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Cross-border transmission of emergency liquidity

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Non-technical summary

Research Question

In response to the global financial crisis, the Federal Reserve Bank (*Fed*) established several emergency facilities during the period from December 2007 to April 2010 peaking at USD 1.2 trillion at the end of 2008. The emergency facilities aimed at lifting liquidity constraints and mitigating bank lending contraction. Funds from the emergency facilities were accessible to U.S. banks as well as subsidiaries of foreign banks. The latter are parts of internal capital markets of internationally active bank holding companies (IBHCs). This study asks whether unconventional U.S. monetary policy in terms of emergency facilities transmitted to banking markets outside the U.S. and changed interest rate setting behavior.

Contribution

With this analysis, we contribute to the literature on the cross-border transmission of monetary policy by examining the link between the Fed emergency facilities and the legal framework in which non-U.S. banks have access to them. The study employs detailed information on the use of emergency liquidity of U.S. banks that had not been available prior to 2011 due to restrictions by the Fed. The data allow us to differentiate between German banks with access to the U.S. liquidity support and banks without access. Our approach compares interest rates of both groups of banks during the period in which the emergency facilities were active and the surrounding period.

Results

We find a significant, contemporaneous decline in the short-term deposit rates of banks with access to the U.S. liquidity facilities compared to banks without access to these funding sources. Banks with access to these facilities show significantly decreased short-term funding costs, while both credit pricing and lending volumes remain unchanged. Short-term corporate loan rates decline as well with a lag between two to four months. These spillover effects of U.S. monetary policy are confined to short-term rates.

Nichttechnische Zusammenfassung

Fragestellung

In Folge der globalen Finanzkrise legte die US-Notenbank (*Federal Reserve Bank*, kurz: Fed) von Dezember 2007 bis April 2010 mehrere Notfall-Fazilitäten (bis zu einer Höhe von USD 1,2 Billionen Ende 2008) auf, um angeschlagene Banken mit ausreichend Liquidität zu versorgen und somit die vorherrschende Kreditklemme abzuschwächen. Ausländische Banken konnten indirekt Zugang zu den Liquiditätshilfen erhalten, sofern sie in den internen Kapitalmarkt einer international agierenden Bankholdinggesellschaft integriert waren, die gleichzeitig mit einer Tochtergesellschaft in den USA vertreten war. Die vorliegende Studie beschäftigt sich mit der Frage, ob sich die geldpolitischen Maßnahmen der Fed über interne Kapitalmärkte auf die Preissetzung in Bankensystemen anderer Länder ausgewirkt haben.

Beitrag

Mit der vorliegenden Studie ergänzen wir die aktuelle Literatur zur Transmission der Geldpolitik um die Rolle von internen Kapitalmärkten bei der Übertragung von geldpolitischen Impulsen auf grenzüberschreitende Bankensysteme. Für die Studie nutzen wir detaillierte Daten zur Inanspruchnahme der von der Fed bereitgestellten Liquiditätshilfen, welche bis zum Jahr 2011 (aufgrund von Restriktionen seitens der Fed) nicht veröffentlicht wurden. Die Informationen ermöglichen es uns, eine Unterscheidung zwischen Banken mit und ohne indirekten Zugang zu US-Liquiditätshilfen zu treffen. Um den Effekt der Liquiditätshilfen auf den deutschen Kreditmarkt zu quantifizieren, werden die Zinsen beider Gruppen während und außerhalb der Laufzeit der Fazilitäten miteinander verglichen.

Ergebnisse

Unsere Studie zeigt – im Unterschied zu den Banken ohne Zugang zu US-Liquiditätsfazilitäten – bei den deutschen Banken mit einem entsprechenden Zugang einen Rückgang der kurzfristigen Einlagezinsen auf. Banken mit einem solchen Zugang weisen einen signifikanten Rückgang in den kurzfristigen Refinanzierungskosten auf, während sowohl die Bepreisung von Krediten als auch die Kreditvergebepolumina hiervon nicht zeitgleich beeinflusst werden. Mit einer Verzögerung von zwei bis vier Monaten sinken jedoch auch kurzfristige Zinsen für Unternehmenskredite. Diese Effekte sind auf kurzfristige Zinssätze beschränkt.

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 of international banks, we can identify banks in Germany with access to U.S. facilities via internal capital markets. Using proprietary 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 German banks with access. Short-term loan rates charged to German corporates also decline, albeit with lags between two and four months. These spillover effects of U.S. monetary policy are confined to short-term rates.

Keywords: Monetary policy transmission, emergency liquidity, internal capital markets, interest rates

JEL classification: E52, E58, F23, F38, G01, G21.

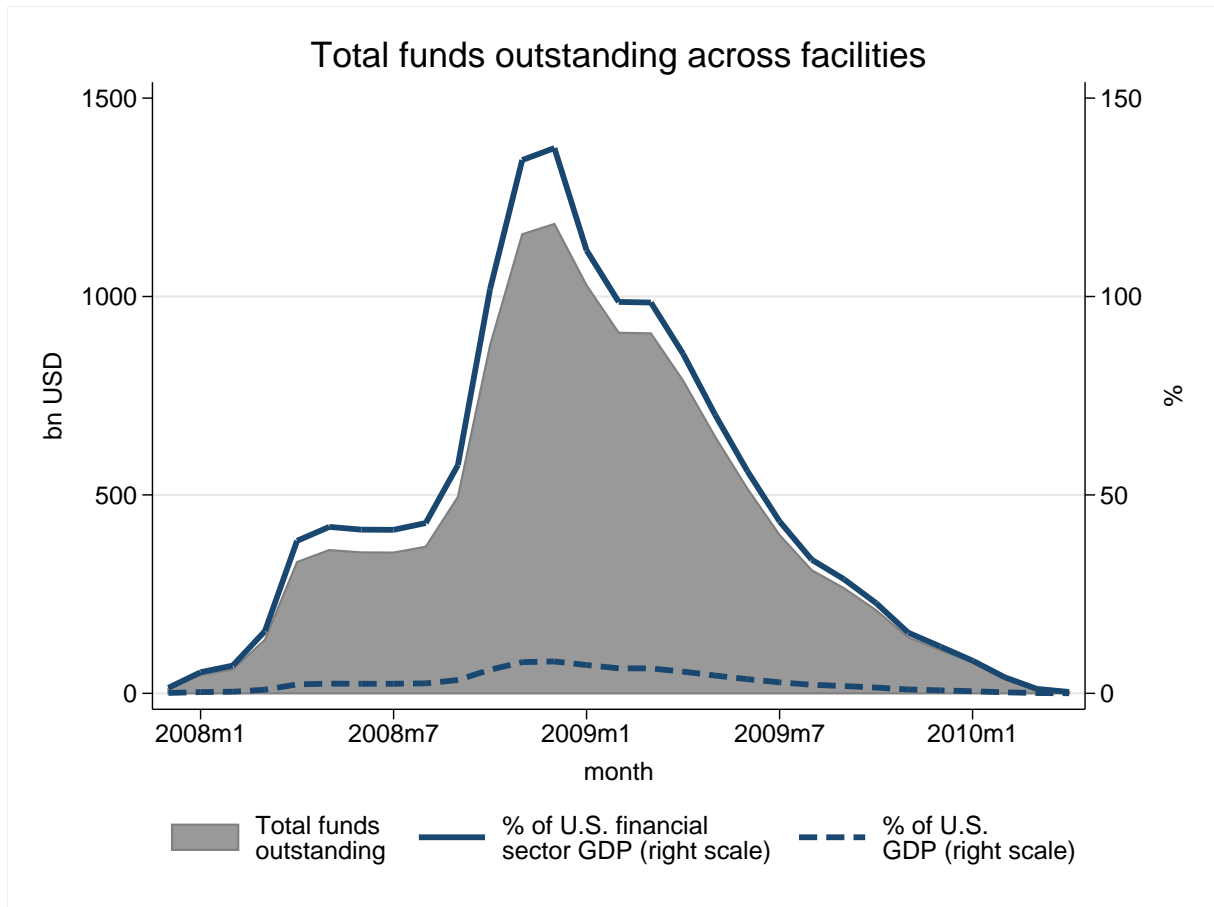
*Contact address: Deutsche Bundesbank, P.O. Box 10 06 02, 60006 Frankfurt, Germany. Phone: +49 69 9566 8194. E-Mail: thomas.kick@bundesbank.de, m.koetter@fs.de, m.storz@fs.de. We are grateful to Deutsche Bundesbank for the provision of data. We received valuable feedback at the Goethe University/Frankfurt School Finance Ski Seminar, the 14th GRETA international conference on credit risk evaluation, the banking workshop at the University of Münster, the empirical accounting and finance workshop at the University of Tübingen, and the seminar series at Deutsche Bundesbank. In particular we are indebted to our discussants Felix Noth and Jan Riepe as well as Martin Götz, Reint Gropp, Rainer Haselmann, Jan Pieter Krahenen, and Sascha Steffen. Any views expressed are only those of the authors and do not necessarily represent the views of Deutsche Bundesbank. All errors are our own.

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, thereby rendering further conventional monetary policy unavailable. To mitigate continuing funding pressure, Figure 1 shows that the U.S. Federal Reserve distributed up to 1.2 trillion USD by means of various emergency lending facilities and the Discount Window to financial institutions with a U.S. banking charter. Notably, the cost of liquidity from these facilities was well below the refinancing cost of the European Central Bank (ECB), as illustrated in Figure 2, and more than half of the distributed volume was used by affiliates¹ of foreign banks (Benmelech, 2012; Acharya, Drechsler, and Schnabl, 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), thereby affecting banks’ funding and lending terms *outside* the U.S. economy.

Figure 1: **Total size of funding facilities**

Bars show 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.



¹We use the term ‘affiliate’ throughout this paper to refer to branches and subsidiaries alike.

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, Martin, and Skeie, 2011](#)), a limitation aggravated at the zero-lower bound ([Adam and Billi, 2007, 2014](#)). The empirical evidence for the U.S. emergency liquidity provision suggests that it mitigated banks funding pressure fairly well ([Wu, 2011; Syrstad, 2014](#)),² effectively substituting for conventional monetary policy in terms of employment and output responses ([Gambacorta, Hofmann, and Peersman, 2014](#)). Whereas short-term funding pressure mounted, lending volumes contracted, and lending rates increased in the U.S. due to the crisis ([Santos, 2010; Ivashina and Scharfstein, 2010](#)), emergency liquidity lines mitigated domestic lending contraction especially through large banks ([Berger, Black, Bouwman, and Dlugosz, 2014](#)). However, the consequences of unconventional U.S. monetary policy for credit and funding outside the U.S. remain uncharted, which is what we shed light on with this paper. In contrast to the aforementioned contributions surrounding the U.S. emergency lending facilities, we therefore examine the cross-border impact and furthermore include all established facilities.

So far, most analyses of cross-border responses to the financial crisis pertain to lending and funding volumes rather than pricing, which is our focus. 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](#)).³ This pattern is consistent with the seminal evidence by [Peek and Rosengren \(1997, 2000\)](#), who find a significant flight home effect of Japanese banks contracting their lending to U.S. firms in response to the stock market crash at home. The withdrawal from both foreign credit and funding markets is, however, not homogeneous across foreign markets, indicating the importance of actively managed internal capital markets of IBHCs in re-allocating financial funds globally (see [Cetorelli and Goldberg, 2012a,b; Galema, Koetter, and Liesegang, 2015](#)). We complement these studies by investigating the role of such internal capital markets for the cross-border transmission of monetary policy 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,⁴ we use a unique setting with three main advantages to cast more light on the international transmission of monetary policy. Our setting hinges on the release of micro data regarding the use of U.S. liquidity on a bank-by-bank basis, manually collected internal capital market connections of IBHCs and supervisory information on interest rate setting for new credit and funding by banks *outside* the U.S. with and without access to emergency liquidity provided by the Fed. As such, we contribute to the few studies of the international transmission of monetary policy through

²Both the Term Auction Facility (TAF) and the Term Securities Lending Facility (TSLF) mitigated liquidity shortages of banks ([Fleming, Hrung, and Keane, 2010](#)), but did not reduce their borrowing costs relative to LIBOR ([Kuo, Skeie, and Vickery, 2012](#)). [Duygan-Bump, Parkinson, Rosengren, Suarez, and Willen \(2013\)](#) find that the ABCP Money Market Mutual Funds Liquidity Facility (AMLF) significantly reduced ABCP yields and prevented fund outflows. [Puddu and Wälchli \(2012\)](#) show that TAF funds were successful in reducing the liquidity risk of U.S. banks.

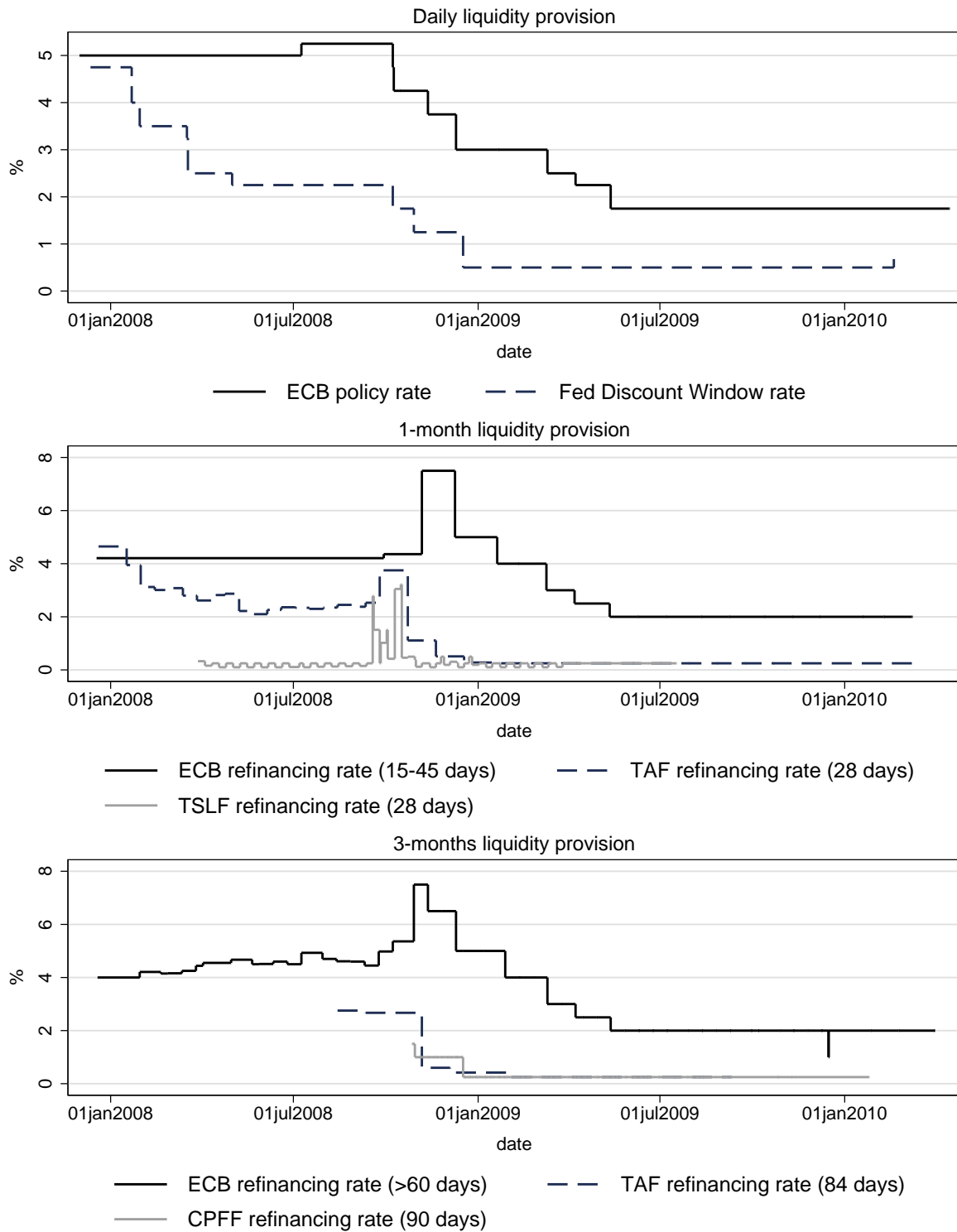
³Lending contraction effects are particularly pronounced when banks are highly leveraged ([Devereux and Yetman, 2010](#)), thereby adding to the dissemination of the financial crisis to both emerging ([Popov and Udell, 2012](#)) and developed economies ([Acharya and Schnabl, 2010; Aiyar, 2012](#)).

⁴Such as [Campello \(2002\)](#) for the U.S., [Cremers, Huang, and Sautner \(2011\)](#) for the Netherlands, or [Frey and Kerl \(2015\)](#) who consider domestic lending conditional on internal capital market activity.

Figure 2: Funding cost of emergency liquidity

The figure plots the refinancing rate of ECB liquidity provision to the average interest rate charged under several Federal Reserve emergency lending facilities.

Comparison of Refinancing Rates



internationally active banks, such as [Cetorelli and Goldberg \(2012a,b\)](#) who observe capital flows in the networks of internationally active U.S. banks or [Buch, Koch, and Koetter \(2011b\)](#) who analyze balance sheet composition of German banks with access to the Term Auction Facility (TAF).

A first important challenge to these studies that we overcome is that emergency liquidity usage is conventionally unobservable to avoid stigmatization and self-fulfilling prophecies of bank distress due to a deterioration of banks' market values ([Cyree, Griffiths, and Winters, 2013](#)). We take advantage of 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) after a lawsuit filed by Bloomberg L.P. against the Federal Reserve System in 2008 ([New York Southern District Court, 2008](#)). The published data on emergency facilities and the Discount Window lists daily funds outstanding for all individual entities between December 2007 and April 2010.

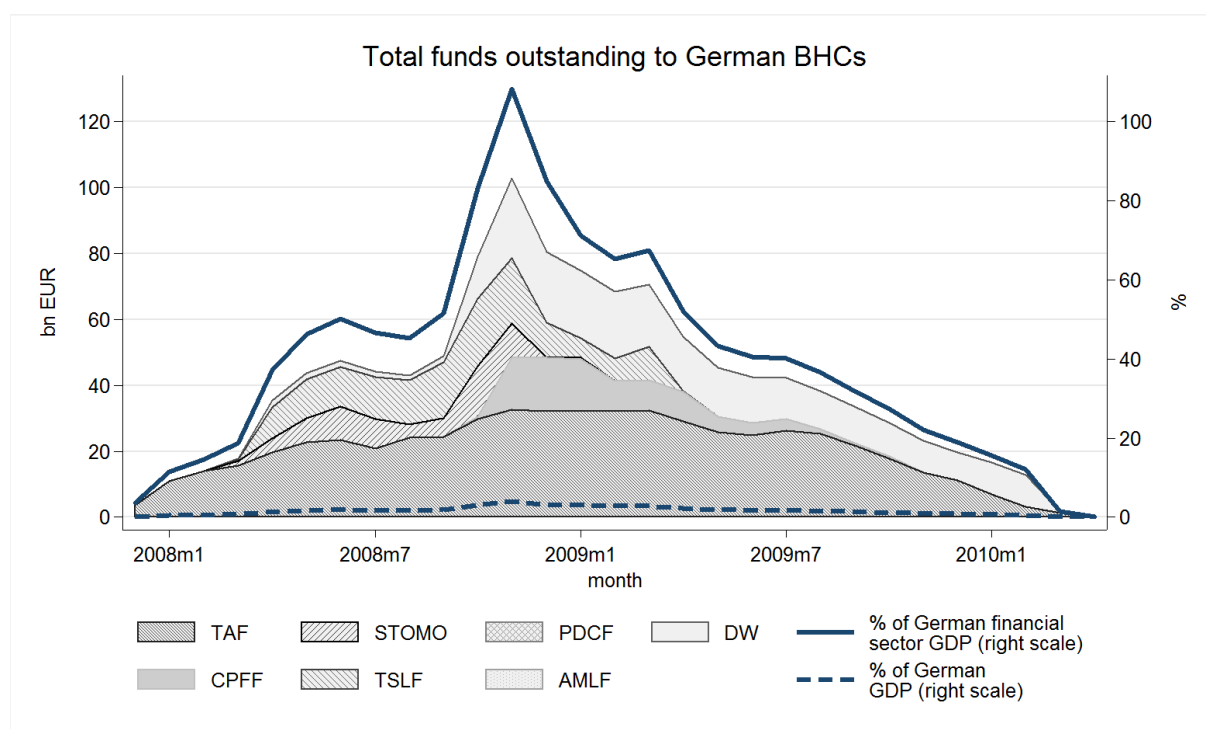
Second, the identification of an exogenous monetary policy shock is crucial, yet notorious due to the simultaneity between banking system health and the policy stance. The Bloomberg data provides the names, the timing, and the volume of Fed liquidity used by non-U.S. banks. We identify the exogenous effect of this unconventional monetary policy by comparing banks on German soil that have access to U.S. liquidity facilities via their affiliates to those banks on German soil that have no such access. To this end, we manually identify the IBHC with which the "Bloomberg banks" are associated and whether these IBHCs operate in Germany. [Figure 3](#) vividly illustrates the intensive use of U.S. emergency liquidity by German banks. They tapped up to 100 billion EUR in September 2008, which amounts to around 10% of the entire volume of the U.S. facilities at the time and is in size comparable to the contribution of Germany's financial system to German GDP.

Third, if liquidity shocks are transmitted to banking markets outside the U.S. through an internal capital markets channel by IBHCs, we expect to see systematically different loan and deposit rates charged on markets outside the U.S. for any additional credit or funding business generated. Such detailed lending and funding rates for new rather than outstanding stocks of loans and deposits are rare. We use detailed interest rate data on new business reported monthly by a representative sample of both German and foreign banks to the German central bank, the Bundesbank. We collect data from annual reports of all IBHCs and match these with all 217 German banks that report detailed loan and funding prices on a monthly basis. In contrast to studies confined to large syndicated loans (e.g. [Giannetti and Laeven, 2012a](#)) or wholesale corporate funding auction platforms (e.g. [Acharya, Imbierowicz, Steffen, and Teichmann, 2015](#)) to identify transmission effects of monetary policy, we thus investigate marginal interest rates charged by a representative sample of banks on commercial and industrial lending to a wide range of corporate customers.

Our results clearly show that short-term funding costs of German banks vis-à-vis corporate depositors declined significantly in response to U.S. liquidity assistance. Short-term deposit rates offered to corporates in Germany by banks with access via the internal capital market of their IBHC were lower compared to short-term deposit rates offered by banks without access to the U.S. emergency facilities. For each percent of emergency funding per total IBHC assets, short-term deposit rates decline by 2.3 basis points. An

Figure 3: Total funds distributed to German banks

Bars show the balance outstanding of all six Federal Reserve funding facilities (TAF, PDCF, TSLF, AMLF, CPFF, STOMO) and the Discount Window in billion EUR (left scale) from December 2007 to April 2010. Lines indicate the balance in % of annual total German GDP and German financial sector GDP, respectively (right scale). GDP data source: OECD.



increase in using the emergency lending facilities by one standard deviation in this case corresponds to a lowering in short-term funding costs by 1.1%. As such, the objective of U.S. monetary policy to reduce short-term funding pressure of banks even extended beyond the boundaries of its own market, albeit at a small magnitude. Short-term corporate loan rates declined after a lag of two to four months. In contrast, 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 find that banks with less pre-crisis exposure to Asset Backed Commercial Paper (ABCP) exhibit a decline in short-term funding rates. The magnitude of this effect declined for growing ABCP exposures, but remains significantly negative. Consistent with this result we also find that the reduction in funding cost are larger for banks that held more liquidity prior to 2007. This result suggests that banks facing no or weak funding constraints substituted other conventional liabilities with cheaper U.S. liquidity as suggested by studies advocating the existence of global, actively managed internal capital markets. We also find that the weakest banks in terms of capitalization reduced funding cost the most. Thus, access to additional emergency funds through internal capital markets did succeed in easing short-term financing conditions for banks substantially exposed to funding constraints.

Our results are robust toward a plethora of alternative definitions of access to U.S.

facilities via internal capital markets, the inclusion of explicit liquidity measures, and semi-annual \times bank fixed effects to gauge possibly confounding (unconventional) European monetary policy measures, matched sampling of banks in Germany to address potential concerns of self-selection of large banks into international activities, placebo tests regarding the timing of liquidity support facilities, and alternative lag structures regarding the transmission speed of U.S. monetary policy to interest rates in the German banking market via internal capital markets.

2 Identification and Methodology

2.1 Facilities and IBHC networks

As a response to the interbank market breakdown resulting from the subprime mortgage crisis in 2007, the Federal Reserve established six different funding facilities in addition to the Discount Window. Although the discount rate was already substantially lowered by December 2007, institutions hardly made use of the Discount Window, possibly to avoid stigmatization. The Term Auction Facility (TAF) and the five other facilities installed subsequently, were thus created as new monetary policy instruments to alleviate liquidity shortages in the financial market in general, rather than supporting individual institutions in need.

Liquidity provision through these facilities took various forms:⁵ TAF, established in December 2007, provided short-term credit (for a maximum of 84 days) through bi-weekly auctions to deposit-taking financial institutions against a wide range of collateral until March 2010. In March 2008, the Primary Dealer Credit Facility (PDCF) and Term Securities Lending Facility (TSLF) were established to provide overnight loans and exchange various types of collateral (including ABCP) 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, with further liquidity provision through the Commercial Paper Funding Facility (CPFF), established only one month later, supporting the market for commercial paper in general. Additionally, primary dealers were provided with liquidity through single-tranche open market operations (STOMO) between March and December 2008. All facilities, with the exception of TAF,⁶ were abolished on February 1, 2010.

Figure 1 illustrates the development of total funds outstanding in relation to the U.S. economy and the U.S. financial sector. By the end of 2008, the size of the facilities corresponded to up to around 8% of total annual U.S. GDP, and 135% of annual U.S. financial sector output. The Federal Reserve System's emergency facilities were thus significantly larger in size than the U.S. government's assistance provided through the Troubled Assets Relief Program (TARP, around 430 billion USD). For an institution to directly participate in the auctions or have access to the facilities, it had to be an entity with a U.S. banking charter, which includes affiliates of non-U.S. IBHCs, thereby providing these banks also with access to U.S. emergency liquidity.

Figure 4 illustrates the three possibilities how we identify banks, that report interest rates to the German central bank, and faced a positive funding shock. The first channel

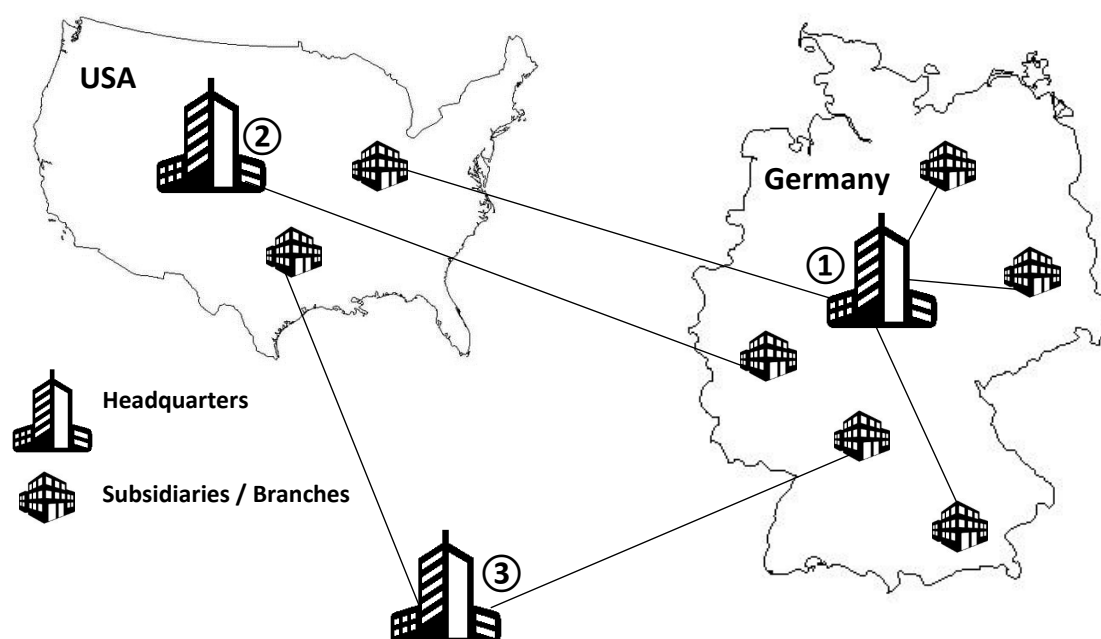
⁵See the Online Appendix for a more detailed description of the facilities' working mechanisms and terms.

⁶The Term Auction facility formally remained active, but ceased to conduct auctions in February 2010.

contains German banks that are a member of an IBHC with a U.S. affiliate. Second, German branches and subsidiaries of U.S. IBHCs 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.

Figure 4: Illustration of observed cases of treated banks

The figure below illustrates the three different possible cases, in which a bank in Germany can have access to U.S. emergency lending facilities through its network. We observe interest rates for 217 different banks in Germany, which are considered to be treated, whenever one bank in its IBHC is a registered bank in the U.S. and can thus have access to U.S. facilities.



Types of IBHCs with access to U.S. emergency facilities

- ① German IBHC with an affiliated bank in the U.S.
- ② U.S. IBHC with an affiliated bank in Germany
- ③ Non-German, non-U.S. IBHC with affiliated banks in both Germany and the U.S.

Banks are considered members of a certain IBHC whenever the latter has an equity interest or voting rights of more than 50% in the bank. Therefore, we manually gather ownership data from the annual reports of IBHCs associated with banks revealed on the Bloomberg list. In case there was a mid-year change of ownership during the time the facilities were in operation, the date of ownership change stated in the annual reports is used. Where no annual reports were available, the IBHC-association was confirmed by information from official company websites.

One exception are German savings banks, which exhibit a two-tiered network structure that consists of multiple regional savings banks being associated with one so-called Landesbank. The latter acts as a head institution for the local savings banks in a certain region conducting, for example, capital market operations or payment services on their behalf. Landesbanken conduct their business only in certain states (*Bundesländer*) and are typically jointly owned by the regional savings banks and the states where they are located. Following the approach of [Puri, Rocholl, and Steffen \(2011\)](#), we thus consider a regional savings bank to have access to U.S. emergency liquidity if they are tied to a Landesbank with a U.S. branch or subsidiary.⁷

Figure 5 shows that this identification scheme results in 139 out of the 217 banks in our sample that are members of an IBHC with access to Federal Reserve funding facilities. These 139 banks on German soil with access to the U.S. liquidity facilities belong to 22 non-U.S. IBHCs, of which all operated their branches or subsidiaries already in 2004, the commencement year of the formal interest rate statistics, up and until today with one exception.⁸ This persistent internationalization pattern in terms of foreign affiliates is consistent with the results reported by [Buch, Koch, and Koetter \(2011a\)](#) and suggests a systematic self-selection of (large) banks in to the U.S. market in anticipation of future emergency liquidity provision to be unlikely. Nonetheless, we also consider alternative access definitions, which are indicated in the bottom portion of Figure 5, and for which we report results in the Online Appendix.

2.2 Specification of emergency facility effects

Based on this identification of internal capital market access of IBHCs to Federal Reserve liquidity facilities, we estimate the effects of U.S. liquidity support on interest rates set in Germany in two ways.

First, we specify a canonical difference-in-difference model that compares interest rate differentials between banks with and without access to U.S. emergency liquidity due to the presence of an *AFFILIATE* prior to the inception of facilities in December 2007 to interest-rate differentials between banks of these two groups after the facilities were abandoned in May 2010. In this baseline estimation we examine a possible change in the funding conditions of banks with access to U.S. funding. We estimate the following regression:

$$r_{i,m} = \alpha_m + \alpha_{it} + \beta \text{AFFILIATE}_i \times \text{POST}_m + \gamma X_{i,m-1} + \varepsilon_{i,m}. \quad (1)$$

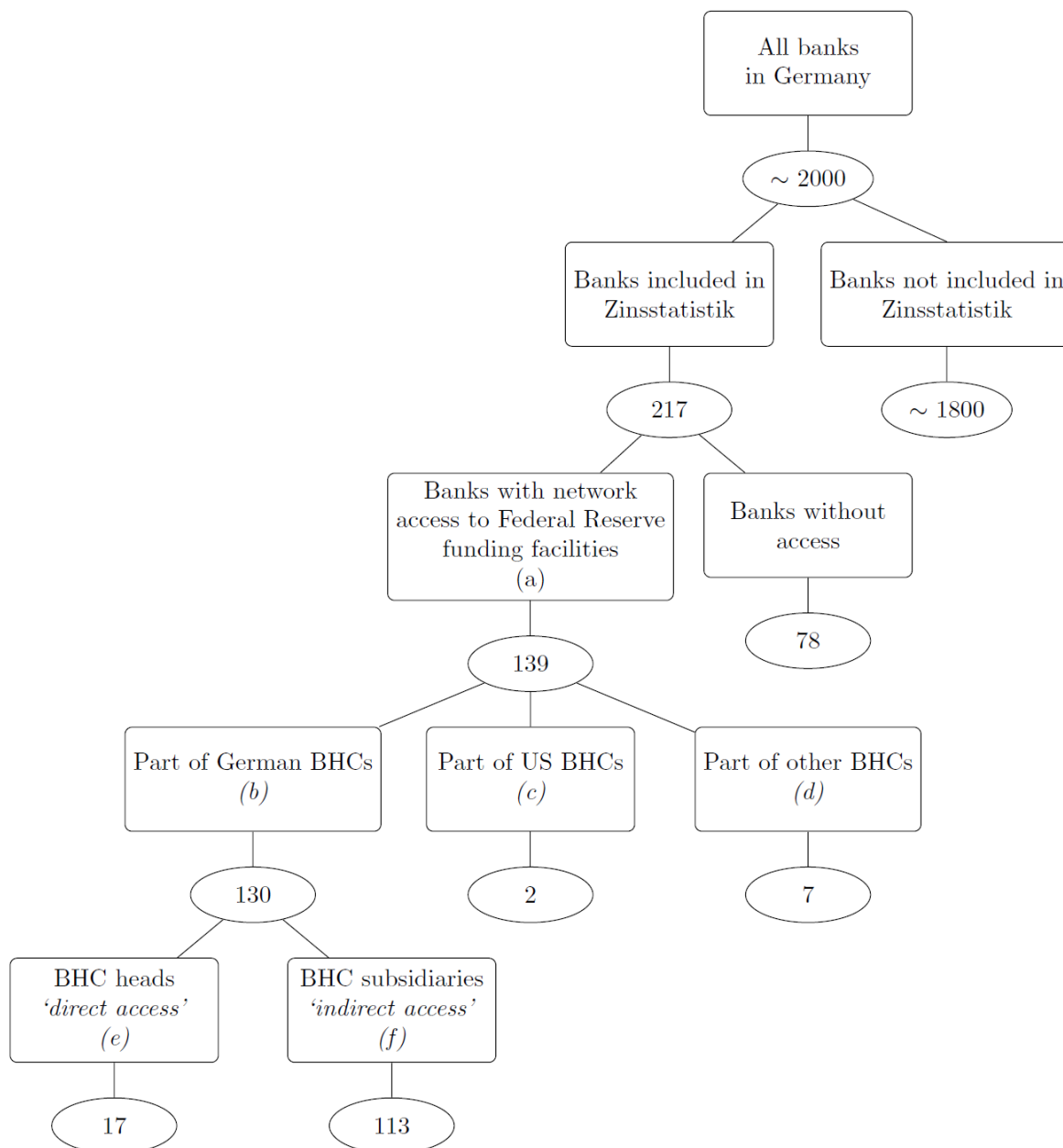
The dependent variables $r_{i,m}$ are different lending and funding interest rates of bank i in month m , AFFILIATE_i is a dummy variable equal to one if a bank has access to emergency funding through a U.S. affiliate in its IBHC network. POST is an indicator of the period after the liquidity treatment stopped and ranges from June 2010 until December 2014. $X_{i,m-1}$ represents a vector of control variables, which are lagged by one month and winsorized by 1% at both ends of their distribution to control for outliers. Control variables are *Bank Size*, *Wholesale Funding*, *Leverage Ratio*, *Latent Liabilities*,

⁷We exclude DekaBank, the investment bank of the German savings bank group.

⁸The exception is Westdeutsche Landesbank (WestLB), which failed in the aftermath of the crisis and exited the German, the U.S., and all other markets.

Figure 5: 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.



Liquidity, and *Central Bank Liabilities*. All variables are defined in Table 1 and we discuss and describe them below.

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 from Deutsche Bundesbank’s monthly balance sheet and liquidity reports.

Variable	Description
<i>Dependent Variables</i>	
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
<hr style="border-top: 1px dashed black;"/>	
<i>Control Variables</i>	
Bank Size	$\ln(\text{Total Assets})$
Leverage Ratio	$(\text{Total Equity})/(\text{Total Assets}) \times 100$
Wholesale Funding	$(\text{Securitized Liabilities})/(\text{Total Assets}) \times 100$
Latent Liabilities	$(\text{Latent Liabilities})/(\text{Total Assets}) \times 100$
Liquidity	$(\text{30-day Net Liquidity Balance}^1)/(\text{Total Assets}) \times 100$
	¹ 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	$(\text{Net Central Bank Liabilities}^2)/(\text{Total Assets}) \times 100$
	² Central bank liabilities of up to 1 year maturity less central bank deposits.

Month-fixed effects α_m capture business cycle effects as well as any effect that is 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 is crucial to minimize possible concerns about confounding policy measures, such as unobserved liquidity facilities provided by the European Central Bank (ECB) (see, for example, [Acharya et al., 2015](#)). Controlling for such unobservables per bank-term in addition to observed monthly liquidity indicators from prudential data, namely liquidity ratios and central bank liabilities, aids the identification of the effect of U.S. facilities on interest rates in Germany.

This specification implies that the direct effect of having an $AFFILIATE_i$ is subsumed by the bank×semi-annual fixed effect since IBHCs did not retreat or entered the U.S. market during the sample period. Likewise, the direct term for $POST_m$ is subsumed by the monthly fixed effects. Whereas such a difference-in-difference approach therefore

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.

Facility	N	Mean	SD	p5	p95
Term Auction Facility (TAF)	667	1,537	2,680	0	7,394
Commercial Paper Funding Facility (CPFF)	667	348	1,399	0	1,853
Single Tranche Open Market Operations (STOMO)	667	108	936	0	0
Term Securities Lending Facility (TSLF)	667	519	2,758	0	192
Primary Dealer Credit Facility (PDCF)	667	112	1,051	0	0
ABCP Money Market Mutual Fund Liquidity Facility (AMLF)	667	4	38	0	0
Discount Window	667	415	2,276	0	1,374
Total Balance	667	3,043	6,956	0	13,262
USAGE	667	7.09	17.89	0.00	46.12

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.⁹ Indeed, the data show significant changes in the amount of borrowed funds, both across IBHCs and time. 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'*, i.e. 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 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. Table 2 reports the average monthly balance of all IBHCs that are associated with banks on German soil in our data sample. 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 our data sample used the various Fed lines at some point in time during the lifetime of the emergency facilities. Furthermore, there is no bank which gained or lost access to the funding due to a change in the IBHC structure.

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 in a fixed-effect regression framework, according to the following equation:

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

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

⁹Figure 1 in the Online Appendix gives an overview over the different average facility usage of IBHCs included in our data sample.

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. The variable *USAGE* is 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. 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.¹⁰ *USAGE* thus represents the funds obtained in percentages of the respective IBHC's size, thereby accounting for size differences of IBHCs with access to funding. Descriptive statistics are available in Table 2.

3 Data sources and treatment validity

3.1 Emergency facilities

Detailed information on the amounts received from the Federal Reserve System by individual IBHCs was made public by Bloomberg in 2011. The dataset provides a complete account of all funds granted for each of the facilities and the Discount Window, as well as aggregated data. Balances vis-à-vis the Federal Reserve are stated on a daily basis during the entire lifetime of the facilities and are available at the IBHC level.

The dataset was released after Bloomberg L.P. had successfully filed a lawsuit against the Board of the Federal Reserve on grounds of the Freedom of Information Act (FOIA) in November 2008. The FOIA gives U.S. citizens the right to access documents and related information on the actions of the government. The Federal Reserve System had refused to provide these information on grounds of the confidentiality of financial information, which is generally excluded from the FOIA. In August 2009, the court ruled in favor of Bloomberg. Despite several appeals by the Federal Reserve System, the data were eventually released in 2011 after the Supreme Court rejected the final appeal. Bloomberg subsequently made the information available through its information network. Furthermore, complete data on the emergency funding facilities is also available through the Federal Reserve's website.

3.2 Interest rates

We obtain monthly interest rates and new business volumes from the interest rate report (*Zinsstatistik*) of Deutsche Bundesbank from January 2004 to December 2014. The report is a mandatory survey of interest rates and business volumes of banks in Germany, conducted on a monthly basis. The reporting banks are a representative sample of around 200 banks of the banking sector in Germany, with large banks regularly included and a varying pool of smaller banks. The sample corresponds to approximately 10% of all banks in Germany and covers more than 75% of aggregate banking assets in Germany.¹¹

¹⁰For further robustness we exclude these banks from treatment in one of our alternative treatment definitions.

¹¹The *Zinsstatistik* is reported for a stratified sample and includes representative proportions of all three main pillars of the German banking system: Commercial, savings, and cooperative banks.

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 products for non-financial corporate clients, for short-term (< 1 year) and long-term (> 2 or 5 years) maturities.¹² From the perspective of the bank, this corresponds to one asset side and one liability side product for each maturity category. Table 1 presents detailed descriptions of the variables. Clients are incorporated non-financial businesses, such as publicly listed or limited companies. Interest rates are reported as averages for newly generated business during the reported month, and all rates are reported in percentages.

3.3 Control variables

We construct control variables from the monthly liquidity and balance sheet report of Deutsche Bundesbank (*Bilanzstatistik*). For an overview of the control variables and their exact definitions see Table 1. *Bank Size* is defined as $\ln(\text{total assets})$ and captures the differences in institution size, *Leverage Ratio* (share of total equity) accounts for the differences in capitalization. Accounting for the differences in funding, *Wholesale Funding* represents the share of securitized debt on the balance sheet, while *Latent Liabilities* captures exposure to latent liabilities as a share of total assets.

Most importantly, we also control for monthly variation in available liquidity of each bank. *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 assets with the central bank of up to one year in maturity. Hence, any cross-sectional differences among banks in the use of unobserved liquidity provision other than the U.S. facilities investigated here should be gauged by these covariates. The fact that the interest rates charged on U.S. liquidity facilities were lower compared to the marginal lending facility of the ECB for the entire sample period (see Figure 2 in the Online Appendix) further suggests that confounding monetary policy by, for example, the ECB is adequately controlled for by these control variables in conjunction with the rich set of fixed effects.

3.4 Descriptive statistics and treatment validity

Table 3 presents in the first two panels summary statistics for the dependent and control variables in the treatment and the control group of the difference-in-difference sample without the treatment period (December 2007 and April 2010) as well as the full sample used in the reduced form estimation represented by Equation (2). Overall, the sample comprises monthly data for 217 individual banks in Germany between January 2004 and December 2014 (132 months). Banks in the treatment group were at some time between December 2007 and April 2010 part of an IBHC with access to the emergency facilities. The remaining banks form the control group (see Figure 5).

The financial products, for which we analyze loan pricing, are the most frequently reported products in the interest report for corporate clients. Variations in the number

¹²We find no impact on medium-term interest rates or new business volumes and therefore focus on short-term and long-term interest rates in the following.

of observations arise because not all banks regularly report values for all categories, either because no new business was generated during a respective month or the respective product is not part of the bank’s business model. The minimum number of observations is 6,600 (for long-term deposits), the maximum is 19,646 (for short-term credits).

The t-test for the equality of means confirms significant differences between the reported rates and the control variables of the treatment and the control group. Banks in the treatment group on average offer higher deposit rates, while simultaneously charging higher credit rates in both samples, with and without the treatment period itself. We later on confirm our results on a matched sample to further address a potential sampling bias.

The bottom panel in Table 3, however, illustrates that *prior* to the inception of U.S. emergency facility lines, neither interest rates on funding and lending nor bank traits developed significantly differently. 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.

4 Results

4.1 Baseline results

Table 4 reports the baseline estimation results according to Equation (1) in columns (I)-(IV) and 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-difference approach. Column (I) exhibits a significantly negative effect of emergency facility usage 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 12.5 basis points, which is substantial given the sample’s average short-term interest rate of 1.6% as it corresponds to a decrease in short-term funding costs of around 7.8%.

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 of 2.5%, this corresponds to a reduction in short-term funding costs by around 1.1%.

Therefore, German banks with access to Fed liquidity facilities benefited, but the economic magnitude of these benefits was relatively small. Yet, these statistically significant effects are remarkable since 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, López-Salido, and Zakrajsek, 2015](#))

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* covers the entire sample period, *Panel A2* excludes the 29 months in which the facilities were in operation (December 2007 to April 2010). *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 $\ln(\text{Total Assets})$, *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), and *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets), all winsorized by 1% on both sides. SE reports the standard error of the t-test for equality of means, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Treatment Group			Control Group			Difference	SE
	N	Mean	SD	N	Mean	SD		
<i>Panel A1: Complete sample</i>								
Short-Term Deposits	13,093	1.725	1.376	6,103	1.803	1.348	-0.078***	0.021
Short-Term Credits	13,866	3.938	1.565	5,780	3.838	1.537	0.100***	0.024
Long-Term Deposits	4,510	2.866	1.291	2,090	2.608	1.168	0.259***	0.033
Long-Term Credits	13,113	4.335	1.201	5,620	4.126	1.164	0.209***	0.019
Bank Size	16,719	23.023	1.399	9,776	22.118	0.976	0.904***	0.016
Wholesale Funding	14,102	10.938	15.363	7,949	7.191	9.913	3.747***	0.191
Leverage Ratio	16,719	5.067	2.303	9,776	4.825	2.022	0.243***	0.028
Latent Liabilities	16,574	2.946	3.812	9,775	2.394	3.068	0.552***	0.045
Liquidity	16,719	15.413	11.411	9,776	18.175	11.861	-2.762***	0.147
Central Bank Liabilities	16,719	0.271	3.008	9,776	0.236	3.091	0.036	0.039
<i>Panel A2: Excluding period with active facilities (without December 2007 – April 2010)</i>								
Short-Term Deposits	10,368	1.520	1.188	4,864	1.584	1.161	-0.064***	0.020
Short-Term Credits	11,004	3.780	1.454	4,718	3.663	1.445	0.117***	0.025
Long-Term Deposits	3,383	2.666	1.278	1,575	2.368	1.119	0.298***	0.038
Long-Term Credits	10,332	4.164	1.222	4,513	3.943	1.153	0.221***	0.021
Bank Size	13,053	23.011	1.394	7,614	22.117	0.979	0.894***	0.018
Wholesale Funding	10,914	10.817	15.488	6,151	7.080	10.075	3.737***	0.220
Leverage Ratio	13,053	5.117	2.360	7,614	4.873	2.022	0.244***	0.032
Latent Liabilities	12,918	2.888	3.737	7,613	2.334	2.946	0.554***	0.050
Liquidity	13,053	15.543	11.458	7,614	18.407	11.939	-2.864***	0.168
Central Bank Liabilities	13,053	0.107	2.845	7,614	-0.207	2.517	0.314***	0.039
<i>Panel B: Growth rates before introduction of facilities (before December 2007)</i>								
Short-Term Deposits	4,548	0.026	0.165	1,899	0.027	0.165	-0.001	0.005
Short-Term Credits	4,678	0.030	0.263	1,638	0.029	0.390	0.001	0.009
Long-Term Deposits	906	0.050	0.392	349	0.010	0.164	0.040*	0.022
Long-Term Credits	4,438	0.013	0.168	1,504	0.023	0.247	-0.010*	0.006
Bank Size	6,099	0.000	0.002	3,528	0.000	0.002	-0.000	0.000
Wholesale Funding	5,260	0.004	0.188	3,092	-0.000	0.127	0.005	0.004
Leverage Ratio	6,099	0.003	0.053	3,528	0.003	0.074	-0.001	0.001
Latent Liabilities	6,030	0.036	1.452	3,527	0.029	0.832	0.006	0.027
Liquidity	5,961	0.108	3.241	3,360	0.055	0.776	0.053	0.057
Central Bank Liabilities	5,908	1.669	93.993	3,359	1.497	74.858	0.173	1.892

Table 4: Impact of Federal Reserve emergency funding on deposit and credit rates

Regression results for deposits 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-difference 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 $\ln(\text{Total Assets})$, *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), and *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks 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 \times semi-annual fixed effects. SE two-way clustered by bank and month in (); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Short-Term		Long-Term		Short-Term		Long-Term	
	Deposits	Credits	Deposits	Credits	Deposits	Credits	Deposits	Credits
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
USAGE					-0.023*** (0.006)	-0.025 (0.022)	0.033 (0.058)	0.023 (0.020)
AFFILIATE x POST	-0.125*** (0.044)	0.081 (0.120)	0.041 (0.083)	-0.065 (0.056)				
Bank Size	0.032 (0.060)	-0.159 (0.197)	0.199 (0.156)	0.046 (0.101)	0.003 (0.161)	0.433 (0.362)	1.035 (0.881)	-0.459 (0.464)
Wholesale Funding	-0.005* (0.003)	-0.007 (0.008)	0.002 (0.008)	-0.007** (0.003)	0.011 (0.009)	0.016 (0.014)	-0.057 (0.035)	0.023 (0.028)
Leverage Ratio	0.012 (0.015)	0.021 (0.034)	0.117*** (0.037)	0.012 (0.023)	0.013 (0.031)	0.076 (0.075)	0.020 (0.109)	-0.152 (0.121)
Latent Liabilities	0.001 (0.003)	-0.013 (0.012)	-0.020 (0.012)	-0.017** (0.008)	0.003 (0.005)	0.006 (0.014)	-0.025* (0.013)	0.024** (0.010)
Liquidity	0.001 (0.001)	0.006* (0.003)	-0.003 (0.003)	0.002 (0.002)	0.001 (0.002)	0.000 (0.004)	0.010 (0.009)	0.000 (0.004)
Central Bank Liabilities	0.005** (0.003)	-0.004 (0.007)	0.012* (0.007)	-0.001 (0.006)	0.003 (0.005)	0.006 (0.011)	0.009 (0.022)	0.007 (0.011)
R^2	0.95	0.71	0.70	0.76	0.98	0.91	0.76	0.64
N	13,595	13,952	4,482	13,415	3,672	3,634	1,378	3,588
<i>Estimation sample properties</i>								
# of banks	192	184	170	187	145	139	116	141
# of treated banks	120	122	110	121	98	101	81	100
Dependent variable Mean	1.595	3.756	2.610	4.068	2.464	4.455	3.379	4.899
Dependent variable SD	1.191	1.405	1.234	1.138	1.690	1.708	1.035	0.819
USAGE Mean					0.606	0.619	0.568	0.602
USAGE SD					1.152	1.182	0.955	1.097
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

as well as bank-level studies documenting the effects of loan volume responses via international banks (as in [Cetorelli and Goldberg, 2012a](#); [Schnabl, 2012](#)).

Ideally, the reduction of funding costs of banks should also ease credit terms to corporate customers, an objective presumably even more important to central banks than easing funding pressure faced by banks per se. Columns (II) and (VI) show insignificant effects 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 Purchase Program (SMP) was passed on to customer rates only in part. Instead, they show that interest margins earned by the bank increase.

The remaining columns (III), (IV), (VII), and (VIII) in [Table 4](#) show that banks with access to U.S. facilities through the IBHC network do neither exhibit significantly different long-term loan nor deposit rates. This result suggests that the emergency facilities in the U.S. were able to relieve short-term pressure in credit and 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 capital markets of IBHCs appear to be of relevance to transmit monetary policy internationally, but possibly unintended consequences abroad for long term financing decisions appear 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 toward either identification scheme, we focus henceforth on the specification represented by [Equation \(2\)](#) to investigate the responses of interest rate setting also during the disbursement period between May 2007 and December 2010.

4.2 Lagged pass-through

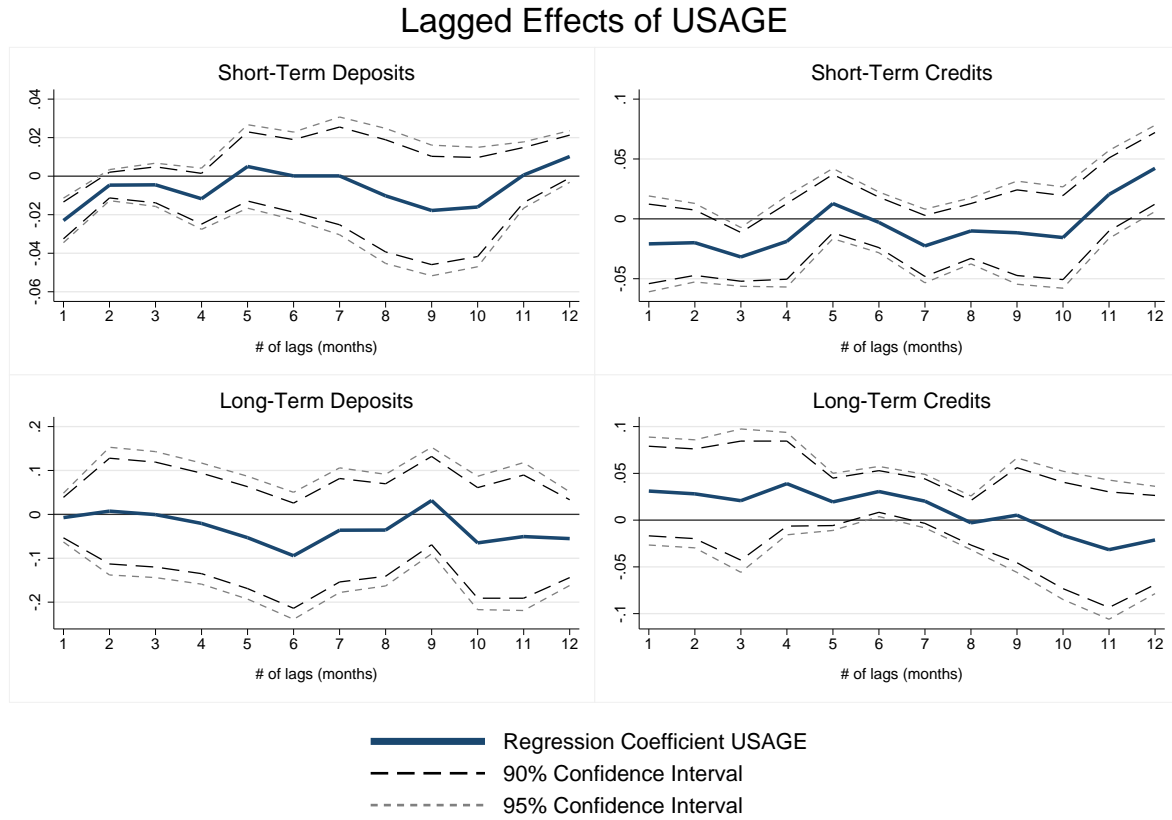
The effect of access to U.S. liquidity facilities on funding and lending rates discussed above assumes that any potential pass-through via internal capital markets of IBHCs occurs instantaneously since we specify the usage by bank i contemporaneously. However, recent studies investigating the effects of other unorthodox monetary policy on interest rates in variants of a Vector Autoregression setting, such as [Boeckx, Dossche, and Peersman \(2015\)](#) for the Eurozone, document lagged effects on interest rates in response to quantitative easing of up to four quarters.

Therefore, [Figure 6](#) 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. These lags illustrate the response of banks’ interest rates up to 12 months after facility usage. The negative effect on banks’ funding cost in terms of contracted corporate deposit rates by banks in Germany with access to U.S. liquidity loses significance after two to three months. Importantly, we also find that short-term customer credit rates exhibit a economically significant reduction due to access to U.S. liquidity that is significantly different from zero for lags between two and four months.

This result highlights that unorthodox liquidity provision in the U.S. not only represented a funding advantage to internationally active banks, but also eased credit terms to German corporates. The magnitudes of these effects are not statistically different from each other. Any refunding advantages enjoyed by banks that are a member of an IBHC with internal capital market access to the U.S. did not result in a competitive advantage

Figure 6: Lagged effects of access to funding facilities on corporate products

Graphs illustrate the regression coefficient and the 95% confidence interval 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 \times 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 %.



in terms of larger markups earned. As such, our results contradict indications in, for example, [Berger and Roman \(2015\)](#) who find that U.S. banks subject to unconventional support schemes, in this case TARP, provided recipient banks with more market power. One important explanation why we find little indication of why differential liquidity assistance induces competitive distortions is that we consider only one portion of a bank's business, namely short-term corporate lending. Another reason might be that both quantitative easing considered in [Cycon and Koetter \(2015\)](#) and [Boeckx et al. \(2015\)](#) and 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 panel of [Figure 6](#) confirm, in turn, the absence of any significant responses in long-run deposit and credit rates contracted with corporate customers in Germany. Any impetus from liquidity assistance on the funding constraints of banks and credit terms to the real sector therefore remains absent in our sample.

4.3 Treatment validity

4.3.1 Matched control group

An important requirement for valid inference in our empirical set-up is to ensure that the comparison of rates on new deposits and loans by banks in Germany with and without access to U.S. liquidity is not subject to confounding factors, such as the size of the bank determining whether it operates a branch in the U.S. or not. Studies for the German banking sector have shown that foreign markets are not entered randomly, but that only few, fairly larger, productive, and profitable banks set up subsidiaries and branches abroad ([Buch et al., 2011a,b](#); [Buch, Koch, and Koetter, 2014](#)). A further possible concern may be that it is exactly these banks that also experience additional inflows of deposits due to implicit bail-out guarantees during crisis times (as e.g. described by [Gatev, Schuermann, and Strahan, 2009](#)).¹³

And indeed, the descriptive statistics for the present sample of banks that report interest rates to Bundesbank ([Table 3](#)) indicate significant differences with respect to dependent and control variables between the treatment and control group.

To address resulting concerns about sample selection bias, we create a matched sample based on propensity score matching following [Caliendo and Kopeinig \(2008\)](#). We match each bank in the treatment group with its nearest neighbor in the control group and subsequently drop all banks in the sample which cannot be matched or do not fulfill the common support assumption. Subsequently, we re-estimate [Equation \(2\)](#) for the matched sample and accordingly report results in [Table 5](#).

To conserve on space, we only depict the coefficient of interest, namely 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 even increases in magnitude. The result suggests a 13.5 basis point decrease per one percent in facility usage, corresponding to an economically significant change of 4.4% in short-term deposit funding cost for the average bank.

¹³Note that we do not find any changes in the volumes of deposits to corroborate this concern.

Table 5: Matched control group

Regression results for deposits and credits to non-financial corporations on a sample matched by propensity score matching. The sample is composed of monthly data ranging from December 2007 to April 2010 (29 months). 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. *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 $\ln(\text{Total Assets})$, *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), and *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets). All regressions include bank \times 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 (); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Short-Term		Long-Term	
	Deposits	Credits	Deposits	Credits
USAGE	-0.135*** (0.048)	-0.033 (0.055)	-0.132 (0.117)	-0.015 (0.047)
R^2	0.99	0.93	0.80	0.87
N	1,318	1,318	1,318	1,318
<hr style="border-top: 1px dashed black;"/>				
<i>Estimation sample properties</i>				
# of banks	87	87	87	87
# of treated banks	68	68	68	68
Dependent variable Mean	1.914	3.941	3.288	4.804
Dependent variable SD	1.567	1.543	0.964	0.823
USAGE Mean	0.630	0.630	0.630	0.630
USAGE SD	0.979	0.979	0.979	0.979
Bank x semi-annual FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes

4.3.2 Random usage assignment

Next, we challenge our test design to define banks as treated depending on their usage of U.S. liquidity facilities while these were in place and conduct two placebo treatment tests. First, instead of the observed usage of facilities ranging between December 2007 and May 2010, we pre-date the timing of liquidity facilities by three years in *Panel A* of Table 6.

The results are not significantly different from zero, thereby confirming 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 *Panel B* 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.

4.4 Facility support and pre-crisis ABCP exposure

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? Or was access to the facilities used similarly by all banks, irrespective of crisis exposure?

To analyze if liquidity assistance access was larger for those banks with large pre-crisis ABCP exposure, we specify an interaction model and show according results in Table 7. Shedding light on the role of large pre-crisis ABCP exposures is particularly relevant in our sample, because several banks based in Germany held very large amounts of ABCP. Since this market was one of the first and most severely affected during the crisis, pre-crisis ABCP approximate well how affected an IBHC was by the financial crisis.

Data on end-of-2006 exposure to ABCP are obtained from [Acharya et al. \(2014\)](#). The dataset contains both the ABCP balance in billion USD, as well as the bank's corresponding end-of-2006 total equity in billion USD. For the variable *ABCP*, the total ABCP balance is divided by total equity. We divide this ratio by 1000 for better scaling as the ABCP balance is relatively large compared to total equity. The resulting variable thus measures the group's exposure in 1000 USD of ABCP per 1 USD of group equity. In case of banks that later on belong to one IBHC, but are listed separately in the dataset, the sum of outstanding ABCP is scaled with the sum of total equity.

The results for short-term rates confirm and corroborate our earlier findings that funding cost of banks in Germany, which were able to use U.S. liquidity facilities exhibit

Table 6: Placebo test results

Regression results for deposits and credits to non-financial corporations, with facility usage moved to three years prior to the actual usage (Panel A) and randomly assigned facility usage (Panel B). 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. 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 $\ln(\text{Total Assets})$, *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), and *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets). All regressions include bank \times 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 (); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

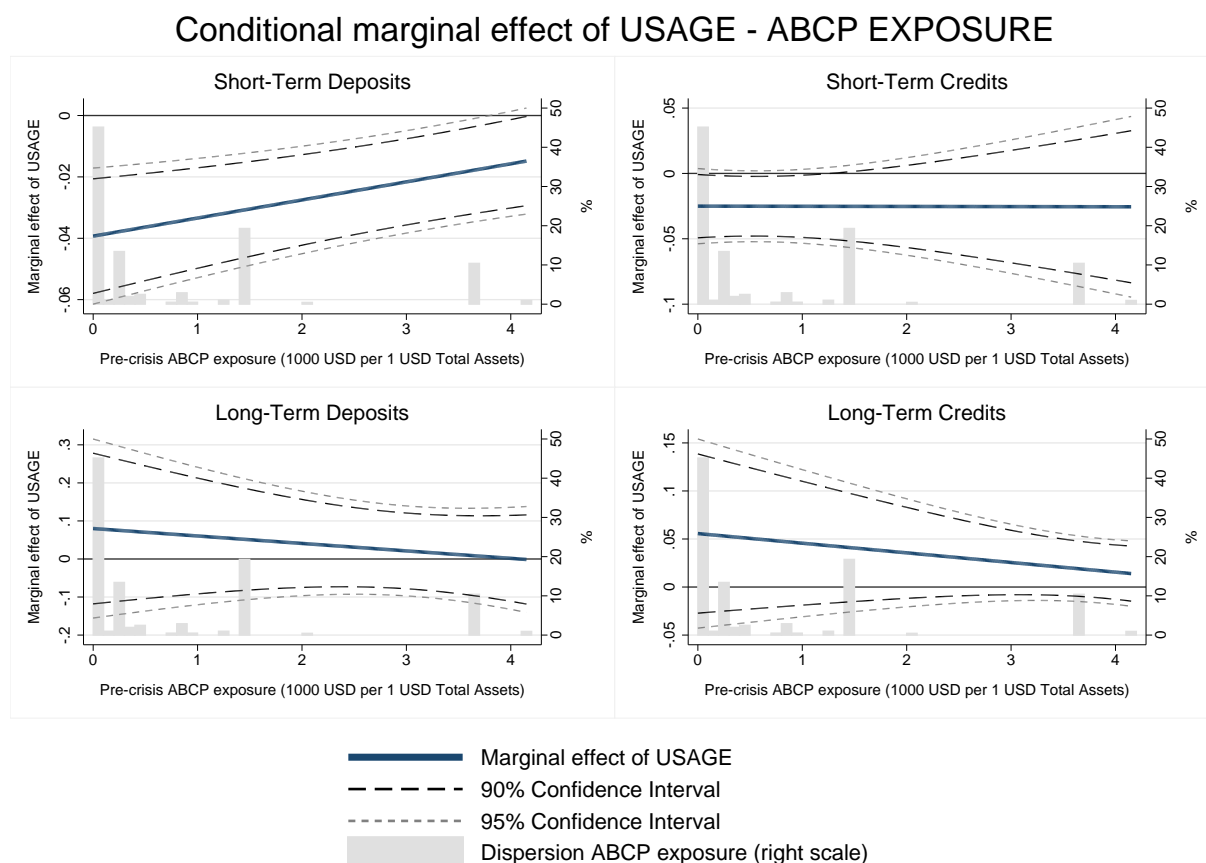
	Short-Term		Long-Term	
	Deposits	Credits	Deposits	Credits
<i>Panel A: Treatment three years prior to actual usage</i>				
USAGE	0.016 (0.012)	0.047 (0.076)	-0.103 (0.185)	-0.055 (0.041)
R^2	0.95	0.58	0.62	0.51
N	3,789	3,710	1,105	3,566
<i>Estimation sample properties</i>				
# of banks	154	149	107	146
# of treated banks	104	107	79	105
Dependent variable Mean	2.566	4.752	3.347	4.757
Dependent variable SD	0.638	0.997	0.923	0.683
USAGE Mean	0.164	0.167	0.227	0.170
USAGE SD	0.333	0.336	0.454	0.345
<i>Panel B: Random treatment</i>				
USAGE	0.000 (0.001)	-0.001 (0.001)	0.006 (0.005)	0.000 (0.002)
R^2	0.98	0.91	0.76	0.64
N	3,672	3,634	1,378	3,588
<i>Estimation sample properties</i>				
# of banks	145	139	116	141
# of treated banks	98	101	81	100
Dependent variable Mean	2.464	4.455	3.379	4.899
Dependent variable SD	1.690	1.708	1.035	0.819
USAGE Mean	1.525	1.466	1.260	1.320
USAGE SD	7.364	7.652	5.707	6.863
Bank x semi-annual FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes

Table 7: Access to funding facilities and pre-crisis ABCP exposure

Regression results for deposits and credits to non-financial corporations. The sample is composed of monthly data ranging from December 007 to April 2010 (29 months). *USAGE* is measured as Federal Reserve funds outstanding in percent of group total assets. *ABCP* refers to the end-of-2006 balance of ABCPs in thousands of EUR per total group equity. 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 $\ln(\text{Total Assets})$, *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), and *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets). All regressions include bank \times 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 (); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Short-Term		Long-Term	
	Deposits	Credits	Deposits	Credits
USAGE	-0.039*** (0.010)	-0.025* (0.014)	0.080 (0.110)	0.056 (0.049)
ABCP x USAGE	0.006*** (0.002)	-0.000 (0.008)	-0.020 (0.030)	-0.010 (0.012)
R^2	0.98	0.91	0.76	0.64
N	3,672	3,634	1,378	3,588
<hr style="border-top: 1px dashed black;"/>				
<i>Estimation sample properties</i>				
# of banks	145	139	116	141
# of treated banks	98	101	81	100
Dependent variable Mean	2.464	4.455	3.379	4.899
Dependent variable SD	1.690	1.708	1.035	0.819
USAGE Mean	0.606	0.619	0.568	0.602
USAGE SD	1.152	1.182	0.955	1.097
ABCP Mean	1.133	1.135	1.054	1.122
ABCP SD	1.299	1.273	1.284	1.274
Bank x semi-annual FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes

Figure 7: Effects of facility funds on corporate products conditional on pre-crisis ABCP exposure
 Graphs illustrate the marginal effect of the treatment variable *USAGE* conditional of pre-crisis ABCP exposure. Marginal effects are calculated based on the OLS regression results presented in Table 7. The regression includes control variables lagged by one month and winsorized at 1% on both ends, as well as bank \times 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 %.



significantly lower deposit rates. Contrary to the baseline reports above, we now also find a contemporaneous negative effect on short-term loans of corporates. The finding that long-term rates charged to German corporations are not responding significantly to U.S. liquidity provision is also confirmed.

But both the direct pre-crisis exposure to the ABCP market as well as the interaction terms are mostly insignificant, the exception being a small positive coefficient estimated for the effect on short-term deposit rates. To assess the effect of economic magnitude, we show the total marginal effect. Figure 7 shows accordingly conditional marginal effects of *USAGE* with respect to the four interest rates conditional on the distribution of ABCP exposures across banks in Germany prior to the crisis.

Note, that 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 two panels of Figure 7 confirm that short-term deposit and loan rates are significantly reduced. This effect is different from zero for the funding cost across

the entire ABCP distribution, but declines for those banks with the largest pre-crisis exposures. Similarly, the reduction in short-term credit rates are significantly negative up to around 1,500 USD of ABCP exposure per USD of group equity, but not for those IBHC members with very large exposures. As such, the U.S. facilities certainly helped to reduce short term loan rates, but customers of the most crisis-affected banks did not benefit from this policy.

The bottom panels corroborate as well that long-term rates did not respond to liquidity assistance across any degree of ABCP exposure.

4.5 Bank traits

Since the main purposes of the facilities was to ease the funding pressure for banks with eminent shortage of liquidity, we also specify interactions models with observed liquidity (Table 8) and leverage (Table 9). Figures 8 and 9 depict the associated total marginal effects corresponding to these estimation results.

Emergency facilities exert their negative effect on short-term deposit rates across the entire range of liquidity positions of German banks. In fact, those 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 1 in the Online Appendix).

Short-term credit rates are only significantly reduced though for those banks with the lowest liquidity positions prior to the inception of the facilities. The transmission of unconventional liquidity lines to corporate customers relied thus primarily on banks that exhibited the worst financial conditions.

Figure 9 corroborates this qualification to the extent 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, Ongena, Peydró, and Saurina (2014), additional liquidity appears to be routed to the corporate sector in particular by the weakest banks in the system.

4.6 Alternative treatment definitions

We consider four alternative differential effects, for which we represent results in the Appendix in Tables 10 through 13. The different subsamples used in these regressions are illustrated in Figure 5.

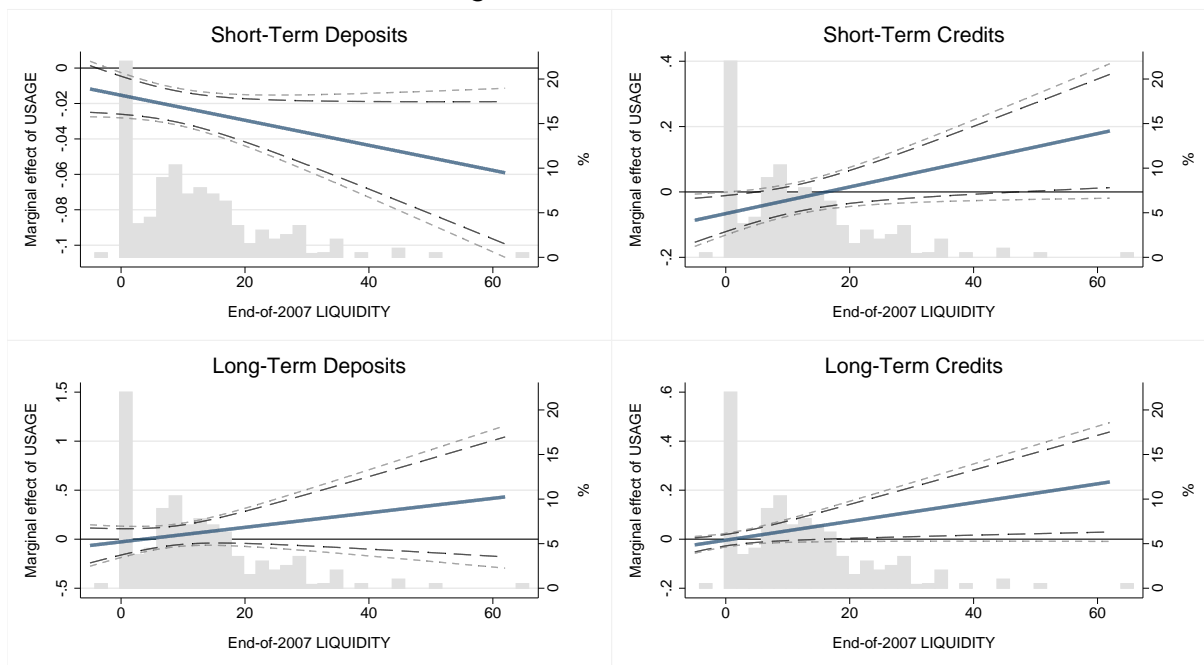
Table 8: **Access to funding facilities and pre-facility liquidity**

Regression results for deposits and credits 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. *LIQUIDITY 2007* refers to the end-of-2007 liquidity in percent of 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 $\ln(\text{Total Assets})$, *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), and *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets). All regressions include bank \times 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 (); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Short-Term		Long-Term	
	Deposits	Credits	Deposits	Credits
USAGE	-0.015*** (0.003)	-0.066** (0.032)	-0.027 (0.074)	-0.004 (0.012)
LIQUIDITY 2007 \times USAGE	-0.001*** (0.000)	0.004** (0.002)	0.007 (0.006)	0.004** (0.002)
R^2	0.98	0.91	0.76	0.64
N	3,672	3,634	1,378	3,588
<hr style="border-top: 1px dashed black;"/>				
<i>Estimation sample properties</i>				
# of banks	145	139	116	141
# of treated banks	98	101	81	100
Dependent variable Mean	2.464	4.455	3.379	4.899
Dependent variable SD	1.690	1.708	1.035	0.819
USAGE Mean	0.606	0.619	0.568	0.602
USAGE SD	1.152	1.182	0.955	1.097
LIQUIDITY 2007 Mean	11.881	11.312	10.510	11.109
LIQUIDITY 2007 SD	9.531	9.042	8.497	8.931
Bank \times semi-annual FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes

Figure 8: Effects of facility funds on corporate products conditional on pre-facility liquidity
 Graphs illustrate the marginal effect of the treatment variable *USAGE* conditional on pre-facility liquidity. Marginal effects are calculated based on the OLS regression results presented in Table 8. The regression includes control variables lagged by one month and winsorized at 1% on both ends, as well as bank \times 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 %.

Conditional marginal effect of USAGE - LIQUIDITY



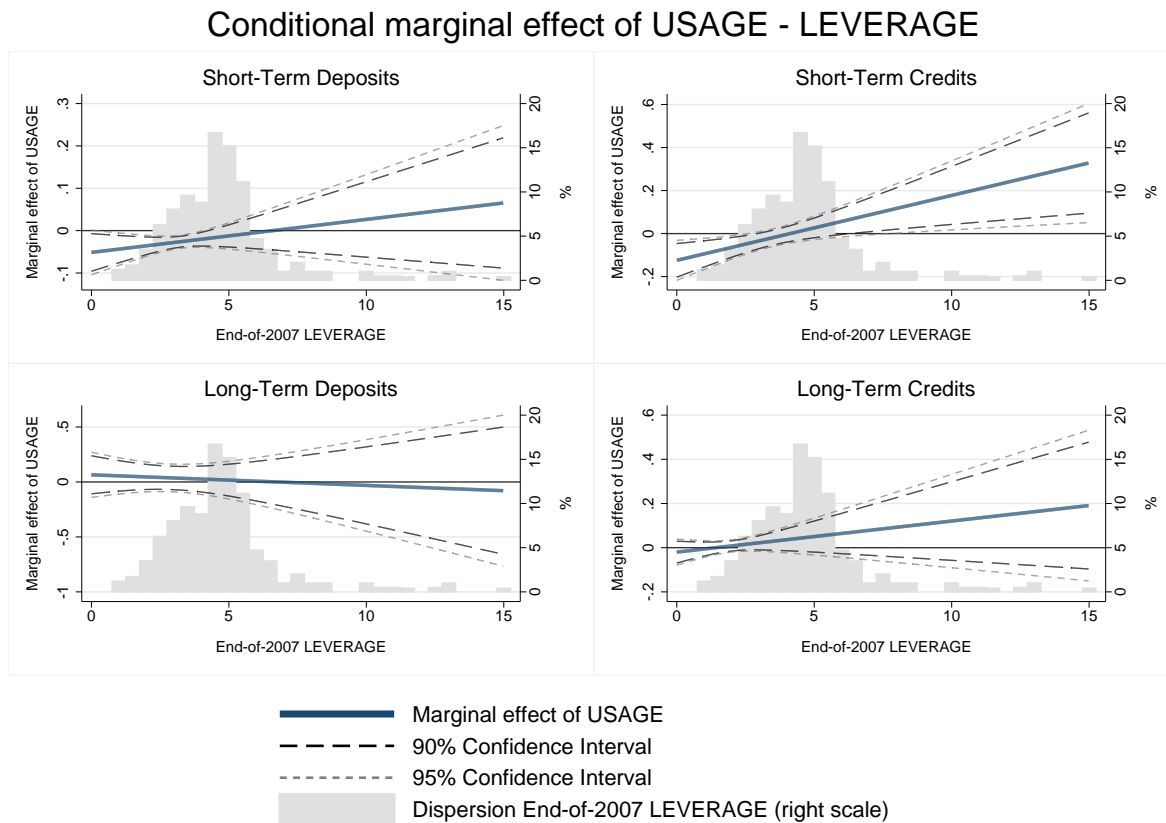
- Marginal effect of USAGE
- 90% Confidence Interval
- 95% Confidence Interval
- Dispersion End-of-2007 LIQUIDITY (right scale)

Table 9: Access to funding facilities and pre-facility leverage

Regression results for deposits and credits 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. *LEVERAGE 2007* refers to the end-of-2007 leverage ratio, given by Equity in percent of 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 $\ln(\text{Total Assets})$, *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), and *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets). All regressions include bank \times 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 (); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Short-Term		Long-Term	
	Deposits	Credits	Deposits	Credits
USAGE	-0.051*	-0.124**	0.065	-0.020
	(0.027)	(0.046)	(0.102)	(0.028)
LEVERAGE 2007 x USAGE	0.008	0.030**	-0.010	0.014
	(0.008)	(0.012)	(0.026)	(0.012)
R^2	0.98	0.91	0.76	0.64
N	3,672	3,634	1,378	3,588
<hr style="border-top: 1px dashed black;"/>				
<i>Estimation sample properties</i>				
# of banks	145	139	116	141
# of treated banks	98	101	81	100
Dependent variable Mean	2.464	4.455	3.379	4.899
Dependent variable SD	1.690	1.708	1.035	0.819
USAGE Mean	0.606	0.619	0.568	0.602
USAGE SD	1.152	1.182	0.955	1.097
LEVERAGE 2007 Mean	4.503	4.470	4.491	4.456
LEVERAGE 2007 SD	1.449	1.490	1.776	1.483
Bank x semi-annual FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes

Figure 9: Effects of facility funds on corporate products conditional on pre-facility leverage
 Graphs illustrate the marginal effect of the treatment variable *USAGE* conditional on pre-facility leverage. Marginal effects are calculated based on the OLS regression results presented in Table 9. The regression includes control variables lagged by one month and winsorized at 1% on both ends, as well as bank \times 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 %.



4.6.1 The impact of savings banks

The special type of savings banks is an important feature of the German banking landscape. Here, we employ an alternative treatment definition to determine in how far the network between savings banks and Landesbanken accounts for our previously reported results. In deviation from our 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 *Panel A* of Table 10 clearly illustrate that our results are not driven by the relatively large number of regional savings banks that 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 *Panel B* we tackle concerns that similarly to regional savings banks, local cooperative banks might also be subject to implicit or even explicit liquidity backstops by the central head institutions (DZ and WGZ Bank), 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.

4.6.2 The impact of large banks

Several banks in our sample are especially large commercial banks or serve as central institutions with special tasks for savings and cooperative banks. As such, they play a prominent role in the market and may strongly affect our results. Therefore, we exclude these large banks in Table 11 to report the effects of emergency facility support independent of these institutions. The interaction term remains significantly negative for short-term deposits whereas the absence of significant effects for short-term credit rates as well as any long-term rates is also confirmed. This result therefore strongly suggests 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.

4.6.3 Effect on German IBHC banks

Figure 5 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 that internal capital markets during crisis may favor home country banks. Therefore foreign banks with access to funding may not be affected in the same way and distort our results. In the following analysis we exclude these banks (all banks in subsamples *c*) and *d*) in Figure 5) from our data sample. The results in *Panel A* of Table 12 confirm the baseline reduction of short-term deposit rates.

We further show the difference in impact between German and non-German IBHC banks among the subsample of all banks with access to the U.S. emergency funding support (subsamples *b*), *c*) and *d*) in Figure 5) in Table 12, *Panel B*. 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. Whereas the estimated coefficients indicate qualitatively identical results compared to the baseline, the exclusion of two affiliates of U.S. IBHCs and six affiliates of other than German or U.S. IBHCs prohibit the precise estimation of these effects.

4.6.4 Effect on German IBHC heads

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 restrict our banks with access to the heads of German IBHCs (subsample *e*) in Figure 5) and analyze the effect compared to the original control group in Table 13, Panel A. Results support our baseline findings, with both increased significance and magnitude for short-term rates. This suggests that German IBHC heads lowered their short-term deposit rates and short-term rates by more than their respective subsidiaries, indicating that they exert more control over the received liquidity.

In analogy, we restrict our sample in 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 5. 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.

4.7 Further robustness of results

Next to the arguably critical definition of which banks had access to U.S. emergency facilities, we conducted a number of further robustness tests that are available in the Online Appendix. We briefly summarize the main upshots here.

An important confounding factor in explaining interest rate setting, next to liquidity provisions, might be unobserved differences in credit and deposit demand that banks face in regional markets. We therefore also specified regional unemployment as well as state \times quarter fixed effects to gauge such unobservable factors. Results remain qualitatively identical.

Next, we exclude one-by-one large banks from the commercial, the savings bank, and the cooperative bank sector, respectively, because these IBHCs themselves might be driving the results. We also exclude all pairs of two from these large banking groups. In both tests, the results remain qualitatively identical.

5 Conclusions

We test if the usage of U.S. emergency facilities that were available to affiliates of foreign banks between December 2007 until April 2010 were transmitted via internal capital

markets of international bank holding companies (IBHC), thereby affecting interest rate setting outside the U.S. banking market. To test for this international interest rate transmission, we combine detailed data about which banks used which type of U.S. liquidity assistance to what extent for how long that was released by the Federal Reserve System in 2011, following a Freedom of Information Act (FOIA) ruling in favour of the press network Bloomberg L.P. We hand-collect for banks that used the Fed liquidity support lines their connection to IBHCs that also operated banks in Germany. For this market, detailed information on the monthly pricing of new lending and deposit taking is reported by a representative sample of banks to the German central bank since January 2004.

We use a difference-in-difference set-up to compare whether banks with access to U.S. liquidity through the internal capital markets of their IBHC passed more favorable funding conditions at the group level on to their German operations. We find that short-term deposit rates exhibit a significant, contemporaneous decline in response to the usage of U.S. liquidity facilities compared to German banks without access to these funding sources. Short-term credit rates do not decline contemporaneously, but decline with a lag of two to four months. 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.

These results are also confirmed when considering banks with particularly large U.S. funding pressure due to large pre-crisis ABCP market exposures, matched samples of banks without access to U.S. liquidity assistance via internal capital markets, alternative random treatment allocation schemes, as well as four variants of how to define membership in an IBHC.

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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A Appendix Tables

Table 10: **Alternative network definitions**

The table presents OLS regression results for deposits and credits to non-financial corporations. In Panel A, savings banks are alternatively assumed to be independent from their respective Landesbank. In Panel B, cooperative banks additionally form a network with their central institutions. 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. 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 $\ln(\text{Total Assets})$, *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), and *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets). All regressions include bank \times 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 (); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Short-Term		Long-Term	
	Deposits	Credits	Deposits	Credits
<i>Panel A: Independent savings banks</i>				
USAGE	-0.022*** (0.005)	-0.031 (0.022)	0.046 (0.067)	0.009 (0.015)
R^2	0.98	0.91	0.76	0.64
N	3,672	3,634	1,378	3,588

<i>Estimation sample properties</i>				
# of banks	145	139	116	141
# of treated banks	30	33	26	32
Dependent variable Mean	2.464	4.455	3.379	4.899
Dependent variable SD	1.690	1.708	1.035	0.819
USAGE Mean	0.233	0.235	0.270	0.212
USAGE SD	1.030	1.063	0.814	0.958
<i>Panel B: Additional cooperatives bank network</i>				
USAGE	-0.020*** (0.006)	-0.031 (0.023)	0.026 (0.059)	0.025 (0.020)
R^2	0.98	0.91	0.76	0.64
N	3,672	3,634	1,378	3,588

<i>Estimation sample properties</i>				
# of banks	145	139	116	141
# of treated banks	136	130	109	134
Dependent variable Mean	2.464	4.455	3.379	4.899
Dependent variable SD	1.690	1.708	1.035	0.819
USAGE Mean	0.756	0.740	0.712	0.735
USAGE SD	1.117	1.154	0.920	1.066
Bank x semi-annual FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes

Table 11: Excluding large banks

The table presents OLS regression results for deposits and credits to non-financial corporations, without large commercial banks, Landesbanken and cooperative banks' central institutions. 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. 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 $\ln(\text{Total Assets})$, *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), and *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets). All regressions include bank \times 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 (); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Short-Term		Long-Term	
	Deposits	Credits	Deposits	Credits
USAGE	-0.023*** (0.007)	-0.024 (0.024)	-0.025 (0.061)	0.010 (0.019)
R^2	0.98	0.90	0.80	0.63
N	3,220	3,182	1,092	3,165
<i>Estimation sample properties</i>				
# of banks	127	121	101	123
# of treated banks	82	85	67	84
Dependent variable Mean	2.498	4.483	3.241	4.919
Dependent variable SD	1.679	1.720	0.930	0.802
USAGE Mean	0.590	0.605	0.479	0.589
USAGE SD	1.182	1.216	0.932	1.121
Bank x semi-annual FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes

Table 12: Effect on German banks

Regression results for deposits and credits to non-financial corporations. Panel A excludes all affiliates of foreign IBHCs. Panel B excludes banks without direct or indirect access to Federal Reserve Funds and assumes only banks of German IBHCs are treated. 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. 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 $\ln(\text{Total Assets})$, *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), and *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets). All regressions include bank \times 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 (); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Short-Term		Long-Term	
	Deposits	Credits	Deposits	Credits
<i>Panel A: Banks of German IBHCs (subsample b)) vs Control Group</i>				
USAGE	-0.020*** (0.006)	-0.030 (0.026)	0.061 (0.061)	0.024 (0.020)
R^2	0.98	0.91	0.76	0.64
N	3,575	3,538	1,330	3,534
<i>Estimation sample properties</i>				
# of banks	141	135	114	139
# of treated banks	95	98	79	98
Dependent variable Mean	2.466	4.459	3.362	4.900
Dependent variable SD	1.686	1.708	1.030	0.822
USAGE Mean	0.594	0.607	0.562	0.600
USAGE SD	1.106	1.138	0.957	1.100
<i>Panel B: Banks of German IBHCs (subsample b)) vs Banks of foreign IBHCs (subsample c)+d))</i>				
USAGE	-0.012* (0.007)	-0.033 (0.026)	0.064 (0.068)	0.021 (0.020)
R^2	0.99	0.92	0.77	0.64
N	2,541	2,640	938	2,596
<i>Estimation sample properties</i>				
# of banks	98	101	81	100
# of treated banks	95	98	79	98
Dependent variable Mean	2.403	4.416	3.439	4.903
Dependent variable SD	1.705	1.711	1.084	0.804
USAGE Mean	0.835	0.814	0.796	0.817
USAGE SD	1.233	1.252	1.054	1.213
Bank x semi-annual FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes

Table 13: Effect on German IBHC heads

Regression results for deposits and credits to non-financial corporations. Panel A includes only German IBHC heads and banks without access to Federal Reserve Funds. Panel B includes only banks of to German IBHCs with access to Federal Reserve funds, assuming only heads are treated, but not subsidiaries. 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. 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 $\ln(\text{Total Assets})$, *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), and *Central Bank Liabilities* (Net Liabilities outstanding to Central Banks in % of Total Assets). All regressions include bank \times 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 (); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Short-Term		Long-Term	
	Deposits	Credits	Deposits	Credits
<i>Panel A: Heads of German IBHCs (subsample e) vs Control Group</i>				
USAGE	-0.079*** (0.020)	-0.105** (0.041)	0.228 (0.186)	0.153 (0.103)
R^2	0.98	0.90	0.71	0.68
N	1,370	1,252	641	1,254
<i>Estimation sample properties</i>				
# of banks	55	47	45	51
# of treated banks	9	10	10	10
Dependent variable Mean	2.501	4.478	3.485	4.802
Dependent variable SD	1.669	1.663	1.088	0.898
USAGE Mean	0.149	0.163	0.279	0.141
USAGE SD	0.496	0.516	0.673	0.477
<i>Panel B: Heads of German IBHCs (subsample e) vs Subsidiaries of German IBHCs (subsample f)</i>				
USAGE	-0.028** (0.014)	-0.027 (0.023)	0.062 (0.125)	0.035 (0.029)
R^2	0.99	0.92	0.77	0.64
N	2,457	2,556	890	2,542
<i>Estimation sample properties</i>				
# of banks	95	98	79	98
# of treated banks	13	14	13	14
Dependent variable Mean	2.412	4.426	3.417	4.903
Dependent variable SD	1.704	1.713	1.081	0.809
USAGE Mean	0.116	0.112	0.231	0.102
USAGE SD	0.713	0.699	0.773	0.687
Bank x semi-annual FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes