of the same table. *Panel B* illustrates the average growth rates in the period before the facilities were introduced, as well as the respective differences in means. Rates are average monthly interest rates on newly generated business in %. Short-term includes maturities of up to one year, long-term deposits refer to maturities over two years, long-term credits to maturities over five years. Credits are all credits of up to one million EUR in size. Control variables are *Bank Size*, given by ln(Total Assets), *Leverage Ratio* (Total Equity in % of Total Assets), *Wholesale Funding* (Securitized Liabilities in % of Total Assets), *Latent Liabilities* (Latent Liabilities in % of Total Assets), *Liquidity* (Difference of 30-day Assets and 30-day Liabilities in % of Total Assets), *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets), and *Interbank Borrowing* (Net Liabilities outstanding to other financial institutions in % of Total Assets), all winsorized by 1% on both sides. SE reports the standard error of the t-test for equality of means, $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. Differences in bold print indicate insignificance according to the normalized differences test (ND) proposed by Imbens and Wooldridge (2009).

	Treatment Group						Control Group						Differences		
	N	Mean	SD	p5	p50	p95	N	Mean	SD	p5	p50	p95	Means	SE	ND
Panel A1: Excluding period with active facilities (without December 2007 – April 2010)															
Short-term deposits	10,368	1.520	1.188	0.093	1.327	3.897	4,864	1.584	1.161	0.140	1.400	3.915	-0.064***	0.020	0.038
Short-term credits	11,004	3.780	1.454	1.847	3.623	6.222	4,718	3.663	1.445	1.727	3.451	6.192	0.117***	0.025	-0.057
Long-term deposits	3,383	2.666	1.278	0.591	2.700	4.635	1,575	2.368	1.119	0.666	2.394	4.210	0.298***	0.038	-0.176
Long-term credits	10,332	4.164	1.222	2.272	4.252	5.968	4,513	3.943	1.153	2.147	3.966	5.716	0.221***	0.021	-0.131
Bank Size	13,053	23.011	1.394	21.432	22.579	26.073	7,614	22.117	0.979	20.891	21.947	24.400	0.894***	0.018	-0.525
Wholesale Funding	10,914	10.817	15.488	0.088	4.121	48.207	6,151	7.080	10.075	0.018	3.264	26.488	3.737***	0.220	-0.202
Leverage Ratio	13,053	5.117	2.360	1.895	4.869	10.140	7,614	4.873	2.022	2.353	4.658	7.814	0.244***	0.032	-0.078
Latent Liabilities	12,918	2.888	3.737	0.016	1.929	10.163	7,613	2.334	2.946	0.032	1.631	7.369	0.554***	0.050	-0.116
Liquidity	13,053	15.543	11.458	2.475	12.746	38.207	7,614	18.407	11.939	3.463	16.164	41.798	-2.864***	0.168	0.173
Central Bank Liabilities	13,053	0.107	2.845	-2.569	-0.589	5.855	7,614	-0.207	2.517	-2.781	-0.760	4.890	0.314***	0.039	-0.083
Interbank Borrowing	13,053	8.071	18.927	-16.332	7.877	35.111	7,614	2.001	12.690	-16.437	0.896	23.171	6.070***	0.244	-0.266
Panel A2: Period with active facilities (December 2007 – April 2010)															
Short-term deposits	2,725	2.505	1.722	0.342	2.115	4.733	1,239	2.664	1.652	0.430	2.537	4.806	-0.159***	0.058	0.067
Short-term credits	2,862	4.547	1.809	2.034	4.558	7.058	1,062	4.617	1.686	2.174	4.623	6.904	-0.070	0.064	0.028
Long-term deposits	1,127	3.468	1.136	1.900	3.381	5.318	515	3.341	0.998	2.000	3.126	4.836	0.126**	0.058	-0.084
Long-term credits	2,781	4.973	0.863	3.582	4.974	6.260	1,107	4.874	0.871	3.537	4.857	6.134	0.099***	0.031	-0.081
Bank Size	3,666	23.066	1.412	21.511	22.615	26.191	2,162	22.123	0.966	20.925	21.985	24.426	0.943***	0.034	-0.551
Wholesale Funding	3,188	11.354	14.922	0.212	5.100	45.503	1,798	7.572	9.329	0.009	4.659	23.937	3.782***	0.389	-0.215
Leverage Ratio	3,666	4.891	2.076	1.983	4.790	8.549	2,162	4.654	2.013	2.203	4.571	7.560	0.237***	0.056	-0.082
Latent Liabilities	3,656	3.151	4.060	0.016	1.956	11.783	2,162	2.606	3.457	0.029	1.759	7.175	0.545***	0.104	-0.102
Liquidity	3,666	14.948	11.234	2.567	11.922	37.429	2,162	17.356	11.548	3.555	14.481	40.706	-2.408***	0.308	0.149
Central Bank Liabilities	3,666	0.857	3.463	-2.221	-0.242	8.419	2,162	1.794	4.219	-2.726	0.223	11.847	-0.938***	0.102	0.172
Interbank Borrowing	3,666	7.519	20.107	-22.556	7.579	35.619	2,162	1.486	13.947	-18.781	0.048	24.540	6.033***	0.490	-0.247
Panel B: Growth rates before introduction of facilities (before December 2007)															
Short-term deposits	4,548	0.026	0.165	-0.085	0.013	0.135	1,899	0.027	0.165	-0.110	0.013	0.171	**-0.001**	0.005	0.006
Short-term credits	4,678	0.030	0.263	-0.272	0.010	0.391	1,638	0.029	0.390	-0.224	0.009	0.305	**0.001**	0.009	-0.002
Long-term deposits	906	0.050	0.392	-0.388	0.000	0.596	349	0.010	0.164	-0.181	0.000	0.216	0.040*	0.022	-0.094
Long-term credits	4,438	0.013	0.168	-0.211	0.001	0.262	1,504	0.023	0.247	-0.239	0.004	0.330	-0.010*	0.006	0.035
Bank Size	6,099	0.000	0.002	-0.001	0.000	0.002	3,528	0.000	0.002	-0.002	0.000	0.002	**-0.000**	0.000	0.008
Wholesale Funding	5,260	0.004	0.188	-0.070	0.000	0.062	3,092	-0.000	0.127	-0.083	-0.002	0.076	**0.005**	0.004	-0.021
Leverage Ratio	6,099	0.003	0.053	-0.040	-0.000	0.049	3,528	0.003	0.074	-0.045	-0.001	0.055	**-0.001**	0.001	0.006
Latent Liabilities	6,030	0.036	1.452	-0.092	-0.003	0.111	3,527	0.029	0.832	-0.102	-0.004	0.113	**0.006**	0.027	-0.004
Liquidity	5,961	0.108	3.241	-0.367	0.000	0.524	3,360	0.055	0.776	-0.382	-0.000	0.516	**0.053**	0.057	-0.016
Central Bank Liabilities	5,908	1.669	93.993	-1.531	-0.021	2.259	3,359	1.497	74.858	-1.520	-0.017	1.982	**0.173**	1.892	-0.001
Interbank Borrowing	6,099	-0.005	8.805	-0.518	-0.004	0.461	3,528	-0.094	3.811	-1.117	-0.009	0.920	**0.090**	0.156	-0.009

Table 4

Impact of Federal Reserve emergency funding on deposit and credit rates

Regression results for deposits from and credits to non-financial corporations. The sample is composed of monthly data ranging from January 2004 to December 2014 (132 months). Columns (I)-(IV) present results for a difference-in-differences regression comparing the period before the introduction of the facilities (before December 2007) to the period after the facilities (after April 2010). *AFFILIATE* is a dummy variable equal to one if a bank's IBHC operates an affiliate bank in the U.S. and zero otherwise, and *POST* is a dummy variable equal to one for the period after emergency funding has occurred (i.e. after April 2010) and zero otherwise. Columns (V)-(VIII) show regression results for the treatment period (December 2007 to April 2010) dependent on actual facility usage. *USAGE* is measured as Federal Reserve funds outstanding in percent of group total assets and its descriptive statistics below the regression pertain to the period between December 2007 and April 2010. Rates are average monthly interest rates on newly generated business in %. Short-term includes maturities of up to one year, long-term deposits refer to maturities over two years, long-term credits to maturities over five years. Credits are all credits of up to one million EUR in size. Control variables are *Bank Size*, given by ln(Total Assets), *Leverage Ratio* (Total Equity in % of Total Assets), *Wholesale Funding* (Securitized Liabilities in % of Total Assets), *Latent Liabilities* (Latent Liabilities in % of Total Assets), *Liquidity* (Difference of 30-day Assets and 30-day Liabilities in % of Total Assets), *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets), and *Interbank Borrowing* (Net Liabilities outstanding to other financial institutions in % of Total Assets), all winsorized by 1% on both sides and lagged by one month. All regressions include month fixed effects and bank fixed effects or bank × semi-annual fixed effects. SE two-way clustered by bank and month in parantheses; $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$.

	Difference-in-differences				Reduced form			
	Short-Term		Long-Term		Short-Term		Long-Term	
	Deposits	Credits	Deposits	Credits	Deposits	Credits	Deposits	Credits
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
AFFILIATE x POST	-0.137***	0.090	0.024	-0.052				
	(0.047)	(0.133)	(0.108)	(0.065)				
USAGE					-0.023***	-0.026	0.033	0.023
					(0.007)	(0.023)	(0.073)	(0.023)
Bank Size	0.029	-0.155	0.184	0.058	0.005	0.435	1.040	-0.455
	(0.057)	(0.200)	(0.156)	(0.100)	(0.182)	(0.406)	(1.078)	(0.520)
Wholesale Funding	-0.006**	-0.006	0.000	-0.005	0.012	0.015	-0.056	0.025
	(0.003)	(0.008)	(0.008)	(0.004)	(0.009)	(0.015)	(0.037)	(0.030)
Leverage Ratio	0.011	0.022	0.114***	0.014	0.012	0.078	0.017	-0.153
	(0.015)	(0.035)	(0.041)	(0.025)	(0.034)	(0.084)	(0.138)	(0.137)
Latent Liabilities	0.001	-0.013	-0.019	-0.017**	0.003	0.006	-0.025	0.023*
	(0.003)	(0.012)	(0.013)	(0.009)	(0.005)	(0.012)	(0.015)	(0.013)
Liquidity	0.001	0.006*	-0.003	0.001	0.001	0.000	0.010	0.000
	(0.001)	(0.004)	(0.003)	(0.003)	(0.002)	(0.004)	(0.010)	(0.004)
Central Bank Liabilities	0.006**	-0.004	0.014	-0.002	0.002	0.006	0.009	0.007
	(0.003)	(0.009)	(0.012)	(0.007)	(0.004)	(0.010)	(0.025)	(0.010)
Interbank Borrowing	-0.003**	0.002	-0.003	0.003	0.002	-0.002	0.002	0.004
	(0.001)	(0.004)	(0.006)	(0.002)	(0.003)	(0.006)	(0.014)	(0.005)
R^2 (within)	0.31	0.28	0.30	0.27	0.70	0.67	0.64	0.50
N	13,597	13,956	4,489	13,421	3,827	3,774	1,568	3,737
Estimation sample properties								
# of banks	194	188	177	193	149	142	139	146
# of treated banks	122	124	114	124	101	102	95	100
Dependent variable Mean	1.595	3.757	2.610	4.068	2.533	4.519	3.430	4.913
Dependent variable SD	1.191	1.406	1.234	1.139	1.700	1.718	1.066	0.817
USAGE mean					0.587	0.629	0.549	0.583
USAGE SD					1.133	2.024	0.924	1.080
Bank FE	Yes	Yes	Yes	Yes	No	No	No	No
Bank x semi-annual FE	No	No	No	No	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5

Access to funding facilities and bank characteristics

Regression results for short-term deposits from and credits (< 1 year) to non-financial corporations. The sample is composed of monthly data ranging from December 2007 to April 2010 (29 months). *USAGE* is measured as Federal Reserve funds outstanding in percent of group total assets. Columns (I) and (II) show the effect of facility usage dependent on pre-crisis ABCP exposure, where *ABCP* refers to the end-of-2006 balance of ABCPs in thousands of EUR per total group equity. Regressions in columns (III) to (VI) estimate the effect based on pre-crisis bank liquidity and leverage, with *LIQUIDITY 2007* and *LEVERAGE 2007* being the end-of-2007 levels of liquidity and leverage, respectively, as defined in the control variables below. In columns (VII) and (VIII) *SUPPORT* is a dummy equal to 1 for banks receiving capital injections or asset support during the month or after support was received as collected by Bosma et al. (2017). Rates are average monthly interest rates on newly generated business in %, credits are all credits up to one million EUR in size. Control variables are *Bank Size*, given by ln(Total Assets), *Leverage Ratio* (Total Equity in % of Total Assets), *Wholesale Funding* (Securitized Liabilities in % of Total Assets), *Latent Liabilities* (Latent Liabilities in % of Total Assets), *Liquidity* (Difference of 30-day Assets and 30-day Liabilities in % of Total Assets), *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets), and *Interbank Borrowing* (Net Liabilities outstanding to other financial institutions in % of Total Assets). All regressions include bank × semi-annual fixed effects and month fixed effects, as well as control variables winsorized by 1% on both sides and lagged by one month. SE two-way clustered by bank and month in parantheses; $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$.

	ABCP		Liquidity		Leverage		Support	
	Short-Term		Short-Term		Short-Term		Short-Term	
	Deposits	Credits	Deposits	Credits	Deposits	Credits	Deposits	Credits
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
USAGE	-0.039***	-0.025*	-0.015***	- 0.066**	-0.052*	-0.124**	-0.030***	-0.032
	(0.010)	(0.014)	(0.003)	(0.032)	(0.027)	(0.046)	(0.004)	(0.022)
ABCP x USAGE	0.006***	-0.000						
	(0.002)	(0.007)						
Liquidity 2007 x USAGE			-0.001**	0.004**				
			(0.000	(0.002)				
Leverage 2007 x USAGE					0.008	0.030**		
					(0.008)	(0.012)		
SUPPORT							-0.092**	0.002
							(0.040)	(0.042)
SUPPORT x USAGE							0.032*	0.038*
							(0.018)	(0.022)
R^2 (within)	0.70	0.67	0.70	0.67	0.70	0.67	0.70	0.67
N	3,672	3,634	3,672	3,634	3,672	3,634	3,672	3,634
Estimation sample properties								
# of banks	145	139	145	139	145	139	145	139
# of treated banks	98	101	98	101	98	101	98	101
Dependent variable Mean	2.464	4.455	2.464	4.455	2.464	4.455	2.464	4.455
Dependent variable SD	1.690	1.708	1.690	1.708	1.690	1.708	1.690	1.708
USAGE Mean	0.606	0.619	0.606	0.619	0.606	0.619	0.606	0.619
USAGE SD	1.152	1.182	1.152	1.182	1.152	1.182	1.152	1.182
ABCP Mean	1.133	1.135						
ABCP SD	1.299	1.273						
LIQUIDITY 2007 Mean			10.510	11.109				
LIQUIDITY 2007 SD			8.497	8.931				
LEVERAGE 2007 Mean					4.503	4.470		
LEVERAGE 2007 SD					1.449	1.490		
SUPPORT Mean							0.279	0.283
SUPPORT SD							0.449	0.451
Bank x semi-annual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

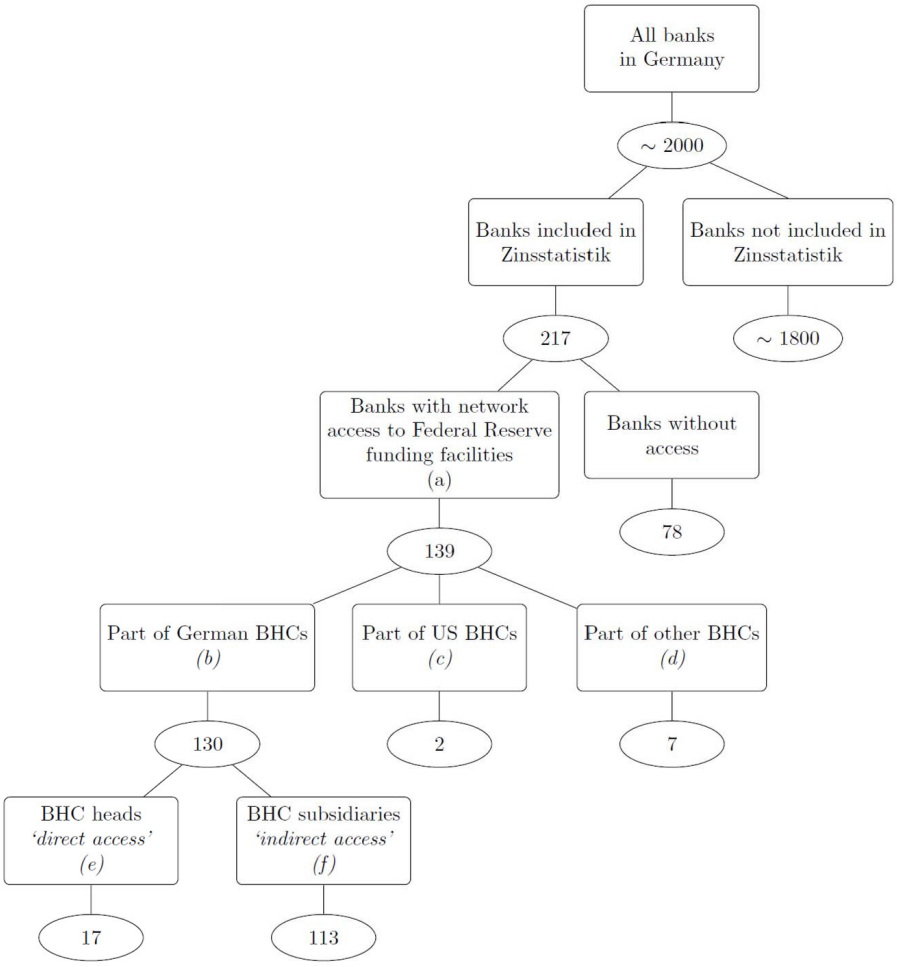
Table 6
Robustness of results
Regression results for short-term deposits from and credits (< 1 year) to non-financial corporations. The sample is composed of monthly data ranging from December 2007 to April 2010 (29 months). Columns (I) and (II) show regression results for deposits a sample matched by propensity score matching. Banks in the treatment group are matched with their nearest neighbor in the control group. Banks without a match or common support are dropped from the original sample. Columns (III) and (IV) present placebo-test results, in which the actual usage of emergency lending facilities has been pre-dated by three years (2004-2007). In columns (V) and (VI) the actual usage of emergency facilities has been randomly re-assigned among all banks in the sample. *USAGE* is measured as Federal Reserve funds outstanding in percent of group total assets. Rates are average monthly interest rates on newly generated business in %, short-term includes maturities of up to one year, long-term deposits refer to maturities over two years, long-term credits to maturities over five years. Credits are all credits up to one million EUR in size. Control variables are *Bank Size*, given by ln(Total Assets), *Leverage Ratio* (Total Equity in % of Total Assets), *Wholesale Funding* (Securitized Liabilities in % of Total Assets), *Latent Liabilities* (Latent Liabilities in % of Total Assets), *Liquidity* (Difference of 30-day Assets and 30-day Liabilities in % of Total Assets), *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets), and *Interbank Borrowing* (Net Liabilities outstanding to other financial institutions in % of Total Assets). All regressions include bank × semi-annual fixed effects and month fixed effects, as well as control variables winsorized by 1% on both sides and lagged by one month. SE two-way clustered by bank and month in parantheses; $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$.

	Matched sample		Placebo I		Placebo II	
	Short-Term		Short-Term		Short-Term	
	Deposits	Credits	Deposits	Credits	Deposits	Credits
	(I)	(II)	(III)	(IV)	(V)	(VI)
USAGE	-0.122***	-0.101*	0.015	0.047	-0.001	-0.002
	(0.033)	(0.051)	(0.014)	(0.089)	(0.001)	(0.002)
R^2 (within)	0.88	0.77	0.63	0.46	0.70	0.67
N	1,916	1,916	3,807	3,724	3,827	3,774
Estimation sample properties						
# of banks	117	117	158	149	149	142
# of treated banks	89	89	106	107	101	102
Dependent variable Mean	2.107	4.127	2.566	4.751	2.533	4.519
Dependent variable SD	1.654	1.629	0.639	0.999	1.700	1.718
USAGE Mean	0.633	0.633	0.164	0.167	1.615	1.483
USAGE SD	0.956	0.956	0.333	0.337	8.069	6.955
Bank x semi-annual FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes

A Appendix Figures

Figure A.1. **Illustration of data sample**

Overview of sample structure by types of banks with and without access to Federal Reserve funding facilities. The analyzed data sample is constructed of German banks included in the interest rate report of Deutsche Bundesbank (*Zinsstatistik*). Banks with access includes all banks which are part of an IBHC network that includes a registered bank in the U.S. Among the banks with access, some also belong to non-German IBHCs. These are either German affiliates of U.S.-IBHCs (subgroup *c)*), or affiliates of foreign, non-U.S. IBHCs (subgroup *d)*). The latter are banks of non-German BHCs, which accessed the facilities through their U.S. affiliates. The subgroup of German banks with access can further be separated into heads of IBHCs, and subsidiaries of IBHCs (*e)* and *f)*). The form of access to the facilities is different for these subgroups, as heads have direct control over the U.S. subsidiaries (which accessed the facilities), while facility funds reach German subsidiaries only through the head companies, thus indirectly. The actual number of banks included in the regressions may vary as the panel is unbalanced and not all banks offer all types of products for which interest rates are observed.



B Appendix Tables

Table B.1
Network assumptions and sample
Regression results for short-term deposits from and credits (< 1 year) to non-financial corporations. The sample is composed of monthly data ranging from December 2007 to April 2010 (29 months). In columns (I) and (II), savings banks are alternatively assumed to be independent from their respective Landesbank. In columns (III) and (IV), cooperative banks additionally form a network with their central institutions. Columns (V) and (VI) present results for the original network definitions, excluding large commercial banks, Landesbanken and cooperative banks' central institutions. *USAGE* is measured as Federal Reserve funds outstanding in percent of group total assets. Rates are average monthly interest rates on newly generated business in %and credits are all credits up to one million EUR in size. Control variables are *Bank Size*, given by ln(Total Assets), *Leverage Ratio* (Total Equity in % of Total Assets), *Wholesale Funding* (Securitized Liabilities in % of Total Assets), *Latent Liabilities* (Latent Liabilities in % of Total Assets), *Liquidity* (Difference of 30-day Assets and 30-day Liabilities in % of Total Assets), *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets), and *Interbank Borrowing* (Net Liabilities outstanding to other financial institutions in % of Total Assets). All regressions include bank × semi-annual fixed effects and month fixed effects, as well as control variables winsorized by 1% on both sides and lagged by one month. SE two-way clustered by bank and month in parantheses; $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$.

	Untreated savings banks		Treated cooperative banks		Excluding large banks	
	Short-Term Deposits	Credits	Short-Term Deposits	Credits	Short-Term Deposits	Credits
	(I)	(II)	(III)	(IV)	(V)	(VI)
USAGE	-0.022***	-0.031	-0.020***	-0.031	-0.023***	-0.025
	(0.007)	(0.024)	(0.007)	(0.024)	(0.007)	(0.025)
R^2 (within)	0.70	0.67	0.70	0.67	0.68	0.67
N	3,827	3,774	3,827	3,774	3,357	3,304
Estimation sample properties						
# of banks	149	142	149	142	131	124
# of treated banks	33	34	140	133	85	86
Dependent variable Mean	2.533	4.519	2.533	4.519	2.564	4.546
Dependent variable SD	1.700	1.718	1.700	1.718	1.689	1.730
USAGE Mean	0.225	0.255	0.733	0.747	0.572	0.619
USAGE SD	1.010	1.962	1.100	2.007	1.162	2.136
Bank x semi-annual FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes

Table B.2

Effect on German banks

Regression results for short-term deposits from and credits (< 1 year) to non-financial corporations. The sample is composed of monthly data ranging from December 2007 to April 2010 (29 months). Regressions in Panel A estimate the effect on banks headquartered in Germany (subsample *b)* in Figure A.1), with columns (I) and (II) showing the effect against all untreated banks. Columns (III) and (IV) in Panel A show the effect against non-German treated banks (subsamples *c)* and *d)* in Figure A.1). In Panel B only heads of IBHCs that are headquartered in Germany are considered to be treated (subsample *e)* in Figure A.1). Regressions in columns (I) and (II) use all banks without access to emergency facilities as the control group, while columns (III) and (IV) estimate the effect on German IBHC heads relative to their subsidiaries (subsample *f)* in Figure A.1). *USAGE* is measured as Federal Reserve funds outstanding in percent of group total assets. Rates are average monthly interest rates on newly generated business in %, and credits are all credits up to one million EUR in size. Control variables are *Bank Size*, given by ln(Total Assets), *Leverage Ratio* (Total Equity in % of Total Assets), *Wholesale Funding* (Securitized Liabilities in % of Total Assets), *Latent Liabilities* (Latent Liabilities in % of Total Assets), *Liquidity* (Difference of 30-day Assets and 30-day Liabilities in % of Total Assets), *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets), and *Interbank Borrowing* (Net Liabilities outstanding to other financial institutions in % of Total Assets). All regressions include bank × semi-annual fixed effects and month fixed effects, as well as control variables winsorized by 1% on both sides and lagged by one month. SE two-way clustered by bank and month in parantheses; $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$.

	Compared to untreated banks		Compared to other treated banks	
	Short-Term Deposits	Credits	Short-Term Deposits	Credits
	(I)	(II)	(III)	(IV)
Panel A: Banks of German IBHCs				
USAGE	-0.020***	-0.031	-0.012**	-0.033
	(0.006)	(0.028)	(0.005)	(0.029)
R^2 (within)	0.69	0.66	0.62	0.67
N	3,726	3,675	2,646	2,741
Estimation sample properties				
# of banks	145	138	101	102
# of treated banks	98	98	98	98
Dependent variable Mean	2.534	4.522	2.473	4.485
Dependent variable SD	1.696	1.715	1.717	1.726
USAGE Mean	0.575	0.590	0.810	0.791
USAGE SD	1.088	1.121	1.215	1.235
Panel B: Heads of German IBHCs				
USAGE	-0.080***	-0.102***	-0.028**	-0.027
	(0.018)	(0.036)	(0.012)	(0.024)
R^2 (within)	0.78	0.68	0.61	0.65
N	1,429	1,301	2,559	2,653
Estimation sample properties				
# of banks	57	50	98	98
# of treated banks	10	10	10	10
Dependent variable Mean	2.565	4.533	2.483	4.493
Dependent variable SD	1.677	1.664	1.716	1.725
USAGE Mean	0.144	0.158	0.112	0.108
USAGE SD	0.486	0.507	0.699	0.687
Bank x semi-annual FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes