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Does the Lack of Financial Stability Impair the Transmission of Monetary Policy?

Viral V. Acharya[#] Björn Imbierowicz[‡] Sascha Steffen[°] Daniel Teichmann[*]

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Abstract

We investigate the transmission of central bank liquidity to bank deposits and loan spreads in Europe over the January 2006 to June 2010 period. We find evidence consistent with an impaired transmission channel due to bank risk. Central bank liquidity does not translate into lower loan spreads for high-risk banks, even as it lowers deposit rates for both high-risk and low-risk banks. This adversely affects the balance sheets of high-risk bank borrowers, leading to lower payouts, lower capital expenditures, and lower employment. Overall, our results suggest that banks' capital constraints at the time of an easing of monetary policy pose a challenge to the effectiveness of the bank lending channel and the effectiveness of the central bank as a lender of last resort.

Keywords: Central bank liquidity, Monetary policy transmission, Corporate deposits, Financial crisis, Lender of last resort, Banking crisis, Loans, Real effects.

JEL classification: E43, E58, G01, G21.

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"[…] *it is nonetheless useful to recall again the limits of monetary policy. Monetary policy transmission may be hampered at times where banks, in particular, but also non-financial sectors need to repair their balance sheets. At times of uncertainty and lack of confidence liquidity may be hoarded rather than be put to use for investment. These are cases where standard monetary policy may be "pushing on a string" (in the words of John Maynard Keynes). These are also impediments that need to be fundamentally addressed by regulators and government entities, via the strengthening of financial balance sheets* […]" (Yves Mersch, Member of the Executive Board of the ECB, May 2013)

1. Introduction

Monetary policy impacts the supply of bank credit implicating a bank lending or risk-taking channel of monetary policy.[1] This approach usually ignores that banks fund their lending activities to a large extent with short-term wholesale deposits, even though the connection between monetary policy and deposit rates is important.[2] In a frictionless and perfectly competitive financial sector, monetary policy changes are passed through fully to deposit and loan rates; however, the profits from lending and deposit taking are fully competed away and unaffected by policy modifications. Financial markets, however, may not be perfectly competitive and financial intermediation subject to agency costs, for example, because some banks are undercapitalized and face regulatory and economic constraints. In turn, banks can benefit from an expansion of their margin business when overall money market rates decline as this increases their net worth (Brunnermeier and Sannikov, 2012, and Brunnermeier and Koby, 2017). In this paper, we investigate how such frictions affected the pass-through of the liquidity provision of the European Central Bank (ECB) to both deposit and loan rates and thereby provide evidence on the effectiveness of the bank-lending channel.

Our setting is the introduction of the full allotment of liquidity by the ECB in October 2008 as a response to the deepening of the global financial crisis. Prior to that date, the ECB issued liquidity to banks in a competitive tender to meet an aggregate liquidity target. Liquidity

[1] Researchers argue that (1) monetary policy affects loan supply by banks (Bernanke and Gertler, 1989, 1995; Kashyap and Stein, 2000); (2) the reduction in loan supply is due to weak bank balance sheet strength (Bernanke and Blinder, 1988; Bernanke, 2007; Jiminez et al., 2012); (3) a low monetary policy rate increases risk taking by banks (Jiminez et al., 2014; Ioannidou et al., 2015; Dell'Ariccia et al., 2017).

[2] An important exception is Drechsler et al. (2016) who argue that the deposit channel of monetary policy can explain a large part of the bank balance sheet channel.

was allocated to the banking sector such that each bank could fund its operations and meet its reserve requirements. After the default of Lehman Brothers in September 2008, the interbank markets became severely stressed (Afonso, Kovner and Schoar, 2011) preventing an efficient allocation of liquidity. On October 8, 2008, the ECB began to fulfill all liquidity requests by individual banks at the prevailing main refinancing (MRO) rate in exchange for collateral via its main refinancing operations, which eventually provided substantial excess liquidity to the banking system. This was the first time the ECB stepped in as a lender of last resort (LOLR) for the euro area banks during the financial crisis.

We construct a novel data set of deposit and loan transactions of European firms with the *same* banks during the January 2, 2006 to June 30, 2010 period and investigate the impact of "aggregate" central bank liquidity (i.e., the total liquidity in the banking system provided by the ECB) on spreads of newly issued deposits and loans before and after the introduction of the full-allotment liquidity concept exploiting cross-sectional differences in the health of these European banks. As the introductory quote suggests, during financial crises, the transmission of monetary policy might be impaired due to the weak balance sheets of some banks.[3] To the best of our knowledge, we are the first to analyze *where* the transmission channel is impaired – the funding or the loan market. This is important to understand the role of central banks during crises in addressing liquidity versus solvency problems as well as for the design of crisis-time monetary policy interventions.

We focus on deposit contracts in the first part of the paper. We show that an increase in central bank liquidity is associated with a significant decrease in bank deposit spreads during the financial crisis. This effect is also economically large in magnitude. During the financial crisis, a one standard deviation increase in liquidity reduces deposit spreads by 12.86 bps

[3] Peek and Rosengren (2012) provide a detailed review of the literature on monetary policy transmission confirming the importance of bank health in transmission during the past financial crises such as in Japan in the 90's. Kashyap and Stein (1997) highlight the cross-country differences in bank health even before the introduction of the euro.

before, and by 14.01 bps after, the introduction of the full allotment policy. Differentiating by bank risk, which we measure using credit default swaps spreads, we find that the deposit spreads of low-risk banks but not of high-risk banks decrease in response to larger amounts of liquidity *prior* to the beginning of the full allotment. Afterwards, both high- and low-risk banks similarly reduce deposit rates when central bank liquidity increases.[4]

The deposit spread differential suggests that an increase in central bank liquidity before the introduction of the full allotment policy was insufficient to reduce the funding risks of high- and low-risk banks. High-risk banks needed to pay substantially higher deposit spreads to compensate depositors and attract funds. Interbank markets were dysfunctional prior to the full allotment and (particularly low-risk) banks hoarded liquidity.[5] The ECB stepped in as LOLR meeting all banks' liquidity requests in full. Substituting for the loss of private funding, the ECB eventually reduced the funding pressure also of high-risk banks.[6]

We conduct a series of tests to address a possible endogeneity of deposit rates. One concern might be that deposit rate and volume are jointly determined. We perform four tests to address this: (1) we exclude all transactions if an earlier request of the same firm, which included interest rate offers, has been canceled on the same day; (2) we exclude all transactions executed after 10:00 am each day to avoid communication between market participants; (3) we focus exclusively on rolled-over deposits assuming that these are less sensitive to deposit rates; and (4) we implement an instrumental variable approach and find that our results remain

[4] These results hold when we include *bank-risk x quarter fixed effects* to account for unobservable (and time-invariant) variation that is both bank risk group specific in different quarters and common across high- and low-risk banks in the same quarter. It might also be that certain banks which, for example, receive state aid or other regulatory interventions behave differently compared to other, non-intervened banks. We thus also include *bank x month fixed effects*, which account for possible bank specific regulatory action within a month. Our results continue to hold. In further robustness tests, we also include *bank-week fixed effects* or test models in which we exclude all control variables and fixed effects. The results do not change.

[5] See, for example, the evidence in Afonso, Kovner, and Schoar (2011), Ashcraft, McAndrews, and Skeie (2011), or Acharya and Merrouche (2012).

[6] One concern might be that high-risk banks do not have sufficient collateral to obtain liquidity. According to the ECB monthly bulletin in October 2010 "the list of assets accepted as eligible collateral for refinancing operations was extended to further ease access to Eurosystem operations in an attempt to reduce asset-side constraints on banks' balance sheets." Insufficient collateral is therefore unlikely to explain our findings.

unchanged. A second concern might be that we only observe deposit transactions when banks have sold deposits. It might be that these are banks that are less risky or too big to fail, which could result in lower deposit spreads during crises. We show that bank risk does not play a significant role in a firm's decision with whom to deposit its funds during the financial crisis, before and after the introduction of the full allotment provision.

We also investigate how the ECB interventions as a LOLR translate into banks' loan lending decisions using the same set of banks we observe in the deposit market. We do not find (and in contrast to the deposit market) a differential impact of ECB liquidity on loan spreads for low- versus high-risk banks prior to the introduction of the full allotment policy; the loan spreads do not respond to central bank liquidity changes for either the high- or low-risk banks. After the introduction, however, the loan spreads of low-risk banks decrease while they remain unchanged for high-risk banks when the ECB increased its liquidity provision. A one standard deviation increase in ECB liquidity from its median level, which corresponds to a 40% increase in liquidity, decreases the loan spreads of low-risk banks by about 65 bps relative to high-risk banks during the full allotment period, which is economically meaningful given an average loan spread of about 306bps.

In addition, we investigate the pass-through of monetary policy for different loan maturities. We find three important results. First, the long-term loan spreads of both low- and high-risk banks do not change if central bank liquidity increases. Second, medium-term loan spreads decrease only for low-risk banks. Third, short-term loan spreads of both low- and high-risk banks decrease. Our results suggest that the transmission channel is impaired particularly for medium- and long-term loans, that is, for loans beyond a maturity of one year.

We then focus on borrowers that borrow from the same group of either low- or high-risk banks before and after the full allotment period (intensive margin). To investigate the differential effect of central bank liquidity for high-risk versus low-risk banks, we use a Heckman regression model thereby addressing concerns that firms self-select into loan-lending

relationships with these banks. We also match firms of low- and high-risk banks in the full allotment period using propensity score matching models. We find consistent results.

An interesting question might be why borrowers do not switch when high-risk banks demand higher loan spreads relative to low-risk banks. We show that high-risk banks charge higher loan spreads particularly to bank-dependent borrowers, which are typically small and medium-sized firms as well as firms without a public debt rating. This is consistent with evidence in Fazzari, Hubbard and Petersen (1988), Gertler and Gilchrist (1994) and Kashyap, Lamont and Stein (1994), who use similar proxies for borrowers' financial constraints and reliance on external funding.

To summarize, we find evidence that the transmission channel of monetary policy in the euro area is impaired in the loan market but not the deposit market even *after* the introduction of the ECB's full allotment policy. This evidence shows that banking sector balance-sheet weakness limited the role of the ECB as LOLR during financial crises. Consistent with the theoretical framework discussed in Brunnermeier and Sannikov (2012) and Brunnermeier and Koby (2017), we find that high-risk banks that charge higher loan spreads to bank-dependent customers might benefit from an increase in central bank liquidity. As the ECB effectively provided unlimited liquidity at a low interest rate, banks lowered deposit rates and refinanced their loans at lower funding costs. Not passing on these lower funding costs to borrowers increased the margins of high-risk banks and thus their net worth relaxing both regulatory and economic constraints. Hence, an increase in central bank liquidity essentially amounted to a "stealth recapitalization" of high-risk banks as argued in Brunnermeier and Sannikov (2012) and Brunnermeier and Koby (2017).

Finally, we investigate the real consequences for borrowers of high- versus low-risk banks due to the ECB's liquidity framework. We analyze changes in the capital structure and financial characteristics of firms over a three-year period after their borrowing during the full allotment period. While the borrowers of high-risk banks increase their credit lines relative to

their term loan borrowing following the ECB's liquidity provision, these firms also invest less, have lower capital expenditures and reduce the number of employees. Overall, our results suggest that the impaired transmission channel of monetary policy is associated with negative real effects of bank-dependent borrowers of high-risk banks.

The rest of the paper is organized as follows. In section two, we discuss the related literature and contributions of our paper. We then describe the institutional setting (section three) and data (section four). We next discuss the effect of central bank liquidity on deposit rates in sections five and on loan spreads in section six. In section seven, we discuss the implications for the real sector and conclude in section eight.

2. Related literature

We review the related literature and discuss our contributions to the literature in this section. Many researchers have investigated the pass-through of monetary policy on bank loan supply through the bank-lending channel and its associated real effects (e.g. Bernanke and Blinder, 1992; Kashyap et al., 1993; Kashyap and Stein, 1994, 1996; Jiminez et al., 2012). These researchers, however, do not consider how banks fund their lending business or how bank deposit and loan markets interact. However, an impaired transmission channel might originate because funding markets are stressed and the design and the effectiveness of monetary policy measures thus might depend crucially on both markets. Moreover, an important dimension of the pass-through is not only the quantity but also the pricing of deposits and loans as weak banks have incentives to increase their margins to relax regulatory and economic constraints.

Second, this literature – usually studying a contraction of monetary policy *outside* of financial crises – argues that the impact of monetary policy is larger for banks with weak balance sheets. Consequently, Jiminez et al. (2012) conjecture that an expansive monetary policy during the recent financial and sovereign debt crisis was prudent as weak banks react stronger to a monetary policy tightening during normal times. Our results suggest the opposite:

weak banks do *not* respond to expansionary monetary policy measures in the loan markets but strong, well-capitalized banks do. Thus, as far as the transmission by weak bank balance-sheets to the real sector is concerned, monetary policy easing might be pushing on a string.

Moreover, comparing the credit default swap (CDS) spreads of banks during the February 2002 to December 2008 period [which is the sample period in Jiminez et al. (2012)] to our sample period of January 2006 to June 2010, we find that weak banks had an average CDS spread of only 17bps during the earlier sample period. Strong banks in our sample period, on the other hand, have an average CDS spread of 23bps. The absolute level of risk appears to be important. During the global financial crisis, bank health substantially deteriorated due to high leverage and poor quality assets. In turn, solvency risks spilled over into short-term funding markets. Consequently, monetary policy transmission and central bank liquidity allocation in short-term funding markets was impaired until the ECB stepped in as LOLR and provided abundant liquidity for high- and low-risk banks. The ECB thus successfully reduced tensions in the money market. However, this intervention was not adequate for the loan market likely due to bank solvency concerns: high-risk banks kept loan interest rates, *ceteris paribus*, higher than low-risk banks, consistent with the theoretical predictions in Brunnermeier and Sannikov (2012).

Our paper also relates to the literature that more broadly shows that bank loan supply declines during financial crises when the banking system is weak (Peek and Rosengren, 1995, Ivashina and Scharfstein, 2010, Popov and van Horen, 2015). In a recent paper, Heider et al. (2017) demonstrate a special role of deposits for bank loan supply when policy rates become negative. We add to this literature by documenting empirically that large liquidity injections by central banks do not reduce financial frictions of bank-dependent firms if the banking sector is under-capitalized.

3. Institutional setting

In order to understand the effect of central bank liquidity on short-term deposit and loan spreads,

it is useful to briefly review the standard instruments of monetary policy in the eurozone (i.e., open market operations, standing facilities, and minimum reserve requirements), and to highlight the ECB's major policy changes.

In contrast to the United States, where open market operations are primarily conducted by buying Treasury bonds, the ECB uses its main refinancing operations (MRO), in which it provides liquidity to financial institutions in exchange for collateral (repurchase agreements) in fixed-rate or variable-rate tenders. These operations are usually conducted on a weekly basis and have a maturity of one week up to three months. By increasing or reducing interest rates in MROs as well as changing the size of the allotment, the ECB can affect both market interest rates and liquidity. The ECB follows a liquidity-neutral allotment concept (i.e., liquidity provision is based on its assessment of the liquidity needs of the banking system in the Eurozone).

The ECB can provide and absorb overnight liquidity using its standing facilities. Banks can use the deposit facility to make unlimited overnight deposits at an interest rate that is usually (at least before the financial crisis started) 1% below the MRO rate. Banks can use the marginal lending facility to obtain overnight liquidity that is usually 1% above the MRO rate. The available collateral restricts the amount a bank can borrow. The standing facilities thus provide a corridor for overnight interest rates.

Monetary policy also includes minimum reserve requirements, which require banks to hold deposits on accounts in the Eurosystem that reflect the amount of banks' customer deposits. The ECB uses minimum reserve requirements to smooth short-term interest rates by averaging positions over a specific period. The minimum reserves are remunerated at the MRO rate. Excess reserves, however, are transferred to the deposit facility. That is, banks usually hold only the minimum reserves at the ECB if money markets are able to redistribute liquidity from banks with a liquidity surplus to banks with a liquidity deficit. In the pre-crisis period, there was no need to hold excess reserves at the ECB, as liquidity was readily available in the

money markets, and central bank liquidity was determined by reserve requirements. The recent financial crisis, however, had a profound impact on European money markets. Banks became increasingly reluctant to lend to each other, which led to further segmentation of this market, particularly in cross-border transactions. The 3-month EURIBOR-OIS spread, the difference between the euro interbank offered rate and overnight indexed swaps, increased to more than 200 bps during the August 2007 to October 2008 period, emphasizing the stress in money markets in the Eurozone.

The ECB was not able to sustain its liquidity-neutral allotment concept during the financial crisis because it became increasingly difficult to forecast the liquidity needs of the banking system. The ECB therefore changed its liquidity provision framework on October 8, 2008 to fully satisfy bank demand for liquidity at a fixed interest rate (fixed rate full allotment). This shift in liquidity provision substantially increased the aggregate liquidity in the banking system, which is reflected in a sharp increase in the deposit facility. The fixed rate full allotment procedure will continue at least until December 2017.

4. Data

We discuss our sample selection and descriptive statistics in this section. All variables are described in Appendix A1.

4.1. Sample selection

To investigate the effect of central bank liquidity on deposit spreads, we employ a unique and proprietary data set from a European trading platform, which ranks among the three largest platforms by volume in Europe. The deposits are sizeable. The average deposit amount on a specific day with each bank over a one-year period corresponds to about 15% of a bank's end of year short-term liabilities. Prior to trading, banks and firms agree on the procedures and execution of trades and sign a framework agreement. This agreement applies to all future trades on the platform. Firms can offer any deposit amount with any maturity. All banks using the platform observe this offer and can bid for the deposit during a pre-specified time period, which

usually is limited to two minutes and is initially set by each firm. Until the end of this period, a firm can select a bid based on its preferences. Banks do not observe other banks' bids but can adjust their offer during the bidding period. This implies that banks adjust their pricing during the bidding process only idiosyncratically, not in response to other banks' bids. Interest rates are quoted on an actual/360 day count convention and transactions are settled on the same day.[7]

Our sample includes executed deposit transactions with a maximum maturity of seven days that are between non-financial firms and banks during the January 2006 to June 2010 period. The maximum maturity is in line with the Eurosystem's regular open market operations as described above. We do not have specific information on individual firms on the platform but have a unique platform-specific identifier for each firm that allows us to distinguish between depositors. Bank competition is measured at the transaction level using the number of banks bidding for the respective deposit. The final sample includes 40,638 euro-denominated deposit transactions from 145 European firms to 43 banks.

Our loan-level data are based on the universe of loan facilities in the LPC DealScan database during the January 2006 to June 2010 period. We drop all loans where we cannot match the borrower to the Chava-Roberts (DealScan-Compustat) link file (which are usually private borrowers and thus not listed on the Compustat database). We collect annual financial statement information for all non-financial firms from Compustat and merge it (with a one-year lag) to each loan contract and require that loan spread, maturity, amount, performance pricing and secured versus unsecured status are available for all loans. We select the lead bank for each loan following Sufi (2007) and Ivashina (2009) and control for mergers and acquisitions (M&As) among banks. We exclude loans from banks that do not operate on the deposit trading platform during our sample period. Overall, our final loan sample includes 2,632 firm-bank loan facilities from 38 banks to 566 firms.[8]

[7]Appendix A2 shows an example of a deposit auction and how the bids are quoted.
[8]Appendix A3 includes a table showing the how many loan observations are dropped during our matching procedure. We also provide a comparison of our sample with the overall sample of European firms. We find that

To measure the amount of *Central Bank Liquidity* available in the banking system, we use the natural logarithm of the sum of the banks' current account and deposit facility holdings with the ECB, centered by their mean value in 2006. These daily data are provided by the ECB. We call this variable *Adjusted Liquidity in the Banking Sector* and use it as our main measure of central bank liquidity in our analyses.[9]

Annual bank characteristics are collected from Bankscope and matched (with a one-year lag) to each deposit and loan transaction. As a measure of bank risk, we use bank CDS spreads with a maturity of five years from Credit Market Analysis (CMA). Using an iterative procedure explained in more detail in Appendix A1, we ensure that high-risk banks have, on average, at least twice the spread of low-risk banks in each week.[10] The 3-month EURIBOR-OIS spread is obtained from the Deutsche Bundesbank and is used as a proxy for counterparty risk in the interbank market. The indicator variable *End of the Reserve Maintenance Period* is one on the last day of the reserve maintenance period and is derived using data from the ECB.

4.2. Descriptive statistics

The data run from January 2, 2006 until June 30, 2010. Table 1 reports descriptive statistics on central market liquidity (Panel A), corporate deposits (Panel B), and loans (Panel C). All data are deflated with 2006 as the base year. Panel A of Table 1 shows the development of central bank liquidity during the pre-financial crisis period, the crisis period until full allotment, and the full allotment period. Using the adjusted liquidity in the banking sector as an

loan spreads are, on average, not significantly different between both samples. Our sample firms are larger both in terms of total assets and loan facility size, have more leverage and lower interest coverage, and also have more tangible assets as they are arguably more mature firms.

[9] We also use other measures for central bank liquidity. These are the *Liquidity in the Banking Sector*, the *Excess Liquidity Ratio*, and the *Liquidity Monetary Operations*. A detailed explanation of all our measures for central bank liquidity in the banking sector is provided in Appendix A1. We also perform all our analyses with these other measures but do not report them for brevity. All results remain robust.

[10] In addition to bank CDS spreads, we also use banks' Moody's long-term issuer credit rating as a measure of credit risk. Importantly, using either method, banks change their risk classification very infrequently. In unreported robustness checks, we exclude all banks that migrate between risk classes during the full allotment period and re-run our regressions. In a different test, we use CDS spreads before the start of the financial crisis (Aug. 9, 2007) to distinguish between high- and low-risk banks. The results remain unchanged. We report the results in Appendix Table A4.

example, we document that central bank liquidity increased from €6 billion in the pre-financial crisis period to €183 billion in the full allotment period.[11]

[Insert Table 1 near here]

Figure 1 depicts the time series using all four measures of central bank liquidity.[12] All measures reflect the same pattern. Prior to the financial crisis, the ECB allotted liquidity to banks such that these were able to fulfill their reserve requirements with very limited excess holdings. This is intuitive given the low interest rate earned in the deposit facility, which during normal times gives banks incentives to lend out excess liquidity in the interbank. After the start of the financial crisis, the ECB started a "frontloading" policy and allocated funds to the market in excess of the benchmark liquidity in the early maintenance period and absorbed these gradually over time (Eisenschmidt, Hirsch, and Linzert, 2009). Figure 1 shows an increase in the amount and volatility of liquidity. The start of the full allotment of liquidity at a fixed rate resulted in a strong increase in aggregate central bank liquidity. On June 25, 2009, the ECB announced it would provide additional liquidity via long-term refinancing operations (LTRO) with a maturity of one year, which induced another surge in aggregate liquidity.

[Insert Fig. 1 near here]

Panel B of Table 1 reports deposit characteristics. The average deposit has a maturity of 1.86 days (*Average Duration*), with an annual *Deposit Rate* of 226.7 bps and a *Deposit Spread* of 51.41 bps.[13] The *Average Notional Deposit Amount* of a transaction is €71 million. Deposit rates and spreads decrease sharply between the pre-full allotment and the full allotment period. On average, about three banks bid for each deposit offered on the plattform.

Panel C of Table 1 reports the loan characteristics. Loan spreads (*AISD*), on average,

[11] The results of an augmented Dickey-Fuller test suggests that central bank liquidity is generated through a stationary process.
[12] The spikes in the figure relate to the last day of the reserve maintenance period. We account for these in all our regressions via the variable *End of Reserve Maintenance Period*.
[13] The deposit spread is defined as the deposit interest rate of a transaction minus the risk free interest rate where we use the marginal deposit facility of the ECB. We also repeat all the analyses also with the main refinancing rate of the ECB as the risk-free interest rate. All results remain robust.

are 183 bps. The spreads increased during the financial crisis and were almost twice as high during the full allotment period. Loan maturities (*Maturity in Months*) and loan amounts (*Facility Size*), on the other hand, substantially shortened. The average loan matures in 54 months and is €799 million in size during our sample period.

4.3. Interest rates

Panel A of Figure 2 depicts the development of the deposit facility, marginal lending facility, MRO, as well as the short-term corporate deposit rates over the 2006 to mid-2010 period. Prior to the financial crisis, the deposit rate was anchored to the MRO. The figure shows that a functioning interbank market together with tender operations with limited allotment allowed banks to actively manage their liquidity, as well as the ECB to steer corporate deposit rates close to the MRO.

[Insert Fig. 2 near here]

Although deposit rates became more volatile at the onset of the financial crisis, the corporate deposit rate remained close to the main refinancing rate. However, with the introduction of the ECB's full allotment policy, the deposit rate dropped sharply moving more closely to the ECB deposit facility interest rate as a direct effect of excess liquidity in the banking system. Panel B of Figure 2 shows the strong negative relation between corporate deposit spreads and aggregate liquidity. Overall, Figure 2 provides the first evidence that monetary policy expansion lowers short-term corporate deposit spreads in financial crises, an effect difficult to identify in normal times.

Panel A of Figure 3 shows the average CDS spread differential between high- and low-risk banks. CDS spreads strongly increased at the start of the financial crisis for high- and low-risk banks and remained at elevated levels, especially for high-risk banks, until June 2010. Panel B shows that deposit spreads decrease during the full allotment period, particularly for the high-risk banks. Panel C shows that low-risk banks charge lower loan spreads than high-risk banks in the full allotment period, which suggests that the transmission of monetary policy to the loan

market might be impaired.

[Insert Fig. 3 near here]

5. Monetary policy and corporate deposits

5.1. Transmission of central bank liquidity to corporate deposit spreads

We first investigate how aggregate central bank liquidity affects corporate deposit spreads before and after the ECB's implementation of the full allotment. We analyze deposit transactions for the January 2, 2006 to June 30, 2010 period and differentiate the transactions into the pre-financial crisis period (January 2, 2006 to August 8, 2007), the financial crisis until full allotment period (August 8, 2007 to October 7, 2008), and the full allotment period (October 8, 2008 to June 30, 2010). We use the following regression model:

$$
\begin{aligned}
&Deposit\ Spread_{i,j,t} \\
&\quad = \alpha + \beta_1 * Central\ Bank\ Liquidity_t + \beta_2 * High\ Bank\ Risk_{j,t} \\
&\quad + \beta_3 * \log(Deposit\ Amount)_{i,j,t} + \beta_4 * Deposit\ Duration_{i,j,t} \\
&\quad + \beta_5 * Bank\ Competition_t + \beta_6 * 3\ m\ EURIBOR - EONIA\ Swap\ Spread_t \\
&\quad + \beta_7 * End\ of\ Reserve\ Maintenance\ Period_t \\
&\quad + \sum_{i=8}^{I} \vartheta_i \quad * Bank\ Controls_{j,t-1} + \mu_j + \delta_i + \gamma_t + \varepsilon_{i,j,t}
\end{aligned}
$$

where the dependent variable is the corporate deposit spread paid by bank *j* to firm *i* at date *t* and the main inference variable is the contemporaneous central bank liquidity measure. We also include other variables that might affect deposit spreads. We include *High Bank Risk,* which we measure using CDS spreads as explained in Section 4.1, in the week prior to the transaction, bank characteristics from most recent end-of-year financial statements. We also include variables to control for the notional deposit amount and duration, a Herfindahl Index calculated as the sum of the squared market share of each bank over the last week using deposit volume (*Bank Competition*), market risk (*3m EURIBOR - EONIA Swap Spread*), and an indicator variable for the last day of the reserve maintenance period to control for the seasonality of ECB liquidity. All models include firm (δ_i) and quarterly fixed effects (γ_t). μ_j

are bank fixed effects. We include indicator variables for bank accounting standards. Standard errors are clustered at the firm- and at the week-level (unreported for brevity) using the methods in Cameron, Gelbach and Miller (2011) and Thompson (2011). Table 2 reports the results.

[Insert Table 2 near here]

The results in column (1) of Table 2 documents that an increase in central bank liquidity results in lower corporate deposit spreads. Columns (2) to (4) show that this effect is only present during the financial crisis period. A one standard deviation increase in central bank liquidity reduces deposit spreads by 12.86 bps in the financial crisis until the initiation of the full allotment period and by 14.01 bps in the full allotment period. Riskier banks pay higher deposit spreads (the coefficient of *High Bank Risk* is positive, however, not statistically significant). Moreover, during the financial crisis, larger banks pay lower spreads, especially during the full allotment period, which is consistent with the existence of a public guarantee for banks that protect their senior creditors during bailouts.

The results for our remaining control variables are as expected: deposits with a longer maturity and more bank competition have higher spreads while deposit spreads in general strongly decreased during the full allotment period.[14] In addition, higher market risk is associated with lower deposit spreads during the financial crisis until the full allotment period begins, suggesting that firms prefer short-term deposits in crises, which is consistent with a flight to money market depositing (Baglioni, 2009). On the last day of the reserve maintenance period, deposit spreads decline, on average. This might be driven by banks that hold excess liquidity over the reserve maintenance period and offer overnight funds on this day that compete with corporate deposits.[15]

[14] Note that the high explanatory power in column (1) derives from the time fixed effects, which alone explain more than 80% of the variation in deposit spreads. In robustness checks, we also employ monthly, semi-annual, and annual time fixed effects, which does not qualitatively change our findings.

[15] Figure 2 demonstrates that deposit spreads increase rather than decrease on these days. However, our data show that although the increases are substantial in some instances (and can therefore be better observed in the figure), the number of deposit spreads reductions on the last day of the reserve maintenance period is much higher.

5.2. Funding risk of high- versus low-risk banks

The results in the previous subsection suggest that the ECB successfully reduced the funding risk of banks during the financial crisis: a higher amount of central bank liquidity decreases corporate deposit spreads. In this subsection, we analyze possible differences in the transmission of central bank liquidity for low versus high-risk banks. We interact *Central Bank Liquidity* with indicator variables for high- and low-risk banks and investigate the effect of aggregate central bank liquidity during the financial crisis. We augment our model specifications and also include *bank risk x quarter fixed effects*. Our implicit assumption is that bank shocks occur at the bank-risk and quarter level. We report the results in Panel A of Table 3.

Column1 (1) and (2) in Panel A of Table 3 show the results before the full allotment period; the regression for column (2) includes the interaction terms. We find a differential effect of central bank liquidity on deposit spreads of high- versus low-risk banks. While the deposit spreads of low-risk banks decrease in response to larger amounts of central bank liquidity, the coefficient for the aggregate liquidity of high-risk banks is only significant at the 10% level and is much smaller. A Wald test under the null hypothesis that these coefficients are equivalent is rejected at the 1% significance level. However, during the full allotment period, there is no evidence of this difference (columns (3) and (4)) and higher aggregate liquidity similarly reduces the deposit spreads of both high- and low-risk banks (column (4)).

[Insert Table 3 near here]

What explains the differential transmission of aggregate liquidity on deposit spreads before the ECB implemented the full allotment framework and what changed afterwards? At the beginning of the financial crisis, credit market shocks transmitted into funding markets that became increasingly stressed (e.g. the 3m EURIBOR-OIS spread increased above 200bps at that time). Banks started hoarding liquidity as a precautionary measure to ensure the availability of liquidity for day-to-day operations (Heider et al., 2015). Aggregate liquidity, in turn, was

insufficiently distributed in the interbank market. At that time, the ECB only allocated enough aggregate liquidity for banks to fulfill their reserve requirements.[16] Our deposit spread differential evidence suggests that central bank liquidity during this phase was insufficient to reduce funding risk of both low- and high-risk banks.[17] High-risk banks needed to pay substantially higher deposit spreads to compensate depositors and attract funds. The differential effect of ECB liquidity on deposit spreads dissipated after the ECB stepped in as a LOLR and introduced its' full allotment policy allotting liquidity as requested by European banks in full.[18]

5.3. Robustness

In this subsection, we discuss the robustness of our results for corporate deposits. Other bank and regulatory actions took place during the financial crisis that might affect our results. We re-run all of our regressions and include monthly time fixed effects to account for specific actions related to all banks in a specific month (e.g. regulatory actions or announcements of other monetary policy changes). In one set of regressions, we include bank risk group x month fixed effects to account for shocks in one month specific to our bank risk groups. In another set of regressions, we employ *bank x month fixed effects*, assuming that bank specific shocks occur at the bank-month level. The results are shown in Panel B of Table 3.

The results in columns (1) to (4) of Panel B of Table 3 support our previous findings. The differences between bank risk types in the transmission of central bank liquidity to corporate money market deposit spreads during the financial crisis until the full allotment period are substantial. During the full allotment period, this difference disappears and more liquidity reduces deposit spreads of banks irrespective of risk. In columns (5) and (6) we report

[16] Strong banks might even bid strategically in central bank tenders (Fecht, Nyborg, and Rocholl, 2011; Cassola, Hortacsu, and Kastl, 2013) and deliberately under-provide lending to weaker banks (Acharya, Gromb, and Yorulmazer, 2012).

[17] The Bank for International Settlements (BIS) even reports that borrowing from a central bank might have been a stigma elevating funding problems of high-risk banks even further.

[18] Our results do not imply a reduction in market discipline due to ECB liquidity provision. In unreported tests, we show that the deposit spread differential between high- and low-risk bank does not change when liquidity increases. Overall, the evidence shown in this paper suggest that the deposit market is not characterized by market discipline and that bank risk is not priced in corporate deposits.

results of regressions without any control variables. We find that the coefficients for *Central Bank Liquidity* are similar to the saturated models. This indicates that our main measure of monetary policy is not highly correlated with other covariates. Instead of using a contemporaneous measure of *Central Bank Liquidity*, we use the average over the week prior to the transaction as in De Andoain et al. (2015) and find very similar results (columns (7) and (8)).[19]

5.4. Endogeneity of deposit spreads

We provide different tests to address possible concerns with the identification of the transmission of monetary policy to deposit spreads.

5.4.1. Selection of banks during the deposit auction

One possible concern with the identification of the transmission of monetary policy to deposit spreads is that we only include banks that obtain deposits in wholesale markets. However, risky banks, or those not benefiting from a too-big-to-fail guarantee, might not be able to secure deposits. We address this matter using data from the deposit auction process, during which we observe all banks bidding for deposits. Specifically, we investigate the criteria based on which a firm selects a bank. We construct a new indicator variable (*Selected*) that is equal to one if a bank is selected in the deposit auction and run an OLS regression with *Selected* as the dependent variable including only auctions with at least two bidding banks during the full allotment period. The results are reported in column (1) of Panel A of Table 4.

[Insert Table 4 near here]

As explanatory variables, we include a measure of bank risk that is constructed as the natural logarithm of one plus the risk ranking of a bank within an auction based on the bank's CDS prices (*Bank Risk Ranking within Auction*). We create another variable that is equal to one if the bank's bid is the highest bid among all banks within the auction (*Highest Bid of Auction*).

[19] In further tests, we aggregate the data at the bank-firm-week level to address possible noise in the data that is associated with higher frequency data. We find similar results which we report in Appendix Table A5.

We include *bank x quarter fixed effects* to control for bank-specific changes at the quarter level and add *bank x firm fixed effects* to control for bank-firm-specific effects (such as the same country or relationships) and cluster standard errors at the bank level. The coefficient of *High Bank Risk* is economically small and statistically insignificant. The highest bid, on the other hand, is highly significant. In other words, firms did not include bank risk in their bank selection process but were more likely to choose banks offering the highest deposit rates.

5.4.2. Joint determination of deposit amount and spread

Another possible concern might be that deposit amount and deposit spread are jointly determined. Firms might offer different deposit amounts depending on the deposit rate or banks might bid differently depending on the notional amount offered. We address this possible endogeneity in two ways.

First, we investigate transactions in which a joint determination of volume and deposit spread are less likely. While depositors on the auction platform offer their funds and then receive interest rate bids, some firms might cancel an offer and replace it with a new one. We therefore exclude all transactions that are executed if an earlier offer by the same firm is canceled on the same day (columns (2) and (3)). Furthermore, information about interest rates quoted on the platform might disseminate and firms adjust their deposit amounts on the platform in response. We limit our data set to transactions which are made prior to 10:00 am on a given day, which makes it less likely that information about interest rates has been communicated between depositors (columns (4) and (5)). Moreover, we investigate only deposits that are rolled over from an earlier transaction with the same amount. In these transactions, deposit volumes are less likely related to the deposit interest rate (columns (6) and (7)). All tests support our previous results.

Second, we account for possible endogeneity between the deposit amount and deposit spread in two-stage least squares (2SLS) regressions similar to those in Acharya and Mora (2015). Ideally, we would like to have exogenous shocks to supply. However, as we do not

know the identities of the firms in our sample we cannot investigate firm-specific supply shocks. As an alternative identification strategy, we incorporate calendar effects as instruments and include dummy variables for Friday and the fourth quarter of a year in our regressions. The identifying assumption is that firms are more likely to deposit funds over weekends and during periods that include several public holidays and that the deposit supply around these dates is unrelated to deposit rates. Columns (1) and (2) in Panel B of Table 4 show the first and second stage regression results. As before, central bank liquidity lowers only the deposit spreads of low-risk banks during the financial crisis until the beginning of the full allotment period; it reduces the deposit spreads for all banks equally during the full allotment period. Note that the deposit amount is insignificant in both periods in the second stage regressions. Our instrumental variables are significant in the first stage and the coefficients are in line with our intuition. Bank risk does not enter the regressions significantly.

Overall, our results are consistent with the interpretation that the ECB stepped in as LOLR and replaced both the demand and supply side of the interbank market through its main refinancing operations and its deposit facility. Banks with excess liquidity could deposit funds while banks with funding problems could borrow funds at a low interest rate, which reduced the corporate deposit spreads of low- and high-risk banks.

6. Monetary policy and corporate loans

To investigate whether the transmission channel of monetary policy to the corporate loan market is impaired, we analyze whether low- and high-risk banks pass along their lower funding costs to their corporate clients during the full allotment period. We match banks from the corporate deposit data set to banks in DealScan and compare their lending and deposit taking behavior.

6.1. Transmission of central bank liquidity to corporate loan spreads by bank risk

We first investigate the impact of central bank liquidity on corporate loan spreads using

an empirical set-up that is comparable to our prior analysis of corporate deposit rates in Section 5. We use an average of the EBC liquidity over a three-month perio prior to loan origination as measure of central bank liquidity.[20] Following the literature on loan pricing (e.g., Ivashina, 2009), our regressions include various control variables related to borrower and bank characteristics, as well as variables to control for loan size and maturity, the number of previous loans of the borrower, whether the loan is secured and contains a performance pricing grid, and market risk (3m EURIBOR to the 3m EONIA swap spread). These variables are described in detail in Appendix A1. All models also contain bank, time, bank risk-time, borrower industry and rating, loan purpose, loan type, and loan currency fixed effects. Standard errors are clustered at the borrower level. We use the following regression specification

$$AISD_{i,j,t} = \alpha + \beta_1 x\ Central\ Bank\ Liquidity_t\ x\ High\ Bank\ Risk_{j,t} + \beta_2 x Central\ Bank\ Liquidity_t x\ Low\ Bank\ Risk_{j,t} + \sum \vartheta\ x\ Controls + \mu_j x\ \gamma_t + \varepsilon_{i,j,t}$$

where the dependent variable is the All-in-spread-drawn (AISD) of a loan from bank *j* to firm *i* at time *t*. *Controls* is an array of bank, firm and loan characteristics as well as other controls described in the previous paragraph. ($\mu_j x\ \gamma_t$) are *bank-risk x time fixed effects*. Table 5 shows the results of pooled OLS regressions using the *AISD* as the dependent variable during the financial crisis period.[21] Standard errors are clustered at the firm- and at the week-level (unreported for brevity) using the methods in Cameron, Gelbach and Miller (2011) and Thompson (2011).The results in column (1) of Table 5 show that an increase in central bank liquidity reduces loan spreads. Again, we find a differential effect for high-risk versus low-risk banks (column (2)): while low-risk banks reduce loan spreads, the interaction term with high-

[20] Loan negotiations take time to unfold before the loan contract is signed. Alternatively, we also use the average of central bank liquidity over the week and the month prior to loan origination. The results do not change and are unreported for brevity.

[21] We do not report the results for the pre-crisis period as we focus on monetary policy during the financial crisis. In the pre-crisis period, we do not find a statistically or economically significant effect of central bank liquidity on loan spreads for neither the low- or high-risk banks.

risk bank does not enter significantly into the regression.

[Insert Table 5 near here]

When we split the overall sample into the financial crisis until the full allotment period and the full allotment period, we do not find any effect of central bank liquidity on loan spreads in the financial crisis until full allotment period for either high- or low-risk banks. However, we find that an increase in central bank liquidity reduces the loan spreads of low-risk banks but not of high-risk banks in the full allotment period.[22] As our introductory quote suggests, monetary policy transmission during periods of unconventional and expansive monetary policy depends on the stability of the banking system; monetary policy might not transmit to the real sector if there are substantial differences in bank balance sheet strength across the euro area.

6.2. Intensive versus extensive Margin

We conduct further robustness tests that help us rule out that our results are driven by changes in borrower-lender matching over time or by differences in borrower risk between high- and low-risk banks

6.2.1. Heckman selection model

A possible concern with our results might be that poorly capitalized banks charge higher interest rates due to a matching of weak borrowers with weak banks during the full allotment period. We thus investigate the loan spreads of borrowers who borrow from the same group of either low- or high-risk banks before and after the full allotment period (intensive margin), as well as the likelihood that a firm switches to a new group of lenders during the full allotment period (extensive margin).

We regress an indicator variable, which is one if the borrower does not switch between

[22] Our control variables affect loan spreads as expected. Borrowers with high market-to-book ratios pay lower spreads. In the financial crisis until the beginning of the full allotment period, loans with longer maturities, a smaller size, and those that are secured have higher spreads. Higher market risk results in higher spreads in the full allotment period. As we have fewer degrees of freedom in our loan regressions compared with our deposit regressions, we also check our results in different model specifications with and without fixed effects. The results are similar.

risk groups and zero otherwise, on borrower, bank, and other control variables as explained above. If firms and banks match only on quality, we would expect bank risk and other bank characteristics to be different between borrowers who switch or do not switch banks. We use an OLS, a probit, and a logit model without fixed effects, as well as an OLS model with bank, time, bank risk-time, borrower industry and rating, and loan type, loan purpose, and loan currency fixed effects.

[Insert Table 6 near here]

The results in Panel A of Table 6 shows that bank characteristics and bank risk are not correlated with the firms' decisions to switch between bank risk groups. Neither our bank risk indicator variable nor any of the banks' characteristics are usually statistically significant.

We next investigate the effect of central bank liquidity on the loan spreads of borrowers who do not switch between bank risk groups before and during the full allotment period. Column (1) of Panel B of Table 6 shows a pooled OLS regression model, while column (2) reports the results of a Heckman selection model using the model employed for the results in column (3) of Panel A of Table 6 as the first stage. The regression results confirm our earlier results. In both models, an increase in central bank liquidity translates into lower loan spreads for borrowers of low-risk banks also when we account for borrower-lender matching. While the coefficient for high-risk banks is significant at the 10% level in column (1), it is not statistically significant in column (2). The Wald test under the null hypothesis that the coefficients of the interaction terms are identical can be rejected at the 5% level in both models. Thus, an increase in central bank liquidity reduces the loan spreads of the borrowers of low-risk banks more relative to high-risk banks in the full allotment period.

6.2.2. Propensity score matching

To ensure that these results are not driven by differences in borrower risk between high- and low-risk banks, we use different propensity score matching (PSM) models: nearest neighbor matching with 10, 50, and 100 neighbors and kernel matching using both the Gaussian

and the Epanechnikov kernel.[23] We restrict the match of neighbors for the nearest neighbor matching to a caliper of 0.1 and for the kernel matching to a bandwidth of 0.01 and use bootstrapped standard errors.[24]

[Insert Table 7 near here]

The results in Panel A of Table 7 show that in the full allotment period high-risk banks' borrowers pay on average 120 bps more when using the nearest neighbor matching methods and 100 bps more than low-risk banks' borrowers when we use the kernel matching methods and. This difference is usually significant at the 1% level.

We then focus on borrowers matched via PSM in multivariate regressions. For both the nearest neighbor and the kernel matching, we use the nearest match to each treatment firm within the defined caliper or bandwidth (n=1). Panel B of Table 7 shows the results of regressions of loan spreads on bank risk, central bank liquidity and bank control variables. We find that central bank liquidity only reduces the loan interest rates of low-risk banks in the full allotment period. The evidence reinforces our earlier result that the loan spread differential reflects an impaired transmission of monetary policy because the banking system is weak.[25]

6.3. Monetary policy and loan maturity

The ECB provides short-term liquidity and its' monetary policy thus targets the short end of the yield curve. However, investment decisions are long-term decisions and influenced by the availability of funding liquidity at longer maturities. In other words, if the transmission channel is impaired we expect to see loan-spread differences between high-and low-risk banks particularly for long-maturity loans. We differentiate between short-, medium-, and long-term

[23] We match borrowers in the full allotment period based on total assets, leverage, current ratio, coverage, market-to-book ratio, tangibility, year, borrower industry code, borrower rating, loan type, loan purpose, loan currency, loan maturity, secured, loan amount, performance pricing, and the number of previous loans.
[24] The restriction to a caliper of 0.1 for the nearest neighbor matching and to a bandwidth of 0.01 for the kernel matching ensures that the matched neighbor is very comparable to the treatment firm with respect to matching characteristics. This can result in a different number of matches between the nearest neighbor and the kernel matching because in some instances there is no neighbor within the defined caliper or bandwidth, respectively.
[25] In other tests, we also include firm x time fixed effects to further control for changes in loan demand of firms and get very similar results.

loans, which have maturities of smaller/equal to one year, one-to-five years or more than five years, respectively, and report the results in Table 8. We run our tests both on the full sample (column (1) and (2)) and on the intensive margin (column (3)).

[Insert Table 8 near here]

The results in Table 8 show that high- and low-risk banks reduce interest rates on short-term loans when central bank liquidity increases during the full allotment period. Wald tests suggest that the reduction is not significantly different between the bank risk group. In contrast, we observe significant loan spread differences between low- and high-risk banks for medium-term loans. Low-risk banks require significantly lower interest rates for medium-term loans when central bank liquidity increases. Panel A of Table 8 shows that the transmission of central bank liquidity is impaired for long-term loans. Both bank risk groups do not reduce loan spreads when central bank liquidity increases. Overall, our results suggest that monetary policy transmission is impaired for loans with maturities above one year. Thus, the investment decisions by borrowers of high-risk banks could be affected by banks' decision not to pass on lower funding costs, which we analyze in section 7.

6.4. Borrower financial constraints

An interesting question is what frictions prevent borrowers from switching from high- to low-risk banks if borrowing at high-risk banks is more expensive. A plausible explanation is that borrowers are financially constrained and thus cannot easily substitute external financing from weak banks. To test this, we follow the approach in Fazzari, Hubbard and Petersen (1988), Gertler and Gilchrist (1994) or Kashyap, Lamont and Stein (1994) and use firm size or the availability of debt ratings as proxies for borrowers' financial constraints and reliance on external funding. We classify firms as *small*, *medium* and *large* by using the 33rd and 67th percentile of the total assets of all firms in the data sample. For firm ratings, we use S&P credit ratings.

In panel B of Table 8, we find that the transmission of central bank liquidity is impaired

for bank-dependent firms at high-risk banks. High-risk banks do not reduce the loan spreads for small- and medium-sized firms as well as for firms without a public debt rating even when central bank liquidity increases. In contrast, both high- and low-risk banks require lower loan spreads from large firms and from firms with a public debt rating, when central bank liquidity increases.

7. Capital structure and real effects of bank loan supply

The results presented in the previous section show that high-risk banks only decrease the loan spreads of short-term loans in response to higher amounts of central bank liquidity; low-risk banks reduce spreads for both short- and medium-term loans. These financing constraints might affect borrower investment and financing decisions. For example, Chodorow-Reich (2014) shows that borrowers with a higher exposure to riskier banks experience negative real effects during financial crises.

In this subsection, we investigate whether banks' decision not to pass on better funding terms to borrowers affects their capital structure and investment decisions. We collect data on the relative percentage of term loans and revolving loans within a firm's capital structure, along with the notional amount of debt outstanding from Capital IQ for the 2005-2013 period. We also use additional data from Compustat for the same period to investigate potential differences in firm characteristics between borrowers who receive a loan from a high-risk relative to borrowers of low-risk banks in the full allotment period. Specifically, we use their total liabilities, payouts, capital expenditures, asset growth, investments, and number of employees.

We focus on borrowers who either borrow from a low or a high-risk bank before and after the full allotment. Moreover and following the approach outlined above, we match borrowers in both groupa of banks using PSM. We then investigate changes in firm characteristics over a period of one (t+1), two (t+2), and three years (t+3) after a firm received

a loan in the full allotment period.[26] We regress changes in firm characteristics on *High Bank Risk* using the PMS sample and report the results in Table 9. For brevity, we only report the coefficient of *High Bank Risk*.

[Insert Table 9 near here]

We find that relative to borrowers from low-risk banks, the percentage of term loans in the capital structure of high-risk bank borrowers decreases by about 6 percentage points in the third year after loan issuance while the percentage of revolving loans increases by 5.5 percentage points. This result is intuitive. The ECB provides high-risk banks with sufficient liquidity to become a credible liquidity provider for borrowers and high-risk banks benefit relatively more from the increase in central bank liquidity relative to low-risk banks. Consistently, we do not find evidence that high-risk bank borrowers draw down their credit lines more than low-risk bank borrowers, suggesting that the result is due to a change in the supply of credit by banks!

We also find somewhat negative effects on investment and employment of firms borrowing from high-risk banks. In year 2 and 3 after loan origination in the full allotment period, payouts, capital expenditures, investments and employment are all lower relative to low-risk bank borrowers. Lawrence et al. (2005) argue that, after a monetary policy shock, corporate real investment may have a lagged response function. Our results, however, are only significant at the five or 10 percent level. A possible explanation might be the number of large firms in our sample, who are less financially constrained.

8. Conclusion

In this paper, we show that banking sector weakness can impair the transmission of monetary policy. Using deposit and loan transaction data for Europe during the period for the January

[26] We also investigate these changes for one, two, and three years *before* a firm has received a loan in the full allotment period to check the parallel trend assumption. Our results confirm that the characteristics of high-risk bank borrowers develop comparably to those of low bank risk borrowers prior to obtaining a loan during the full allotment period.

2006 to June 2010 period, we document that an increase in ECB liquidity up to levels demanded by banks ("full allotment") results in (i) the same decrease of deposit spreads for low- and high-risk banks, and (ii) a reduction of loan spreads charged by low-risk banks, but (iii) has almost no effect on the loan spreads of high-risk banks. Consistent with the theoretical framework discussed in Brunnermeier and Sannikov (2012) and Brunnermeier and Koby (2017), high-risk banks with the ability to charge higher loan spreads from bank-dependent customers might benefit from an increase in central bank liquidity by not passing on their lower funding costs. This increases the margins of high-risk banks and thus their net worth, thereby relaxing both regulatory and economic constraints. This effect is statistically and economically large. A standard deviation increase in aggregate central bank liquidity decreases the loan spreads of low-risk banks by around 65 bps relative to high-risk banks. We also document that, while borrowers of high-risk banks increase their credit lines relative to their term-loan borrowing following the liquidity provision by the ECB, these firms also invest less, have lower capital expenditures and reduce the number of employees.

The ECB's introduction of the full allotment in October 2008 was in particular also a reaction to banks' liquidity problems in the interbank market. Prior research has largely ignored problems in funding markets focusing exclusively on the transmission to the real economy via loan markets. However, an impaired transmission channel might originate because funding markets are stressed and the design and the effectiveness of monetary policy measures thus might depend crucially on both markets.

Thus, it is an important question whether the transmission of monetary policy to the real economy is impaired even *after* the ECB has addressed the problems in the funding market. Our results suggest that the ECB has indeed addressed the funding problems with the introduction of the full allotment. However, we also find evidence that the transmission channel of monetary policy in the euro area is still impaired in the loan market, which is consistent with the view that banking sector balance-sheet weakness limited the role of the ECB as LOLR

during the financial crisis. In other words, we have to look at both the deposit *and* the loan market to separate if bank balance-sheet effects are at work even after the ECB has addressed the funding problems of banks. The deposit data are key as they highlight that even when funding conditions are restored to the same level by the ECB for low-risk and high-risk banks, the loan outcomes are not highlighting a divergence between liquidity- and solvency induced outcomes for banks.

Overall, our results suggest that banks' capital constraints at the time of an easing of monetary policy pose a challenge to the effectiveness of the bank lending channel and the effectiveness of the central bank as a lender of last resort. These results have potentially important implications for other (unconventional) monetary policy measures in the Eurozone such as the Long-Term Refinancing Operations (LTRO), which were also undertaken in the presence of relatively weak bank balance sheets. Finally, while we focused on large firms due to data availability constraints, the transmission of monetary policy by weak banks is likely to be even further restricted for financially constrained firms. This is worthy of further inquiry to understand the full economic magnitude of the effects we have unearthed.

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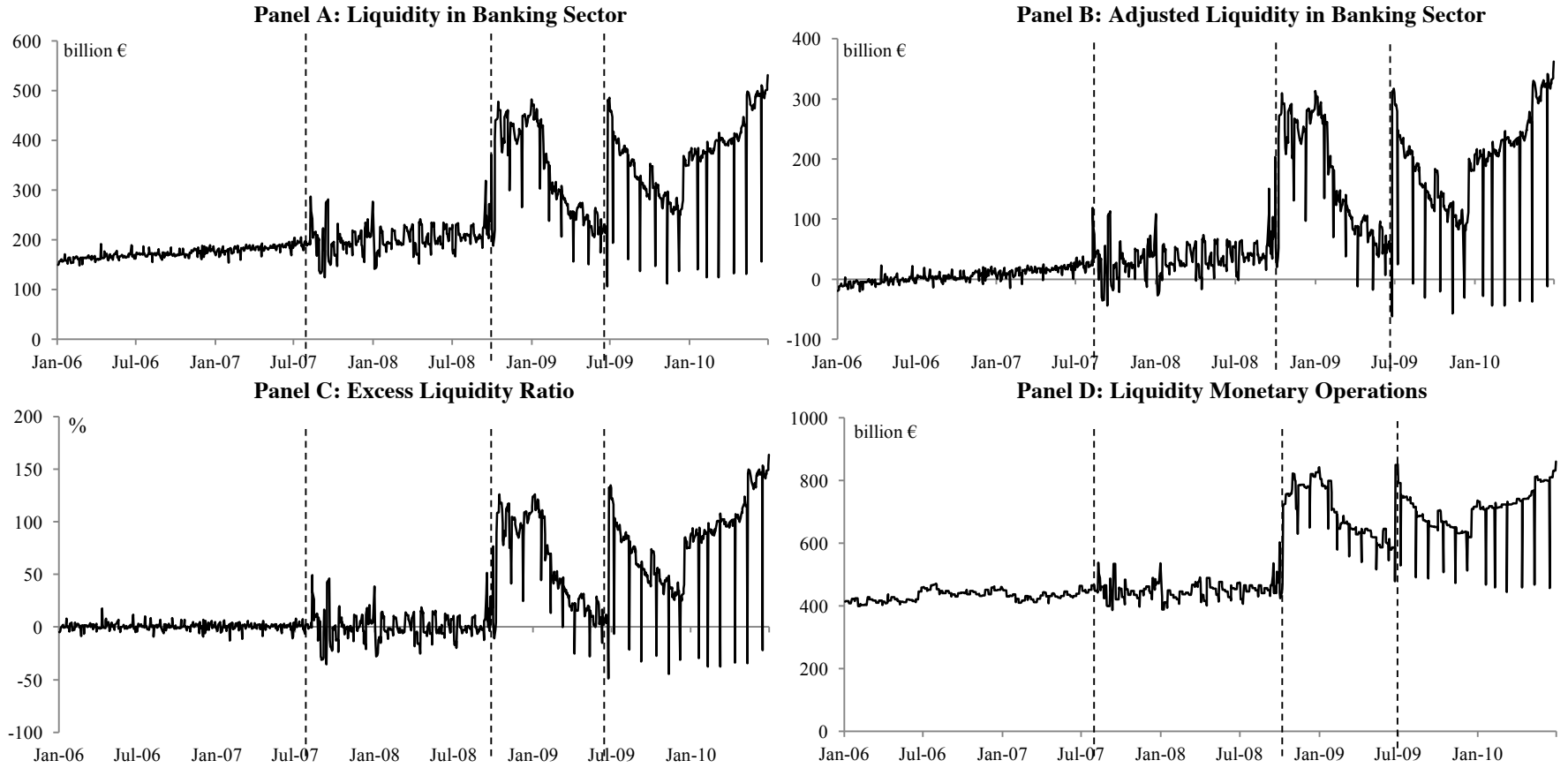


Fig. 1. Central Bank Liquidity. The figure shows four measures of aggregate market liquidity provided to the banking sector by the ECB ("central bank liquidity") during the January 2006 to June 2010 period without taking logarithms. The first vertical dashed line in each figure indicates the start of the financial crisis on August 8, 2007; the second vertical dashed line indicates the start of the period when the ECB announced to fully allot the amount banks request via the refinancing operations at a fixed rate given sufficient adequate collateral; and the third vertical dashed line indicates the first longer-term refinancing operation (LTRO) with a maturity of one year as fixed rate tender procedure with full allotment. All measures are derived from ex post data published by the ECB on daily aggregate liquidity conditions in the Eurosystem and explained in detail in Appendix A1.

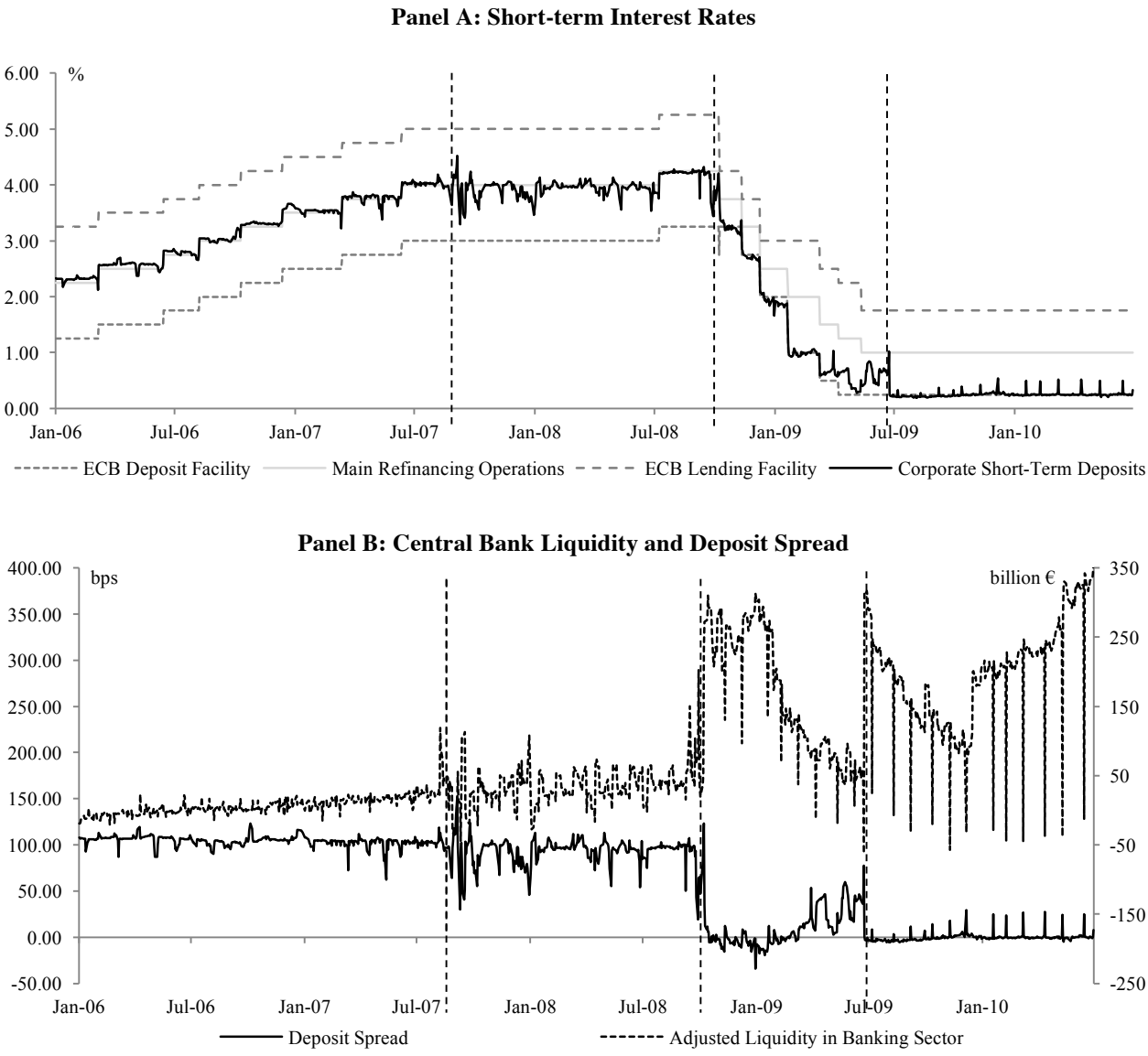
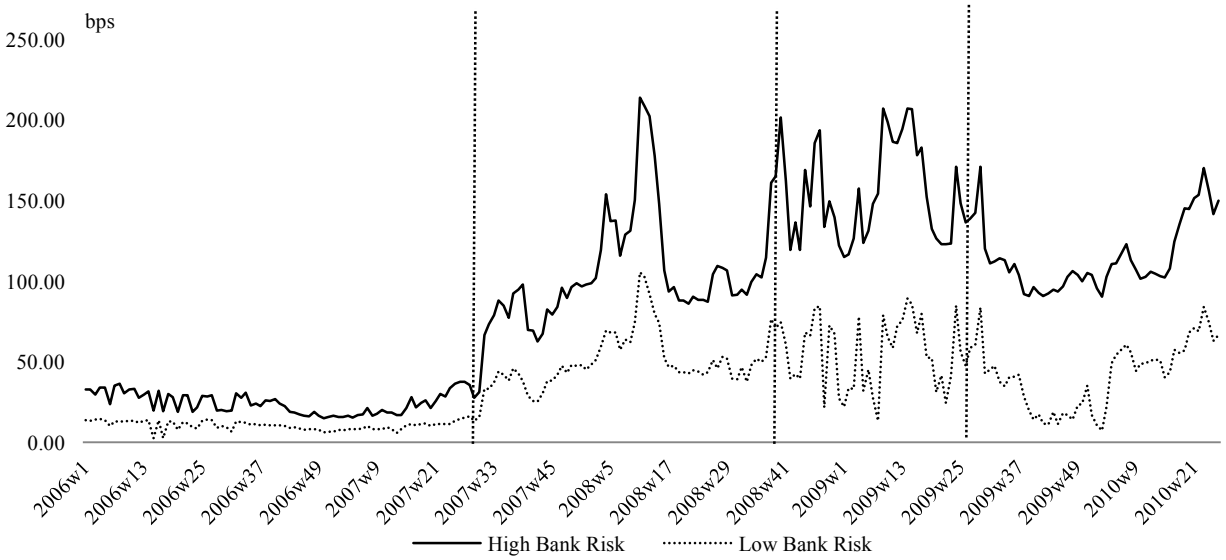
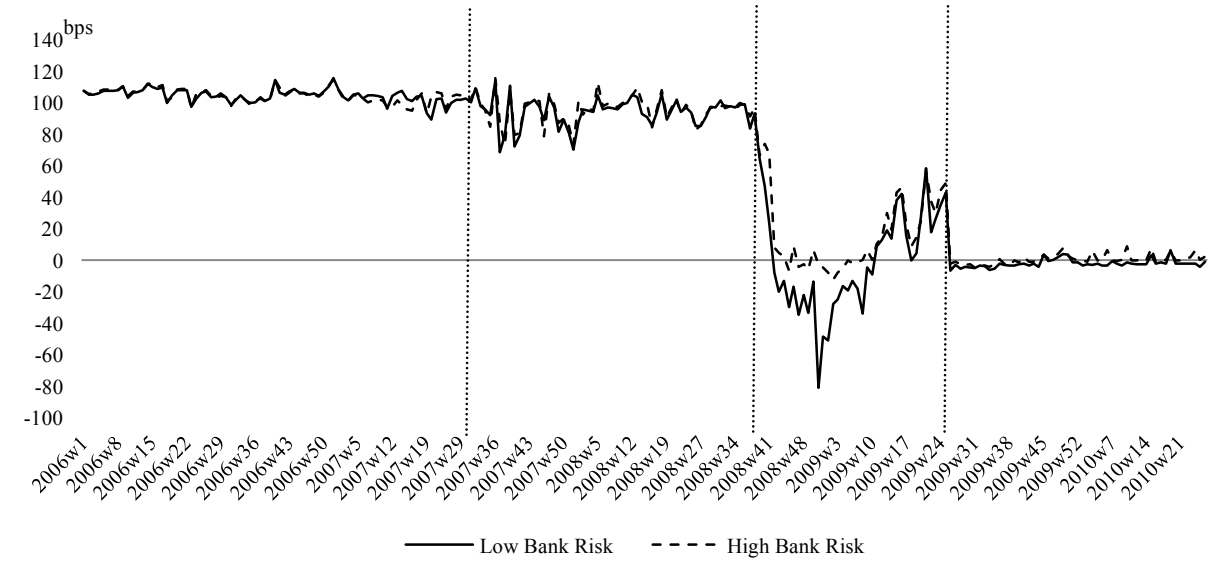


Fig. 2. Short-term Interest Rates and Central Bank Liquidity. Panel A shows the development of the interest rates for the *ECB Deposit Facility*, the *ECB Main Refinancing Rate*, and the *ECB Marginal Lending Facility*, together with the average daily *Corporate Short-Term Deposit Rate* in percent over the 2006 to June 2010 period. Panel B illustrates the development of the *Deposit Spread* (solid line, in bps) and the *Adjusted Liquidity in the Banking Sector* (dashed line, € billion). The vertical dashed lines indicate (1) the start of the financial crisis on August 8, 2007; (2) the start of the full allotment period in August 2008; and (3) the first longer-term refinancing operation (LTRO) with a maturity of one year as fixed rate tender procedure with full allotment in July 2009. All variables are defined in Appendix A1.

Panel A: Banks' CDS Spread by Bank Risk



Panel B: Deposit Spread by Bank Risk



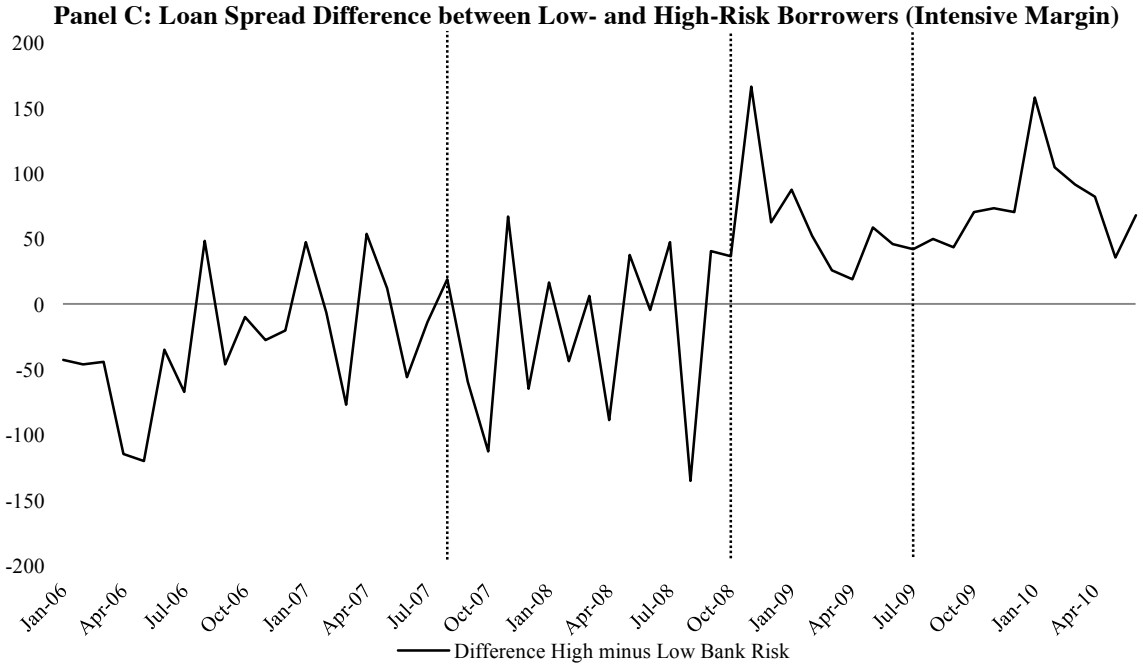


Fig. 3. Bank Risk and Deposit and Loan Spreads. Figure 3 shows banks' average five-year CDS spread by bank risk (Panel A), the *Deposit Spread* by bank risk (Panel B), and the *Loan Spread* difference of borrowers on the intensive margin by bank risk (Panel D) in basis points from 2006 to 2010:Q2. Panel C shows the percentage difference of average corporate deposit spreads of low-risk minus high-risk banks divided by the deposit rate. The first vertical dashed line in each figure indicates the start of the financial crisis on August 8, 2007; the second vertical dashed line indicates the start of the period when the ECB announced to fully allot the amount banks request via the refinancing operations at a fixed rate given sufficient adequate collateral; and the third vertical dashed line indicates the first longer-term refinancing operation (LTRO) with a maturity of one year as fixed rate tender procedure with full allotment.

Table 1. Descriptive Statistics

The table shows the descriptive statistics of variables for the January 2006 to June 2010 period. This period is also split into the financial crisis period from August 9, 2007 to June 30, 2010, the financial crisis until the full allotment period from August 9, 2007 to October 7, 2008, and the full allotment period from October 8, 2008 until June 30, 2010. All variables are defined in Appendix A1. Panel A reports the central bank liquidity provided by the ECB without taking logs. Panels B and D report transaction data. The *Deposit Rate* is reported in basis points (bps) per annum using an actual/360 day count convention. The *Deposit Spread* is calculated as the difference between the deposit rate and the ECB deposit facility rate. The *All in Spread Drawn* is taken from the LPC DealScan database. Panel C (Panel E) shows bank (borrower) averages of accounting variables.

Panel A: Central Bank Liquidity

	Total Period	Pre-Financial Crisis	Crisis until Full Allotment	Full Allotment Period
Adjusted Liquidity in Banking Sector (€ billion)	81.798	6.097	35.214	183.142
Liquidity in Banking Sector (€ billion)	250.043	174.341	203.459	351.386
Excess Liquidity Ratio (%)	28.241	0.655	1.213	71.964
Liquidity Monetary Operations (€ billion)	540.635	432.822	450.02	701.367

Panel B: Corporate Short-term Deposit Market

	Total Period	Pre-Financial Crisis	Crisis until Full Allotment	Full Allotment Period
Number of Transactions	40,638	8,456	12,078	20,104
Deposit Rate (bps)	226.7	327.41	398.46	81.15
Deposit Spread (bps)	51.41	103.93	93.29	4.16
Average Notional Deposit Amount (€ million)	70.8	71.1	78.8	65.9
Average Duration (days)	1.86	1.84	1.83	1.89
Bank Competition	0.10	0.12	0.10	0.10

Panel C: Loan Characteristics

	Total Period	Pre-Financial Crisis	Crisis until Full Allotment	Full Allotment Period
Number of Facilities	2,632	1,132	725	775
AISD (bps)	183.45	131.27	160.4	306.52
Maturity in Months	54.17	62.07	50.07	43.42
Facility Size (€ million)	799	777	997	634
Number of Previous Loans of Borrower	5.61	5.19	5.09	6.98
Secured	38.84%	42.72%	29.53%	41.13%
Performance Pricing	37.82%	34.23%	35.23%	47.31%
Loan Type				
Term Loan	45.74%	47.35%	46.76%	42.45%
Revolver/Line ≥ 1 Yr.	42.21%	42.93%	35.03%	47.87%
364-Day Facility	7.56%	6.89%	10.48%	5.81%
Bridge Loan	3.91%	2.30%	7.03%	3.35%
Revolver/Line < 1 Yr.	0.57%	0.53%	0.69%	0.52%
Loan Purpose				
Corporate purposes	43.43%	34.54%	40.83%	58.84%
M&A related	31.57%	33.57%	44.97%	16.13%
Debt Repayment	14.13%	20.05%	6.48%	12.65%
Working Capital	9.27%	9.01%	7.45%	11.35%
Other	1.60%	2.83%	0.28%	1.03%

Table 2. The Transmission of Central Bank Liquidity to Deposit Spreads

Table 2 reports OLS regression results of *Deposit Spread* on *Aggregate Central Bank Liquidity*, bank risk, and other control variables. It shows the results of four different regression specifications over different time periods. *Central Bank Liquidity* is measured by the adjusted liquidity in the banking sector. *High Bank Risk* is a dummy variable defined using banks' CDS spreads and explained in detail in Appendix A1. All variables are defined in Appendix A1. Bank accounting standard FE are either the general accepted accounting principles (GAAP) of the respective country of the bank or the international financial reporting standards (IFRS). Bank accounting variables are used as stated in the annual report in the year prior to the transaction. A constant is included but omitted. Standard errors are clustered at the bank-week level. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	Total Period (1)	Pre-Financial Crisis (2)	Crisis until Full Allotment (3)	Full Allotment Period (4)
ECB Market Liquidity				
Central Bank Liquidity	-28.928***	-0.196	-20.551**	-36.064***
Bank Risk				
High Bank Risk	-0.061	-0.105	1.749	0.192
Bank Accounting Variables				
log(Total Assets)	-4.371***	-0.353	-2.130***	-4.771***
Leverage	0.118	0.403***	0.323	-0.776
Off-Balance-Sheet Exposure	-0.005	0.027	0.020	-0.085
Return on Assets	-1.287*	-4.672**	-0.277	-0.647
Total Asset Growth	0.039***	-0.021	0.005***	0.034
Net Interest Margin	-3.391	1.856***	-2.212	-6.646*
Cost/Income Ratio	-0.009	-0.101**	-0.033	-0.022
Net Loans/Customer Deposits	-0.036**	-0.013**	-0.001	-0.033
Non-performing Loans/Total Loans	0.525	-0.170***	-0.403	1.215*
Net Derivative Exposure / Total Assets	0.120	-0.051**	-0.113	0.525**
Liquid Assets/Short-Term Funding	-0.005	-0.019	0.001	-0.002
Total Deposits/Total Assets	0.019	-0.071	0.031	-0.017
Further Control Variables				
log(Notional Deposit Amount)	-0.152	0.145**	0.103	-0.687
Deposit Duration	0.691***	0.303***	0.737*	0.629***
Bank Competition	8.504	-8.289	66.328	-26.440
3m EURIBOR-EONIA Swap Spread	-15.553*	55.835	-27.282*	-5.201
End of Reserve Maintenance Period	-8.155***	-6.891	-6.062	-14.333***
Crisis Until Full Allotment	-1.735			
Full Allotment Period	-51.977***			
Firm FE	Yes	Yes	Yes	Yes
Time (quarter) FE	Yes	Yes	Yes	Yes
Accounting Standard FE	Yes	Yes	Yes	Yes
Observations	31,201	4,963	10,179	16,059
R-squared	0.918	0.498	0.289	0.529

Table 3. The Transmission of Central Bank Liquidity to Deposit Spreads by Bank Risk

This table reports the OLS regression results of the *Deposit Spread* of corporate deposits with a maximum maturity of seven days on *Central Bank Liquidity*, bank risk and further control variables. It shows the results of six different regression specifications over different time periods. *Central Bank Liquidity* is measured as the adjusted liquidity in the banking sector. *High Bank Risk* is a dummy variable defined using banks' CDS spreads and explained in detail in Appendix A1. All variables are defined in Appendix A1. All control variables as shown in Table 2 are included. A constant is included but omitted. Standard errors are clustered at the bank-week level. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level.

Panel A. High- versus low-risk banks

	Crisis until Full Allotment		Full Allotment Period	
	(1)	(2)	(3)	(4)
ECB Market Liquidity				
Central Bank Liquidity	-22.130***		-36.044***	
*Central Bank Liquidity * High Bank Risk*		-11.378		-35.639***
*Central Bank Liquidity * Low Bank Risk*		-24.950***		-38.349***
Controls and Fixed Effects (FE)				
Control Variables	Yes	Yes	Yes	Yes
Bank Risk * Time (quarter) FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Accounting Standard FE	Yes	Yes	Yes	Yes
Wald Test of Interaction Terms		0.008		0.331
Observations	10,179	10,179	16,059	16,059
R-squared	0.303	0.304	0.537	0.537

Panel B. Robustness

	More saturated models				No further control variables		Central Bank Liquidity lagged 1 week	
	Crisis until Full Allotment		Full Allotment Period		Crisis until Full Allotment	Full Allotment Period	Crisis until Full Allotment	Full Allotment Period
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ECB Market Liquidity								
*Central Bank Liquidity * High Bank Risk*	-3.652	-4.824	-38.387***	-39.110***	-17.845	-38.715***	-3.125	-8.573**
*Central Bank Liquidity * Low Bank Risk*	-34.411***	-32.137***	-38.934***	-40.388***	-27.671***	-44.457***	-15.731**	-9.388**
Controls and Fixed Effects (FE)								
Control Variables	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Bank Risk * Time (month) FE	Yes	No	Yes	No	No	No	No	No
Bank * Time (month) FE	No	Yes	No	Yes	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Accounting Standard FE	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Wald Test of Interaction Terms	0.0075	0.0014	0.8291	0.5377	0.0043	0.7502	0.0005	0.6841
Observations	10,179	10,179	16,059	16,059	10,906	18,111	10,179	16,059
R-squared	0.347	0.421	0.583	0.748	0.034	0.191	0.404	0.702

Table 4. Notional Deposit Amounts, Bank Risk and Deposit Spreads

The table reports results from different regressions to address possible endogeneity concerns associated with the transmission of ECB liquidity to deposit spreads. In column (1) of Panel A, the data include all auctions. The columns show OLS regression results of a dummy variable, which is one when a bank is selected in an auction and zero otherwise on control variables. *Bank Risk Ranking within Auction* is derived by ranking banks within an auction using their CDS spread and taking the logarithm of their rank, plus one. It only includes transactions with at least two banks bidding for a deposit amount. Columns (2) and (3) only include deposit transactions where on the same day no prior auction was initiated by the firm without selecting a bank bid. Columns (4) and (5) only include deposit transactions that were traded prior to 10:00 am on a given day. Columns (6) and (7) only include rolled over deposits, that is, amounts that are deposited again with the same notional after having matured. *Central Bank Liquidity* is measured as the adjusted liquidity in the banking sector. *High Bank Risk* is a dummy variable defined using banks' CDS spreads and explained in detail in Appendix A1. All variables are defined in Appendix A1. In Panel B, column (1) shows the first stage of a 2SLS regression model where the logarithm of the notional deposit transaction amount is instrumented with dummy variables indicating Friday and the 4th quarter of a year. The test for underidentification is an LM test with the null hypothesis that matrix does not have full rank (i.e., is not identified). The test for overidentification is based on Hansen's J-statistic and has the null hypothesis that the instruments are valid. Column (2) shows the second stage regression result of the *Deposit Spread* of corporate deposits with a maximum maturity of seven days on the instrumented logarithm of the notional deposit transaction amount, as well as on *Central Bank Liquidity*, bank risk and further control variables. Constant term is in all regressions included but omitted. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level. Standard errors are clustered at the bank-week level. In column (1) of Panel A and columns (8) and (9) of Panel B, we use heteroscedasticity-robust standard errors clustered at the bank-level (not bank-week level).

Panel A. Endogeneity (bank selection)

	Selection of Banks by Firms	Excluding transactions where another auction was canceled by the firm earlier on the same day		Early transactions (prior to 10am)		Rolled-over funds	
	Financial Crisis Period	Crisis until Full Allotment	Full Allotment Period	Crisis until Full Allotment	Full Allotment Period	Crisis until Full Allotment	Full Allotment Period
Dependent Variable	Selected (Yes/No)	Deposit Spread	Deposit Spread	Deposit Spread	Deposit Spread	Deposit Spread	Deposit Spread
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bank Risk Ranking within Auction	-0.008						
Highest Bid of Auction	0.457***						
ECB Market Liquidity							
*Central Bank Liquidity * High Bank Risk*		-6.782	-34.294***	6.942	-22.634***	-8.367	-28.234***
*Central Bank Liquidity * Low Bank Risk*		-23.387**	-39.672***	-16.527***	-18.871***	-16.134**	-27.823***
High Bank Risk		9.683	11.431	10.231	-18.266	5.830	25.246
log(Notional Deposit Amount)		-0.057	-1.183	0.440	-0.398	-0.493	-0.484
Further Controls and Fixed Effects (FE)							
Friday							
Fourth Quarter of Year							
Control Variables	No	Yes	Yes	Yes	Yes	Yes	Yes
Bank Risk * Time (quarter) FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Bank * Time (quarter) FE	Yes	No	No	No	No	No	No
Bank * Firm FE	Yes	No	No	No	No	No	No
Firm FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Accounting Standard FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Wald Test of Interaction Terms		0.0025	0.634	0.0015	0.3251	0.0243	0.9298
Observations	45,293	5,854	9,516	578	2,190	343	1,102
R-squared	0.401	0.312	0.543	0.149	0.675	0.351	0.701

Panel B. Endogeneity (instrumental variables)

	Instrumental Variables Regression	
	Full Allotment Period	
	First Stage	Second Stage
Dependent Variable	*Log(Deposit Volume)*	*Deposit Spread*
	(3)	(4)
ECB Market Liquidity		
*Central Bank Liquidity * High Bank Risk*		-29.384***
*Central Bank Liquidity * Low Bank Risk*		-33.543***
High Bank Risk		-8.299
log(Notional Deposit Amount)		-5.312
Further Controls and Fixed Effects (FE)		
Friday	0.067***	
Fourth Quarter of Year	0.051	
Control Variables	Yes	Yes
Bank Risk * Time (quarter) FE	Yes	Yes
Bank * Time (quarter) FE	Yes	Yes
Bank * Firm FE	No	No
Firm FE	Yes	Yes
Accounting Standard FE	Yes	Yes
Wald Test of Interaction Terms		0.443
Observations	16,059	16,059
R-squared		
F-statistic	7.46	
Underidentification test p-value	0.0014	
Overidentification test p-value	0.7431	

Table 5. The Transmission of Central Bank Liquidity to Loan Spreads

The table reports OLS regression results of syndicated loan spreads on *Central Bank Liquidity*, bank risk, and additional control variables. It shows six different regression specifications over different time periods. *Central Bank Liquidity* is measured as the average over the quarter prior to loan origination of the adjusted liquidity in the banking sector. *High Bank Risk* is a dummy variable defined using banks' CDS spreads and explained in detail in Appendix A1. All variables are defined in Appendix A1. Bank and borrower accounting variables are used as stated in the annual report in the year prior to the transaction. Constant term is included but omitted. Standard errors are clustered at the bank-week level. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level.

	Financial Crisis Period		Crisis until Full Allotment		Full Allotment Period	
	(1)	(2)	(3)	(4)	(5)	(6)
Central Bank Liquidity	-114.148**		390.122		-73.328	
*(1) Central Bank Liquidity*High Bank Risk*		-87.537		518.803*		-24.971
*(2) Central Bank Liquidity *Low Bank Risk*		-165.117***		200.293		-188.184***
Bank Risk						
High Bank Risk	24.613	45.057**	41.583**	122.705	-0.974	-47.840
Borrower Accounting Variables						
log(Total Assets)	-4.999	-5.058	7.637	7.399	-17.294	-17.93
Leverage	-15.458	-14.7	35.855	36.851	3.122	8.525
Current ratio	-3.801	-4.391	20.25	19.705	0.056	-0.105
Coverage	0.157***	0.158***	0.056*	0.058*	0.179	0.129
Market to Book	-16.495**	-16.741**	-17.013***	-17.317***	-31.581*	-32.389*
Tangibility	21.727	18.774	-31.006	-32.173	88.244	79.981
Bank Accounting Variables						
log(Total Assets)	16.417	17.304	-128.378*	-122.530*	70.394*	70.005**
Leverage	-3.378	-2.941	-5.931	-6.321	-5.621	-4.085
Return on Assets	-2.464	-2.061	-20.09	-20.345	3.043	3.978
Total Asset Growth	0.062	0.053	0.543**	0.529**	-0.168	-0.187
Non-performing Loans/Total Loans	4.029	3.935	21.325**	22.101**	1.303	0.703
Further Control Variables						
log(Maturity in Months)	15.626	15.772	28.200***	28.401***	-1.612	-1.091
Secured	25.677*	26.033*	40.870***	41.469***	-12.607	-12.956
log(Facility Size)	-18.572***	-18.522***	-14.821**	-14.527**	-11.977	-12.100
log(Number of Loans of Borrower)	5.123	4.913	1.215	1.432	7.268	6.745
Performance Pricing	-9.106	-8.806	-24.523**	-24.951**	-3.849	-2.315
3m EURIBOR-EONIA Swap Spread	74.857**	82.702***	-17.152	-14.308	83.349**	101.956**
Full Allotment Period	51.682	45.812				
Bank Risk * Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Borrower Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Borrower Industry Code FE	Yes	Yes	Yes	Yes	Yes	Yes
Loan Type, Purpose, Currency FE	Yes	Yes	Yes	Yes	Yes	Yes
Wald Test of Interaction Terms (1) = (2)		0.0925		0.1604		0.0161
Observations	1,156	1,156	533	533	623	623
R-squared	0.752	0.753	0.812	0.813	0.721	0.724

Table 6. Intensive and Extensive Margin

Panel A reports regression results where the dependent variable is an indicator variable that is one if a borrower has received a loan from one bank risk category prior and during the full allotment period (intensive margin). All variables are defined in Appendix A1. The borrower variables are log(total assets), leverage, current ratio, coverage, market-to-book, and tangibility. The control variables are log(maturity in months), secured, log(facility size), log(number of loans of borrower), performance pricing, and the 3m EURIBOR-EONIA swap spread. Standard errors are heteroscedasticity-robust and clustered at the firm-level. Panel B reports OLS regression results of *AISD* on *Central Bank Liquidity*, bank risk, and control variables focusing on borrowing along the intensive margin (column (1)). Column (2) shows the second stage of a Heckman regression model using column (3) of Panel A as the first stage. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level. In column (1), standard errors are clustered at the bank-week level. In column (2), standard errors are derived using resampling via the jackknife method and clustered at the firm-level.

Panel A. Probability to Observe a Loan of an Existing Borrower of Bank Risk Category (Intensive Margin)

	(1)	(2)	(3)	(4)
Estimation Method	OLS	Logit	Probit	OLS
Bank Risk				
High Bank Risk	-0.110	-0.558	-0.341	0.083
Bank Accounting Variables				
log(Total Assets)	-0.013	-0.088	-0.052	-0.330*
Leverage	0.014	0.065	0.041	-0.033
Return on Assets	0.022	0.103	0.066	0.010
Total Asset Growth	0.000	0.003	0.001	0.001
Non-performing Loans/Total Loans	-0.022	-0.116	-0.065	0.029
Borrower Accounting Variables	Yes	Yes	Yes	Yes
Further Control Variables	Yes	Yes	Yes	Yes
Bank Risk * Time FE	No	No	No	Yes
Borrower Rating FE	No	No	No	Yes
Borrower Industry Code FE	No	No	No	Yes
Loan Type, Purpose, Currency FE	No	No	No	Yes
Clustering (Firm)	No	No	No	Yes
Observations	754	754	754	623
R-squared / Pseudo R-squared	0.207	0.172	0.171	0.547

Panel B. Heckman selection model

	(1)	(2)
	OLS	Heckman Model
*(1) Central Bank Liquidity * High Bank Risk*	-174.808*	-221.681
*(2) Central Bank Liquidity * Low Bank Risk*	-284.557**	-333.108**
Bank Risk * Time FE	Yes	Yes
Borrower Rating FE	Yes	Yes
Borrower Industry Code FE	Yes	Yes
Loan Type, Purpose, Currency FE	Yes	Yes
Observations	272	Uncensored / Censored / Total Obs. 272 / 422 / 694
Observations - Borrow only from High Bank Risk prior full allotment	58	58
Observations - Borrow only from Low Bank Risk prior full allotment	13	13
Observations - Borrow from both Bank Risk categories prior full allotment	201	201
Wald Test of Interaction Terms (1) = (2)	0.0285	0.0433
R-squared	0.771	

Table 7. Central Bank Liquidity and Loan Spreads: Intensive Margin & PSM

The table reports regression results of borrowers along the intensive margin in the full allotment period. Panel A shows results from propensity score matching using a nearest neighbor estimator with 10, 50, and 100 nearest neighbors all with a caliper of 0.1 together with a Gaussian and an Epanechnikov kernel estimator both with a bandwidth of 0.01. The propensity score is estimated using a logit regression model and borrowers are matched on the odds ratio. Standard errors are reported in parentheses using 50 bootstrap replications. Panel B reports OLS regressions of the AISD of matched borrowers on *Central Bank Liquidity* interacted with *High Bank Risk* or *Low Bank Risk*. Columns (1) and (2) show the results using the nearest neighbor matching (n=1). Columns (3) and (4) report the results using kernel matching within a bandwidth of 0.1. We use the same bank control variables as in Table 5. All variables are explained in Appendix A1. Standard errors are clustered at the bank-week level. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level.

Panel A: Propensity Score Matching

	Estimation Method	Intensive Margin
High Bank Risk	Nearest Neighbor (*n*=10)	121.385***
High Bank Risk	Nearest Neighbor (*n*=50)	121.277***
High Bank Risk	Nearest Neighbor (*n*=100)	121.277***
High Bank Risk	Gaussian Kernel	99.725**
High Bank Risk	Epanechnikov Kernel	99.725***

Panel B: Loan Spread - Intensive Margin - Matched Borrowers

	(1)	(2)	(3)	(4)
Matching Method	Nearest Neighbor Matching		Kernel Matching	
*Central Bank Liquidity * High Bank Risk*	-39.895*	40.897	-166.558	-133.954
*Central Bank Liquidity * Low Bank Risk*	-121.089***	-155.680**	-212.002**	-214.211**
High Bank Risk	-10.182	-70.065	-16.043	-78.054
Bank Control Variables	No	Yes	No	Yes
Observations	264	264	358	358
Wald Test of Interaction Terms	0.0175	0.0489	0.0982	0.0527
R-squared	0.0995	0.1644	0.1005	0.1483

Table 8. Monetary Policy, Loan Maturity, and Bank-Dependence

The table reports regression results of *AISD* on *Central Bank Liquidity*, bank risk, and additional control variables. In Panel A, *Central Bank Liquidity* is split by loan maturity intervals. Loans are classified as short term when maturity ≤ 1 year, medium term when maturity is >1 year and ≤ 5 years, and long term when maturity > 5 years. In Panel B, firm size classes are determined based on the 33rd and 67th percentile of total assets of all firms in the data sample. All other variables are defined in Appendix A1. We include all control variables and fixed effects used in Table 5. Standard errors are clustered at the bank-week level. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level.

Panel A: Loan Maturity

	Full Sample	Full Sample	Intensive Margin
	(1)	(2)	(3)
*Central Bank Liquidity * Short-term Loan*	-228.187**		
*Central Bank Liquidity * Medium-term Loan*	-68.923		
*Central Bank Liquidity * Long-term Loan*	318.403		
*Central Bank Liquidity * High Bank Risk **			
(1) Short-term Loan		-265.484**	-592.328***
(2) Medium-term Loan		-19.792	-49.226
(3) Long-term Loan		368.907	-45.516
*Central Bank Liquidity * Low Bank Risk **			
(4) Short-term Loan		-200.722*	-540.985***
(5) Medium-term Loan		-206.797***	-277.036**
(6) Long-term Loan		190.460	457.176
Bank Risk * Loan Maturity Intervals	Yes	Yes	Yes
Bank Risk * Time FE	Yes	Yes	Yes
Further Control Variables and Fixed Effects	Yes	Yes	Yes
Wald Test of Interaction Terms [(1)=(4) / (2)=(5) / (3)=(6)]		0.5500 / 0.0281 / 0.4842	0.7416 / 0.0115 / 0.3148
Observations	623	623	272
R-squared	0.747	0.750	0.837

Panel B: Bank Dependence

	(1)	(2)	(3)	(4)
*Central Bank Liquidity * Small Firm*	-32.306			
*Central Bank Liquidity * Medium Firm*	-66.217**			
*Central Bank Liquidity * Large Firm*	-113.656**			
*Central Bank Liquidity * No Rating*			-37.663	
*Central Bank Liquidity * Rating*			-279.689**	
*Central Bank Liquidity * High Bank Risk **				
(1) Small Firm		27.78		
(2) Medium Firm		-25.099		
(3) Large Firm		-87.297**		
(4) No Rating				7.828
(5) Rating				-80.725*
*Central Bank Liquidity * Low Bank Risk **				
(6) Small Firm		-177.940**		
(7) Medium Firm		-185.167***		
(8) Large Firm		-170.025**		
(9) No Rating				-142.211***
(10) Rating				-271.657***
Bank Risk * Firm Size Intervals	Yes	Yes	No	No
Bank Risk * Rating Dummy	No	No	Yes	Yes
Bank Risk * Time FE	Yes	Yes	Yes	Yes
Further Control Variables and Fixed Effects	Yes	Yes	Yes	Yes
Wald Test of Interaction Terms [(1)=(6) / (2)=(7) / (3)=(8)]		0.0082 / 0.0025 / 0.0432		
Wald Test of Interaction Terms [(4)=(9) / (5)=(10)]				0.0086 / 0.0336
Observations	623	623	623	623
R-squared	0.724	0.728	0.73	0.733

Table 9. Debt Capital Structure and Firm Characteristics

The table reports OLS regressions and propensity score matching (PSM) results of changes in borrower characteristics of borrowers along the intensive margin in the full allotment period on bank risk and control variables. All variables are derived at the firm level and measured in real terms with 2006 as the base year using the Consumer Price Index (CPI) as published by the OECD. *Asset Growth* is the ratio of total assets in t divided by the value of total assets in t-1, minus 1. *Payouts* are total dividends, *Investment* is total invested capital, and *Employment* is the number of employees in thousand. The panels show regression results of either pp.Δ (percentage point differences), or logΔ (log differences) or Δ (differences) from year *t* to *t*+1, *t* to *t*+2, and *t* to *t*+3, with *t* as the year when the loan is initiated in the full allotment period, on several control variables. The control variables and fixed effects used in Table 6 are included. All variables are defined in Appendix A1. We us a Gaussian kernel estimator with a bandwidth of 0.01 for the PSM models. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level using heteroscedasticity-robust standard errors clustered at the firm-level.

	pp.Δ (t; t+1)	pp.Δ (t; t+2)	pp.Δ (t; t+3)
	(1)	(2)	(3)
Method	PSM	PSM	PSM
Capital Structure			
Term Loans/ Total Debt	-1.959**	-6.799***	-6.293**
Revolving Loans/ Total Debt	5.353**	5.098**	5.462***
Notional Outstanding/ Total Debt	0.576	-0.612	-1.067
Total Liabilities	-0.015	-0.111	-0.073
Investments & Employment			
Payouts	0.017	-0.124*	0.019
Capex	0.017	-0.170*	-0.158*
Asset growth	5.35	1.163	3.02
Investments	-0.018	-0.143*	-0.052*
Employment	-0.95	-12.414**	-31.133**

Appendix A1. Description of Variables

The table provides descriptions of all variables, together with their units of measurement. All financial variables are winsorized at the 1st and 99th percentile and measured in real terms with 2006 as the base year using the Consumer Price Index (CPI) as published by the OECD.

Variable	Unit	Description
ECB Liquidity		
Liquidity in Banking Sector	Log (€ billion)	Natural logarithm of the absolute amount of liquidity in the banking sector. It is calculated as the logarithm of the sum of banks' current account and deposit facility holdings with the ECB. The items used for the calculation are published by the ECB ex post on a daily basis in the "Data on daily liquidity conditions."
Adjusted Liquidity in Banking Sector	Log (€ billion)	Natural logarithm of the absolute amount of liquidity in the banking sector. It is calculated as the logarithm of the sum of banks' current account and deposit facility holdings with the ECB. The items used for the calculation are published by the ECB ex post on a daily basis in the "Data on daily liquidity conditions." The variable is centered around its mean value in 2006.
Excess Liquidity Ratio	%	Relative excess ECB liquidity in the banking sector. It is computed as the sum of banks' current account and deposit facility holdings with the ECB divided by the d minimum reserve requirement imposed by the ECB for the specific reserve maintenance period, minus 1. The items used for the calculation are published by the ECB ex post on a daily basis in the "Data on daily liquidity conditions". The measure indicates the excess liquidity available in the banking sector above the "regular" level which is the minimum reserve requirement imposed by the ECB for the specific reserve maintenance period.
Liquidity Monetary Operations	Log (€ billion)	Natural logarithm of the absolute amount of liquidity provided by the ECB by means of open market operations and the marginal lending facility. The items used for the calculation are published by the ECB ex post on a daily basis in the "Data on daily liquidity conditions". The regular open market operations consist of the main refinancing operations and the longer-term refinancing operations. These items have been complemented in our observation period by a covered bond purchase program announced on March 7, 2009 and introduced on July 2, 2009, and by the liquidity absorbing provision of foreign currency to Eurosystem counterparties via FX swaps in June 2009, which in the period before were contained in the autonomous factors.
Bank Risk Variables		
Bank Risk	Integer	Credit default swap spread in bps on the bank's senior unsecured debt with a five year maturity.
High Bank Risk	Dummy	Dummy variable, derived from an iterative procedure. First, we use Moody's ratings and derive the lowest CDS spread of all banks rated A1 or worse in each week. Second, all banks with a CDS spread higher than this threshold are classified as high-risk banks. Third, in each week we compute the ratio of the average spread of all banks above and below the threshold. If this ratio has a value of 2 or larger we stick to this classification. If the ratio is smaller than 2, we derive a second threshold, using decreasing iterative steps of 0.5bps starting from the first threshold, below which banks are classified as low-risk banks such that the ratio of the average weekly spread of all banks above and below the threshold is at least 2.
Deposit Transaction Variables		
ECB Deposit Facility Rate	%	Interest rate at which banks can deposit funds overnight at the ECB deposit facility. In theory, it constitutes the lower bound interest rate for the interbank short-term market.
Deposit Spread	bps	Spread between the deposit rate and the ECB deposit facility rate.
log(Notional Deposit Amount)	Log (€)	Natural logarithm of the notional € deposit amount of the transaction.
Duration	days	The duration of the deposit transaction ranges from overnight up to one week.

Bank Competition	Integer	Calculated as the sum of the squared market share of each bank over the last week using deposit volume
Number of outstanding Deposit transactions of the Firm	Integer	Outstanding number of deposit transactions of the firm on the platform (not yet mature), excluding the current transaction. The maximum maturity of deposits considered for this variable is one week.
Bank Accounting Variables		
log(Total Assets)	Log (€ million)	Natural logarithm of the bank's total assets in €-million as reported on the balance sheet.
Leverage		Ratio of total liabilities to total assets as reported on the balance sheet.
Off-Balance-Sheet Exposure	%	Ratio of off-balance-sheet items divided by the sum of total assets and off-balance-sheet items. The amount of off-balance-sheet items is used from Bankscope. It is calculated as the sum of managed securitized assets reported off-balance sheet, other off-balance sheet exposure to securitizations, guarantees, acceptances and documentary credits reported off-balance sheet, committed credit lines, and other contingent liabilities.
Return on Assets	%	Return on assets as calculated by Bankscope.
Total Asset Growth	%	Annual asset growth as calculated by Bankscope based on annual balance sheet data.
Net Interest Margin	%	Net interest margin as calculated by Bankscope.
Cost/Income Ratio	%	Ratio of administrative costs to income excluding increase of risk provisions as calculated by Bankscope.
Net Loans/Customer Deposits	%	Ratio of net loans to customer deposits as calculated by Bankscope.
Non-performing Loans/Total Loans	%	Ratio of non-performing loans to gross loans as calculated by Bankscope.
Net Derivative Exposure / Total Assets	%	Ratio of the difference between derivative assets and derivative liabilities to total assets.
Liquid Assets/Short-Term Funding	%	Ratio of liquid assets to short-term funding as calculated by Bankscope.
Total Deposits/Total Assets	%	Ratio of total deposits and short-term funding to total assets based on annual balance sheet data.
Borrower Variables		
log(Total Assets)	Log (€ million)	Natural logarithm of the firm's total assets in €-million as reported on the balance sheet.
Leverage	%	Ratio of total liabilities to total assets as reported on the balance sheet.
Current ratio	%	Ratio of current assets to current liabilities as reported on the balance sheet.
Coverage	%	Ratio of EBITDA to interest expenses as reported in the income statement.
Market-to-Book	%	Ratio of the sum of book value of liabilities and market value of equity to book value of total assets. The data are collected from Compustat for firms available in Compustat North America. For firms only available in Compustat Global we use the market-to-book ratio as reported by Datastream.
Tangibility	%	Ratio of tangible assets (property, plant and equipment) to total assets as reported on the balance sheet.
Log(Number of Loans of Borrower)	Integer	Natural logarithm of the number of loans (packages) of the borrower in LPC DealScan from 1982 to the start of the loan.
Borrower IPO (years)	Integer	Years since the IPO of the borrower.
Credit Rating		
Investment Grade Rating	Dummy	Dummy variable equal to one, if the borrower's S&P long-term issuer rating is BBB- or better.
Non-Investment Grade Rating	Dummy	Dummy variable equal to one, if the borrower's S&P long-term issuer rating is BB+ or worse.
Not Rated	Dummy	Dummy variable equal to one if the borrower has no S&P long-term issuer rating.
Syndicated Loan Variables		
AISD	bps	Coupon spread over LIBOR plus one time fees on the drawn portion of the loan as stated in DealScan
log(Facility Size)	log (€ million)	Natural logarithm of the loan facility amount in year 2006 € million.

log(Maturity in Months)	log (Integer)	Natural logarithm of the maturity of the loan in months
Secured	Dummy	Dummy variable equal to one if the loan is secured.
Performance Pricing	Dummy	Dummy variable equal to one if the loan contains a performance pricing grid.
Loan Type		
Term Loan		Dummy variable if the loan is defined as type "Term Loan" in DealScan.
Revolver/Line >= 1 Yr.		Dummy variable if the loan is defined as type "Revolver/Line ≥ 1 Yr." in DealScan.
364-Day Facility		Dummy variable if the loan is defined as type "364-Day Facility" in DealScan.
Bridge Loan		Dummy variable if the loan is defined as type "Bridge Loan" in DealScan.
Revolver/Line < 1 Yr.		Dummy variable if the loan is defined as type "Revolver/Line < 1 Yr." in DealScan.
Loan Purpose		
Corporate purposes		Dummy variable if the loan is defined to have the primary purpose "Corp. purposes" in DealScan.
M&A related		Dummy variable if the loan is defined to have a M&A-related primary purpose in DealScan (e.g., LBO, MBO, SBO, Takeover).
Debt Repayment		Dummy variable if the loan is defined to have the primary purpose "Debt Repay" in DealScan.
Working Capital		Dummy variable if the loan is defined to have the primary purpose "Work. cap" in DealScan.
Other		Dummy variable if the loan is defined to have a different primary purpose in DealScan than those above.
Time Indicator Variables		
Crisis until Full Allotment	Dummy	Dummy variable, which is one from August 8, 2007 until October 7, 2008.
Full Allotment Period	Dummy	Dummy variable, which is one from October 8, 2008 until the end of our observation period June 30, 2010. On October 8, 2008 the ECB announced that it would allot the full amount banks request via the refinancing operations at a fixed rate given sufficient adequate collateral, in contrast to the prior competitive tender with limited allotment.
Addition Control Variables		
3-Month EURIBOR-EONIA Swap Spread	bps	Spread between the 3-month EURIBOR and the 3-month EONIA swap. It is an indicator for the risk in the market excluding interest rate change risk and interest rate expectations.
End of Reserve Maintenance Period	Dummy	Dummy variable, which is one on the last day of the ECB's reserve maintenance period.

Appendix A2. Sample

This table shows the construction of the loan-level dataset. Panel A shows how we arrive from the universe of loans at our sample. Panel B reports the results of a comparison of regression sample with a larger sample, which includes the loans originated not by our sample banks.

Panel A: Loan Sample Selection

All loan facilities in DealScan: 2006 - 2010:Q2		63,991
match Chava-Roberts (2008) Linking File	-42,982 =	21,009
merge Compustat data	-8,614 =	12,395
clean DealScan data (e.g., spread included, notional reported, etc.)	-2,527 =	9,868
restrict sample to European banks which also operate on platform	-7,236 =	2,632

Panel B: Differences in Loan and Borrower Characteristics due to Restriction of Sample to Platform Banks

	Δ(Included - Excluded)
Loan Characteristics	
All in Spread Drawn (bps)	2.327
Facility Size (€ million)	417***
Maturity in Months	0.248
Borrower Characteristics	
Total Assets (€ million)	4,459***
Leverage	0.017**
Current ratio	-0.069*
Coverage	-14.021***
Market-to-Book	-0.032
Tangibility	0.049***

Appendix A3. Exemplary Deposit Auction

The table shows an exemplary deposit transaction for illustrative purposes.

Time of trade	Firm ID	Bank Name	Maturity Date	Transaction Start Date	Time of Bank Bid	Product	Currency	Status	Status of Bank Bid	Notional Amount	Quote value
14-11-2005 12:35:58	xxxxxxxx	Bank1	15-11-2005	14-11-2005	14-11-2005 12:35:43	Deposit	EUR	EXEC	LCAN	76,200,000	2.06
14-11-2005 12:35:58	xxxxxxxx	Bank2	15-11-2005	14-11-2005	14-11-2005 12:35:34	Deposit	EUR	EXEC	EXEC	76,200,000	2.08
14-11-2005 12:35:58	xxxxxxxx	Bank3	15-11-2005	14-11-2005	14-11-2005 12:35:33	Deposit	EUR	EXEC	LCAN	76,200,000	2.07
14-11-2005 12:35:58	xxxxxxxx	Bank4	15-11-2005	14-11-2005	14-11-2005 12:35:35	Deposit	EUR	EXEC	LCAN	76,200,000	2.05
14-11-2005 12:35:58	xxxxxxxx	Bank5	15-11-2005	14-11-2005	14-11-2005 12:35:39	Deposit	EUR	EXEC	LCAN	76,200,000	2.06
14-11-2005 12:35:58	xxxxxxxx	Bank6	15-11-2005	14-11-2005	14-11-2005 12:35:26	Deposit	EUR	EXEC	LCAN	76,200,000	2.07

Trade Number	Identifying number for a specific trade.
Time of Trade	Time when the auction is closed. It shows the date and the exact time in seconds. All transactions are executed on the same day.
Firm ID	Numerical identifier for each firm, anonymized for confidentiality reasons.
Bank Name	Bank names available but changed for confidentiality reasons.
Maturity Date	The maturity of the trade.
Transaction Start Date	The start date of the trade.
Time of Bank Bid	The exact time a bank is bidding for a deposit amount. If a bank provides several bids in a transaction we use the last bid of this bank.
Product	The product which is traded.
Currency	The currency of the product.
Status	The status of the entire auction. EXEC means that the trade is executed.
Status of Bank Bid	The status of each bank's bid in the auction. LCAN means ListCancel, that is, another bank bid was selected by the firm. EXEC depicts the executed trade.
Notional amount	The notional amount banks bid for.
Quote value	The deposit interest rate banks are bidding in the auction. Banks bid an annual interest rate in percent using an actual/360 day count convention.

Appendix A4. The Transmission of Central Bank Liquidity to Deposit and Loan Spreads

The table reports OLS regression results of syndicated loan spreads on *Central Bank Liquidity*, bank risk, and further control variables. It shows six different regression specifications over different time periods. *Central Bank Liquidity* is measured as the average over the quarter prior to loan origination of the adjusted liquidity in the banking sector. *High Bank Risk* is a dummy variable defined using banks' CDS spreads. In this table, it is determined as explained in detail in Appendix A1 but using only the week of August 9, 2007, when the financial crisis started, and holding it constant for each bank in the following period. Panel A shows the results for the deposits and Panel B for the loan sample. All variables are defined in Appendix A1. Bank and borrower accounting variables are used as stated in the annual report in the year prior to the transaction. Constant term is included but omitted. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level using two-way clustered standard errors at the firm- and at the week-level (unreported for brevity) using the method as proposed by Cameron, Gelbach and Miller (2011) and Thompson (2011) and the code provided by Petersen (2009).

Bank Risk Fixed at Start of Financial Crisis

Panel A: Deposits	Financial Crisis Period		Crisis until Full Allotment		Full Allotment Period	
	(1)	(2)	(3)	(4)	(5)	(6)
Central Bank Liquidity	-29.426***		-19.365***		-33.487***	
*(1) Central Bank Liquidity*High Bank Risk*		-31.101***		-7.765		-29.595***
*(2) Central Bank Liquidity*Low Bank Risk*		-29.067***		-18.773***		-34.398***
Borrower, Bank, Further Control Variables						
Bank Risk * Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Borrower Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Borrower Industry Code FE	Yes	Yes	Yes	Yes	Yes	Yes
Loan Type, Purpose, Currency FE	Yes	Yes	Yes	Yes	Yes	Yes
Wald Test of Interaction Terms		0.298		0.001		0.272
Observations	24,115	24,115	10,074	10,074	14,041	14,041
R-squared	0.909	0.909	0.259	0.276	0.512	0.508

Panel B: Loans	Financial Crisis Period		Crisis until Full Allotment		Full Allotment Period	
	(1)	(2)	(3)	(4)	(5)	(6)
Central Bank Liquidity	-110.742**		263.225		-69.114	
*(1) Central Bank Liquidity*High Bank Risk*		-86.498		363.435		-37.126
*(2) Central Bank Liquidity*Low Bank Risk*		-131.195**		187.684		-109.163***
Borrower, Bank, Further Control Variables						
Bank Risk * Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Borrower Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Borrower Industry Code FE	Yes	Yes	Yes	Yes	Yes	Yes
Loan Type, Purpose, Currency FE	Yes	Yes	Yes	Yes	Yes	Yes
Wald Test of Interaction Terms		0.3093		0.2636		0.0272
Observations	1,156	1,156	533	533	623	623
R-squared	0.753	0.754	0.806	0.806	0.721	0.722

Appendix A5. The Transmission of Central Bank Liquidity to Deposit Spreads: Bank-Firm-Week Level

The table reports OLS regression results of *Deposit Spread* on *Aggregate Central Bank Liquidity*, bank risk, and other control variables using data aggregated to the bank-firm-week level. It shows four different regression specifications over different time periods. *Central Bank Liquidity* is measured by the adjusted liquidity in the banking sector. All variables are defined in Appendix A1. Bank accounting standard FE are either the general accepted accounting principles (GAAP) of the respective country of the bank or the international financial reporting standards (IFRS). Bank accounting variables are used as stated in the annual report in the year prior to the transaction. A constant is included but omitted. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level using two-way clustered standard errors at the bank- and at the week-level (unreported for brevity) using the method as proposed by Cameron, Gelbach and Miller (2011) and Thompson (2011) and the code provided by Petersen (2009).

	Crisis until Full Allotment		Full Allotment Period	
	(1)	(2)	(3)	(4)
ECB Market Liquidity				
Central Bank Liquidity	-17.751		-46.992***	
*Central Bank Liquidity * High Bank Risk*		-11.081		-45.474***
*Central Bank Liquidity * Low Bank Risk*		-19.367***		-53.807***
Fixed Effects (FE) and Clustering				
Bank Risk * Time (quarter) FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time (quarter) FE	Yes	Yes	Yes	Yes
Accounting Standard FE	Yes	Yes	Yes	Yes
Wald Test of Interaction Terms		0.003		0.225
Observations	4,126	4,126	5,909	5,909
R-squared	0.246	0.262	0.4723	0.474

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