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

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Abstract

We investigate the transmission of central bank liquidity to bank deposit 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 borrowers of high-risk banks, leading to lower payouts, lower capital expenditures, and lower asset growth. These firms replace term loans drawing down existing credit lines. Our results suggest that during a banking crisis, the transmission of central bank liquidity to the real sector may be more effective if accompanied by a strengthening of banking sector health.

Keywords: Central bank liquidity, Unconventional monetary policy, Monetary policy transmission, Corporate deposits, Financial crisis, Banking crisis, Loans, Real Effects.

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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

Since 2008, Europe has faced two major crises, the global financial crisis that originated in the US mortgage market and the sovereign debt crisis that started with Greece's fiscal crisis in 2010 and eventually spilled over to other European countries. Economic stability and growth in the Eurozone remains elusive even several years after the onset of the first crisis. Moreover, the availability of funding liquidity to the real economy can no longer be taken for granted: We still observe a significant decline in lending to the non-financial sector in countries such as Ireland, Portugal, Spain or Greece as well as a substantial loan-spread differential between loans originated in those countries relative to, for example, Germany.[1]

The European Central Bank (ECB) responded to the deepening of the global financial crisis and reduced its main refinancing operation rate (the interest rate used to anchor interbank market rates) almost to the zero lower bound. It also introduced a series of non-standard measures such as the full allotment of liquidity to increase the effectiveness of its monetary policy.[2] Before the financial crisis deepened in the fall of 2008, the ECB issued liquidity in a competitive tender in order to meet an aggregate liquidity target but without directly addressing

[1] Using recent and aggregate data from the ECB's website, we find that banks in "weak" countries significantly reduced lending during the April 2014 to April 2015 period. Particularly, lending to the non-financial sector in Ireland, Portugal and Spain fell by 14%, 6% and 5%, respectively, emphasizing the effect that financial instability has on the real sector.

[2] The full allotment was the first non-standard meaure the ECB employed. Over time, other measures such as the Securities Market Purchase Program (SMP), the Long-Term-Refinancing-Operations (LTRO) and the Outright Monetary Transasction Program (OMT) and the Quantitative Easing (QE) were introduced.

individual liquidity needs by euro area banks. Instead, liquidity was allocated to the banking sector such that each bank was able to fund its operations and to meet its reserve requirements.[3] However, after the default of Lehman Brothers in September 2008, the interbank markets were severely stressed (Afonso, Kovner and Schoar, 2011) preventing an efficient allocation of liquidity. On October 8, 2008, the ECB started to fully allot all liquidity requests by individual banks at a fixed interest rate in exchange for collateral via its main refinancing operations, which eventually provided substantial excess liquidity to the banking system.[4] 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.

In this paper, we examine the effects of these non-standard monetary policy measures of the European Central Bank (ECB) during the 2008-2009 financial crisis on corporate deposit and loan rates. As the introductory quote by Yves Mersch, Member of the Executive Board of the ECB, suggests, during financial crises, monetary policy might be impaired because banks differentially respond to these measures dependent on their own financial health.[5] The European setting is particularly interesting given the differences in bank health as well as borrower bank dependence across the euro area. In particular, we ask the following questions: How does monetary policy transmit to the real economy through the banking sector before and after introduction of full allotment of liquidity by the ECB? How does monetary policy transmit to deposit vis-à-vis loan rates? And, how do banks differentially respond to central bank interventions if they are poorly capitalized? Overall, how effective is a policy that increases the

[3] The allocation and flow of central bank liquidity from the ECB into the system is explained in detail in the Online Appendix.
[4] The ECB increased its balance sheet by about €500 billion in 2008.
[5] Peek and Rosengren (2013) 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.

liquidity in the banking sector but does not address bank health?

To preview our results, we find evidence that the transmission channel of monetary policy in the euro area is indeed impaired: high-risk banks charge substantially higher loan spreads compared with low-risk banks even after the start of the full-allotment period. Thus, a sustained period of lose monetary policy that only increases liquidity in financial markets is insufficient and does not reach the real sector if the banking sector is undercapitalized.

We construct a novel and unique data set of bank deposit and loan transactions of European firms for the January 2, 2006 to June 30, 2010 period. To investigate the impact of unconventional monetary policy during the financial crisis, we split our data into the "pre-financial crisis" period (January 2, 2006 to August 7, 2007), the "financial crisis until the full allotment" period (August 8, 2007 to October 7, 2008), and the "full allotment" period (October 8, 2008 to June 30, 2010).[6] More specifically, we 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.[7] This is the first paper that empirically investigates the effect of monetary policy on deposit contracts, i.e. whether the ECB can reduce funding constraints as a LOLR during a financial crisis and how this eventually affects banks' lending and investment decisions.

Our results show no effect of central bank liquidity on corporate deposit and loan spreads in the pre-financial crisis period. This changes substantially after the onset of the crisis. An increase in central bank liquidity is associated with a significant decrease in bank deposit spreads

[6] American Home Mortgage Investment Corp. declared bankruptcy on August 6, 2007 and, based on their net asset value on August 7, 2007, BNP Paribas suspended redemptions for three of its funds (Brunnermeier, 2009).

[7] We calculate several measures of aggregate central bank liquidity also including excess aggregate liquidity as explained later on. All results are robust to the calculation of aggregate liquidity. For brevity, we report the results for only one of these measures.

during the financial crisis.[8] Differentiating by bank risk, we find that the deposit spreads of low-risk banks decrease in response to larger amounts of liquidity during the financial crisis until the full allotment period. High-risk banks, on the contrary, do not decrease deposit rates prior to full allotment. Only after the ECB introduced the full allotment framework, both high- and low-risk banks similarly reduce deposit rates if central bank liquidity increases.

These results hold when we include bank-risk-time 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-month fixed effects, which account for possible bank specific regulatory action within a month. Our results continue to hold.[9]

Moreover, we use an instrumental variable approach to address the possible concern that deposit spread and deposit volume might be jointly determined. We use the number of outstanding deposit transactions of a firm as instrument in the first stage to instrument for deposit volume.[10] The results remain unchanged. In total, our findings are consistent with an insufficient amount of aggregate liquidity in the banking system prior to the full allotment period, for example, because of a precautionary hoarding of liquidity by banks when interbank markets were dysfunctional (e.g., Afonso, Kovner, and Schoar, 2011; Ashcraft, McAndrews, and Skeie, 2011; Acharya and Merrouche, 2012). The ECB stepped in substituting for the loss of private funding

[8] Note that 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).
[9] In further robustness tests, we also include bank-week fixed effects what does not change our findings.
[10] In additional tests, we also use the amount of outstanding deposits of a firm as an instrument. The results are the same.

and eventually reduced the funding pressure also of high-risk banks.

In a second step, we 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 and focusing on loan rates. In contrast to the deposit market, we do not observe an impact of central bank liquidity on loan spreads during the financial crisis until full allotment has been implemented. During the full allotment period, however, we find that the loan spreads of low-risk banks decrease in response to higher amounts of central bank liquidity while the loan spreads of high-risk banks remain unchanged.

This finding suggests that the functioning of the transmission channel of monetary policy is intimately linked to bank health. Importantly, the transmission does not work for high-risk banks. This is consistent with recent empirical research emphasizing the importance of risk-shifting incentives for portfolio choices of undercapitalized European banks (e.g., Acharya and Steffen, 2015; Acharya et al., 2015; Popov and van Horen, 2015). Acharya and Steffen (2015a), for example, emphasize that banks' investments in risky European sovereign debt crowded out lending to the corporate sector during the financial crisis.[11]

To address the potential concern that banks and borrowers match on quality, we investigate loan spreads for borrowers that 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 starts borrowing from this group of lenders (extensive margin). Moreover, it could be that borrower characteristics differ systematically between low and high-risk banks. Focusing on the intensive margin of borrowing, we also investigate the differential effect of central bank

[11] 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.

liquidity for high-risk versus low-risk banks using a Heckman regression model. Furthermore, we also match firms of low- and high-risk banks in the full allotment period using propensity score matching models. Overall, these tests support our prior result that higher amounts of central bank liquidity translate into lower loan spreads for only low-risk but not for high-risk banks during the full allotment period.

In additional tests, we further differentiate between loan maturities (i.e., between long-, medium-, and short-term loans). 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 show that the transmission channel is impaired particularly for medium- and long-term loans, that is, for loans beyond a maturity of one year.

In a final step, we analyze changes in borrower capital structure and financial characteristics conditional on borrowing during the full allotment period. Importantly, we find that borrowers of high-risk banks draw down credit lines significantly more than borrowers of low-risk banks. We also find that the amount of debt of borrowers of high-risk banks *increases* over the three-year period after we observe a loan relative to borrowers of low-risk banks. In other words, revolving loan commitments are an important funding source for borrowers of high-risk banks during financial crises consistent with Ivashina and Scharfstein (2010) and Cornett et al. (2011).

Furthermore, we find that borrowers of high-risk banks have lower payouts, lower capital expenditures, and lower asset growth over a three-year period after having received a loan in the full allotment period compared with borrowers of low-risk banks. We do not observe differences

in investment or employment between borrowers of low- and high-risk banks. Overall, our results suggest that the impaired transmission of monetary policy during the full allotment period is associated with negative real effects of bank-dependent borrowers of high-risk banks.

Our paper relates to a large literature investigating monetary policy transmission through changes in bank loan supply (Bernanke and Blinder, 1992; Kashyap and Stein, 2000; Bernanke and Gertler, 1995; Dell'Ariccia et al., 2013; Jiménez et al., 2014). This literature finds that monetary policy expansion decreases interest rates. We add to this literature documenting that there is a differential transmission of unconventional monetary policy of high- versus low-risk banks during financial crises as well as a differential effect on deposits and loans.

Our paper also relates to the literature that more broadly investigates bank loan supply during financial crises when the banking system is weak. Peek and Rosengren (1995), for example, find that weak banks hit by the recession in New England (1990-1991) reduce their balance sheet more compared with better-capitalized banks because they cannot meet capital requirements. Chodorow-Reich (2014) shows that bank-dependent firms received less credit and experience a decline in employment after the Lehman failure if they were borrowing from weak banks. Acharya et al. (2015) provide related results for the euro area for bank dependent firms borrowing from GIIPS banks before the start of the sovereign debt crisis. We add to this discussion that large liquidity injections by central banks do not reduce financial frictions of bank-dependent firms if the banking sector is under-capitalized.

Finally, our paper also relates to the literature that studies the effects of unconventional central bank interventions. Krishnamurthy et al. (2014) find lower sovereign bond yields after ECB interventions due to lower default and redenomination risk. Pelizzon et al. (2015) document that ECB interventions weakened the sensitivity of the liquidity provision by the market makers

to changes in Italian sovereign default risk. Acharya, Pierret and Steffen (2015) show that ECB interventions reduce market discipline in the euro area. US Money Market Funds increase funding of riskier banks following ECB interventions. We add to this literature showing that non-standard monetary policy interventions do not effectively transmit to the economy if banking systems are under-capitalized.

The paper proceeds as follows. In the next section, we present the institutional setting. In Section 3, we describe the data and provide some descriptive statistics. In Section 4, we present the results for the effect of monetary policy on corporate deposit spreads. In Section 5, we show the impact of monetary policy on corporate loans. The results for firm capital structure and financial characteristics are provided in Section 6. Section 7 concludes.

2. 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 all banks' liquidity needs).

The ECB can provide and absorb overnight liquidity using the 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 money markets in Europe. 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 EU.

The ECB was not able to sustain its liquidity-neutral allotment concept in the financial crisis because it became increasingly difficult for the ECB to forecast the liquidity needed in the

banking system. The ECB therefore changed its liquidity provision framework on October 8, 2008 to fully satisfy the demand of banks for liquidity at a fixed interest rate (fixed rate full allotment). This shift in liquidity provision substantially increased the aggregate liquidity the EBC provided to 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 2016.

3. Data

3.1. 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. On average, the deposits traded on this platform represent about 15% of the short-term liabilities of our sample banks. 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 are able to offer any deposit amount with any maturity. All banks using the platform observe this offer and are able to bid for the deposit during a pre-specified time period, which usually is limited to two minutes (chosen by the firm in advance). Until the end of this period, the 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 but 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.

We limit our sample to executed deposit transactions with a maximum maturity of seven days between non-financials 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 the individual, depositing firms 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 by the number of banks bidding for the deposit amount a firm offers on the platform. We include each bank only once irrespective of its individual number of bids in the transaction. A higher value therefore reflects higher bank competition.

We obtain loan contract information from LPC's DealScan for the January 2006 to June 2010 period. As most of the loans in our sample are syndicated loans, we select the lead lender in each syndicate following earlier literature (e.g. Cai et al., 2015). We construct the merger history for each lead lender in DealScan using information obtained from the FDIC and the National Information Center (NIC). We exclude loans from banks that do not operate on the deposit trading platform during this period. Using Robert's DealScan-Compustat Linking Database (Chava and Roberts, 2008), we collect annual financial statement information from Compustat for all non-financial borrowers and merge it (with a one year lag) to each loan contract.

To measure the amount of *Central bank Liquidity* available in the banking system, we use the natural logarithm of the sum of banks' current account and deposit facility holdings with the ECB, centered by their mean value in 2006.[12] These daily data are provided by the ECB. We call this variable *Adjusted Liquidity in the Banking Sector* and use it as the main measure for central bank liquidity in our analyses.[13]

Annual bank-specific characteristics are collected from Bankscope and matched (with a

[12] An exemplary balance sheet of the ECB is shown in the Online Appendix.
[13] 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.

one year lag) to each deposit and loan transaction. As a measure for bank risk, we use bank credit default swap (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.[14] The 3-month EURIBOR-OIS spread is obtained from the Deutsche Bundesbank and is used as a proxy for the risk in the interbank market.[15] 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.

All variables are described in Appendix A1. The final dataset includes 40,638 money market firm-bank euro-denominated deposit transactions from 145 firms to 43 banks and 2,632 firm-bank loan facilities from 38 banks to 566 firms.

3.2.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), loans (Panel C), bank characteristics (Panel D) and borrower characteristics (Panel E). All data are measured in real terms 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

[14] We also use banks' Moody's long-term issuer credit rating as a measure of credit risk. We classify banks with a rating of A1 or worse as high-risk banks and re-run all our analyses. Additionally, we also build three bank risk classes defining low-risk banks as those with a rating of Aa1 or better and high-risk banks as having a rating of A1 or worse with the remainder being medium-risk banks. Note that irrespective of whether we use CDS or ratings to differentiate between high- and low-risk banks, individual 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. Additionally, we fix the risk classification for each bank at the start of the financial crisis and re-run our analyses. The results remain unchanged. We do not report the results for reasons of space.

[15] While in a EURIBOR transaction the principal is exchanged, in an EONIA transaction only swap payments are made. The spread between the 3-month EURIBOR and the EONIA is therefore an indicator for the risk in the market excluding interest rate change risk and interest rate expectations (Coeuré, 2012). In unreported regressions, we also include the Composite Indicator of Systemic Stress (CISS) provided by the ECB, which is a measure for systemic risk in the eurozone (Hollo, Kremer, and Lo Duca, 2012). Our main results remain unchanged.

the adjusted liquidity in the banking sector as an 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.

[Insert Table 1 near here]

Figure 1 depicts the time series of our four measures of central bank liquidity.[16] 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.[17] This is intuitive given the low interest rate earned in the deposit facility, which gives banks incentives to lend out excess liquidity in the interbank market in normal times. 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 bank liquidity. The ECB announced on June 25, 2009 that 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.[18] The *Average Notional Deposit Amount* of a transaction is €71 million. Deposit rates

[16] 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*.

[17] Variation (if any) in aggregate liquidity is related to forecasting errors of the autonomous factors, which are neutralized in subsequent operations (Ejerskov, Moss, and Stracca, 2008).

[18] 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 repeat all analyses also with the main refinancing rate of the ECB as risk free interest rate. All results remain robust.

and spreads sharply decrease between the pre-full allotment and the full allotment period. On average, about three banks bid for an offered deposit amount (*Bank Competition*).

Panel C of Table 1 reports loan characteristics. Loan spreads (*All in Spread Drawn*), on average, are 183 bps; the spreads increased during the financial crisis, almost doubling 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.

Panels D and E of Table 1 report bank and borrower characteristics, respectively, and show an increase in risk during the financial crisis period. Banks show an increase in leverage, cost to income ratio, and non-performing loans during the full allotment period, while their return on assets and asset growth strongly decrease. Borrower leverage increases, while coverage and the market-to-book ratio decrease, with the fraction of non-investment grade rated firms increasing from 26.94% to 36.83%.

3.3. Interest Rates

Panel A of Figure 2 depicts the development of interest rates related to 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. This provides empirical evidence that a functioning interbank market together with tender operations with limited allotment provide an incentive for banks to manage their liquidity actively and efficiently, as well as allow the central bank 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 announcement of the full allotment, the deposit rate dropped sharply and was anchored to the ECB deposit facility interest rate as a direct effect of excess liquidity. This might be problematic, as the ECB can no longer establish its key policy rate in short-term markets (Beirne, 2012).

Panel B of Figure 2 depicts the strong negative relation between corporate deposit spreads and aggregate liquidity. The figure shows that during the full allotment period, deposit spreads sometimes dropped below the marginal deposit facility interest rate of the ECB.[19] Overall, Figure 2 provides first evidence that monetary policy expansion lowers short-term corporate deposit rates in financial crises, an effect difficult to identify in normal times.

In Figure 3, we show deposit and loan spread differences for high-risk versus low-risk banks. 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 the end of our observation period.

Panel B of Figure 3 depicts the deposit spreads of low- and high-risk banks. The full allotment of liquidity resulted in a substantial decrease of deposit spreads, with especially low-risk banks paying substantially lower spreads.

Panel C of Figure 3 shows a comparable pattern can be observed for the loan spreads of borrowers who receive a loan from one bank risk category prior to the full allotment period and receive another loan from the same bank risk category in the full allotment period (intensive margin). Low-risk banks charge much lower loan spreads than high-risk banks in the full allotment period suggesting that the monetary policy transmission channel is impaired.

[19] This represents arbitrage opportunities for banks. Arbitrage might occur in segmented markets when banks' bargaining power is elevated (Shleifer and Vishny, 1997; Bech and Klee, 2011).

[Insert Fig. 3 near here]

4. Monetary Policy and Corporate Deposits

4.1. Transmission of Central Bank Liquidity to Corporate Deposit Spreads

In a first set of tests, we focus on the role of the ECB as a LOLR to reduce funding risks of banks during crises. In particular, we investigate how ECB liquidity affects corporate deposit spreads before and after the implementation of the full allotment framework. We analyze deposit transactions during the January 2, 2006 to June 30, 2010 period and split this period 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) as before. Table 2 shows the results of pooled OLS regressions. We use the following regression model:

$$\begin{aligned} Deposit\ Spread_{j,t} &= Central\ Bank\ Liquidity_t + High\ Bank\ Risk_{i,t} + Bank\ Controls_{i,t} \\ &+ \log(Deposit\ Amount)_{j,t} + Deposit\ Duration_{j,t} + Bank\ Competition_{j,t} \\ &+ 3\ Month\ EURIBOR - EONIA\ Swap\ Spread_t + Fixed\ Effects + \varepsilon_{j,t} \end{aligned}$$

where the dependent variable is the corporate deposit spread in transaction *j* paid by bank *i* and the main inference variable is central bank liquidity measured at day *t* of the deposit transaction. We also include other variables that might affect deposit spreads. We include an indicator variable for high bank risk (which we measure using CDS spreads) in the week prior to the transaction, bank characteristics from most recent end-of-year financial statements, and variables to control for the notional deposit amount and duration, the number of banks bidding for the deposit (bank competition), market risk (3-month EURIBOR to the 3-month 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 and quarterly fixed effects. We include indicator variables for bank accounting standards and use heteroscedasticity-robust standard errors clustered at the bank level.[20]

[Insert Table 2 near here]

Column (1) of Table 2 documents that an increase of central bank liquidity results in lower corporate deposit spreads. Columns (2) to (4) show that we observe this effect only during the financial crisis period. A one standard deviation increase of central bank liquidity reduces deposit spreads by 12.86 bps in the financial crisis until full allotment period and by 14.01 bps in the full allotment period. Table 2 also shows that high bank risk per se does not have an effect on corporate deposit spreads. However, during the financial crisis, larger banks paid lower spreads, especially during the full allotment period, consistent with the interpretation that some banks are perceived as too big to fail and benefit from (explicit or implicit) guarantees from the government through lower funding costs. Moreover, large banks are more likely to have access to alternative funding sources.

Surprisingly, higher market risk, reflected in the 3-month EURIBOR to the 3-month EONIA swap spread, results in higher deposit spreads in the pre-financial crisis period but lower spreads during the financial crisis until the full allotment period. The negative coefficient during the financial crisis until the full allotment period suggests that firms prefer shorter deposit maturities in crises, which is consistent with a flight to money market depositing (Baglioni, 2009). This in turn decreases short-term deposit spreads. On the last day of the reserve maintenance period, deposit spreads on average decline. This might be driven by banks holding

[20] We also repeat all analyses clustering standard errors at the bank and at the firm level using the methodology of Petersen (2009). The results are the same.

excess liquidity over the reserve maintenance period and therefore offering overnight funds on this day, which compete with the depositing firms' offers.[21] The 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.[22]

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

Overall, the results in the previous subsection suggest that the ECB successfully reduced funding risk of banks during the financial crisis: a higher amount of central bank liquidity decreases corporate deposit spreads. In this subsection, we test if there are differences in the transmission of central bank liquidity between low-risk and high-risk banks. To do this, we interact liquidity with indicator variables for high- and low-risk banks and investigate the effect of aggregate liquidity during (1) the financial crisis period, (2) the crisis until the full allotment period, and (3) the full allotment period. Note that in addition to the model specifications shown in Table 2 we also include bank risk-time (quarter) fixed effects.

Column (4) of Table 3 documents substantial differences as to the transmission of central bank liquidity to corporate money market deposit spreads during the financial crisis until the full allotment period between bank risk types. While the deposit spreads of low-risk banks decrease in response to larger amounts of liquidity, the coefficient for aggregate liquidity for high-risk banks is only significant at the 10% level and much smaller. A Wald test under the null hypothesis that these coefficients are equivalent is rejected at the 1% confidence level. However, during the full allotment period this difference disappears in Model VI where higher aggregate

[21] Figure 2 seems to indicate 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 frequency of decreases on the last day of the reserve maintenance period is much higher.

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

liquidity reduces deposit spreads of both high- and low-risk banks.

[Insert Table 3 near here]

What explains the differential transmission of aggregate liquidity on deposit spreads during the period before the ECB implemented the full allotment framework? The deposit spread differential suggests that there is an insufficient amount of aggregate liquidity in the banking system. High-risk banks need to pay substantially higher deposit spreads to attract funding. Banks might start hoarding liquidity as a precaution because of an increasingly stressed interbank market (the 3-month EURIBOR-OIS spread exceeded 200 bps during this time). In other words, this behavior does not allow aggregate liquidity to distribute among banks, such that each bank is able to efficiently fulfill its reserve requirement. During the financial crisis until the full allotment period, the ECB only allocated that amount of aggregate liquidity to the market, which was sufficient for banks to fulfill (almost exactly) their reserve requirements. Accordingly, strong banks might 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). Note that the general demand for a precautionary hoarding of liquidity can also be inferred from Figure 1, which shows that irrespective of its measurement, central bank liquidity strongly increases during the full allotment period.

4.3. Robustness

In this subsection, we test the robustness of our results for corporate deposits. Other bank and regulatory actions were undertaken during the financial crisis that might affect our results. We re-run all of our regressions including monthly time fixed effects to account for specific actions related to all banks in a specific month (such as regulatory or announcements of other monetary policy changes). In one set of regressions, we include bank risk group interacted with

these monthly fixed effects to account for changes in one month specific to our bank risk groups. In another set of regressions, we employ bank-month fixed effects, controlling for changes in a month that is specific to one particular bank. The results are shown in Table 4.

[Insert Table 4 near here]

The results in Panel A of Table 4 strengthen 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, the coefficient for high-risk banks is, however, insignificant. During the full allotment period, this difference disappears and more liquidity reduces deposit spreads of banks irrespective of risk.

Instead of using a contemporaneous measure of central bank liquidity, we also repeat the same regression models using lagged measures. For example, we also use central bank liquidity lagged by one day or as the average over the week prior to the transaction as in De Andoain et al. (2015). We report the results in Panel B of Table 4 and find very similar results.

Another possible concern might be that deposit amount and deposit spread are jointly determined. Firms might offer different amounts depending on the deposit rate. Moreover, banks might bid different interest rates depending on the notional amount offered. Although firms on the platform first offer their funds and then receive interest rate bids, some firms might cancel a request given the observed interest rates, change the amount, and place another, different, request.[23] Additionally, some firms might communicate interest rates between each other and adjust amounts accordingly. We account for this possible endogeneity in two-stage least squares (2SLS) regressions similar to those in Acharya and Mora (2015). We instrument the notional

[23] We are able to observe all requests and their outcomes. Excluding transactions that are executed after previous requests of the same firm have been canceled on the same day does not change our findings. We also include only those transactions where the difference between the highest and lowest bids are 10bps, 5bps or 1bp to account for the fact that customers chose between the bids. Again, the results do not change but remain unreported for brevity.

amount of a transaction with the number of outstanding money market deposits of a firm. The rationale is that firms with many outstanding money market deposit transactions should have a lower supply, that is, offer lower amounts, irrespective of the deposit rate. Table 5 shows the results.

[Insert Table 5 near here]

Higher central bank liquidity lowers deposit spreads only for low-risk banks during the financial crisis until the full allotment period while it lowers spreads for all banks equally in the full allotment period. Note that the deposit amount is insignificant in both periods in the second stage regressions in Table 5. Our instrumental variable is significant in the first stage and the coefficient in line with our hypothesis.[24] Bank risk does not enter the regressions significantly. Overall, our results are consistent with the interpretation that the ECB, after stepping in as LOLR, effectively replaced the interbank market mitigating funding risk for high-and low-risk banks.

5. Monetary Policy and Corporate Loans

The ECB replaced both the demand and supply side of the interbank market through its main refinancing operations and its deposit facility, where bank with excess liquidity could deposit and banks that have problems funding themselves can borrow liquidity at a low interest rate,

[24] In unreported regressions, we also include our instrument in the second stage regression setup and find that it has no statistically significant influence on deposit spreads, in line with the 2SLS assumption of orthogonality between the instrument and the second stage dependent variable. We also repeat the 2SLS regressions using the amount of a firm's outstanding money market deposits. The results are very comparable. In another set of instrumental variable regressions, we employ a three-stage least squares (3SLS) approach and estimate two structural equations simultaneously via the generalized method of moments (GMM). All variables not included in one structural equation serve as instruments for the other structural equation. We do not include central bank liquidity, bank risk, bank competition, or bank accounting variables in the structural equation of the notional deposit amount. We also do not include the number of outstanding deposit transactions in the structural equation for the deposit spread such that we have a sufficient number of instruments available in both structural equations. Our results are also confirmed using this methodology.

which eventually reduced the corporate deposit spreads as shown above. To be able to answer the question whether the monetary transmission channel is impaired, we need to also ask whether (both high- and low-risk) banks pass on these lower funding costs from the ECB and corporate deposit markets to their corporate clients. To investigate this, we match the banks from the corporate deposit data set to banks in Dealscan directly comparing their lending and deposit taking behavior.

5.1. 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 only defining aggregate liquidity slightly differently. We use an average of the liquidity provided by the ECB over the quarter prior to loan origination (that is, the previous three months) as measure of central bank liquidity.[25] Following earlier literature on loan pricing, the 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 (3-month EURIBOR to the 3-month EONIA swap spread). These variables are described in detail in the appendix. All models also contain bank, time, bank risk-time, borrower industry and rating, and loan purpose, loan type, and loan currency fixed effects. Standard errors are clustered at the borrower level. We use the following regression specification

[25] The rationale is that loan negotiations take some time to unfold. 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.

$$Loan\ Spread_{i,j,t}$$

$$= Central\ Bank\ Liquidity_t\ x\ High\ Bank\ Risk_{i,t}$$

$$+ Central\ Bank\ Liquidity_t\ x\ Low\ Bank\ Risk_{i,t} + \sum Controls_{i,j,t} + \varepsilon_{it}$$

where the dependent variable is the All-in-spread-drawn (AISD) that is used in the loan pricing literature. Table 6 shows the results of pooled OLS regressions using loan spreads as dependent variable during the crisis period.[26] Column (1) of Table 6 shows 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-risk bank does not enter significantly into the regression.

[Insert Table 6 near here]

When we split the period into the financial crisis until full allotment period and the full allotment period, we do not find any effect 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 in the full allotment period while it does not have an effect on the loan spreads of high-risk banks. As our introductory quote suggests, the transmission of monetary policy during unconventional and expansive monetary policy depends on the stability of the banking system and monetary policy might not have the desired effect if there are substantial differences in financial sector health across the euro area.

Recent empirical research investigates investment and lending behavior of high- versus low-risk banks in Europe which helps us understand why monetary policy transmission might

[26] For brevity, we do not report multivariate regression results for loan spreads comparable to Table 2 and accordingly not for the pre-financial crisis period. The results for the pre-financial crisis period show that borrower, bank, and control variables are comparable to the financial crisis until full allotment period results in Table 6 while central bank liquidity and high bank risk are insignificant.

not work if banks are poorly capitalized. Acharya and Steffen (2015) find that under-capitalized banks invest in risky Eurozone sovereign debt to shift risk or to game risk-weights. In fact, they show that banks' investments in sovereign debt crowded out lending to the corporate sector. In a related study, Acharya, Ignatowski and Steffen (2015) find that poorly capitalized banks continued lending to high-risk borrowers to avoid writing-off already scarce capital during the financial crisis. Using similar data, Acharya et al. (2015) find that risk-shifting behavior of undercapitalized banks are of first-order importance for explaining the negative real effects suffered by European firms. Related, Popov and van Horen (2015) show that lending by European banks with sizeable holdings of GIIPS sovereign bonds declined relative to non-exposed banks.

Taken together, this literature suggests that portfolio choices by poorly capitalized banks in the euro area are driven by risk-shifting incentives leading to different investment and lending decisions relative to well-capitalized banks. Worse, as our results demonstrate, the lack of capital by some banks adversely affects the transmission mechanism of monetary policy of central banks. Even as the ECB stepped in as LOLR and replaced the interbank market, which effectively reduced funding costs of high- and low-risk banks, this did not transmit to the real economy and loan spreads charged by high-risk banks. Only low-risk banks charged lower spreads in the full allotment period when central bank liquidity increased.[27]

5.2. Intensive versus Extensive Margin

We provide further robustness tests that help us to rule out that our results are driven by changes in borrower-lender matching over time. Low-risk banks might attract borrowers with

[27] Our control variables affect loan spreads as expected. Borrowers with high market-to-book ratios pay lower spreads. In the financial crisis until 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.

lower credit risk during the full allotment period, whereas high-risk might banks might match with riskier borrowers, which could explain our results. For this purpose, we investigate borrowing along the intensive and extensive margin. In addition, we use propensity score matching (PSM) methods to ensure comparability of borrowers of high- and low-risk banks. Finally, we also account for loan maturity to ensure that differences in loan spreads between high- and low-risk banks are not driven by differences in the maturity of granted loans.

5.2.1. Intensive and Extensive Margin — Borrower Characteristics

A possible concern with our results might be that it is not a supply effect with poorly capitalized banks charging higher interest rates but rather the consequence of a matching of borrowers with banks. After the start of the full allotment, weak borrowers might have matched with weak banks to take advantage of the additional central bank liquidity which affected (and ultimately increased) loan lending rates. To address this concern, we investigate loan spreads for borrowers that 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 becomes a first-time borrower from this group of lenders during the full allotment period (extensive margin). We carry out most of our analyses for borrowers along the intensive margin.

We first investigate the differences in borrower characteristics between the intensive and extensive margins, as well as between low- and high-risk banks. Panel A in Table 7 shows that during the full allotment period, 221 firms use 775 loan facilities, out of which 345 relate to borrowing along the intensive margin. 20.29% of these are facilities of firms that borrow only from high-risk banks in our observation period, 4.93% are facilities of borrowers who receive a loan only from low-risk banks in our observation period, and 74.783% are facilities of firms who receive a loan both from low- and high-risk banks in the period prior to full allotment and

borrow again in the full allotment period. Table 7 also shows that 345 firms that receive a loan in the period prior to the full allotment period do not obtain a loan during the full allotment period, whereas out of the 221 borrowers receiving a loan during the full allotment period, 96 are borrowers who also received a loan in the period prior to the full allotment period and 125 are first-time borrowers in our dataset. During the full allotment period, 55.484% (430 out of 775) of loans relate to borrowing along the extensive margin, of which 81.86% (64.186% + 17.674%) are loans granted by high-risk banks.

[Insert Table 7 near here]

In Panel B in Table 7, we report results from a comparison of borrower characteristics by bank risk and between borrowers along the intensive and extensive margin. This comparison helps us to rule out that borrower risk characteristics are substantially different between bank risk groups. For this purpose, we split borrowers into three groups, (1) those who stay within the high- or low-risk bank group (intensive margin), (2) those who switch between bank groups (extensive margin), and (3) new borrowers after the ECB initiated full allotment (extensive margin). Panel B reveals that new borrowers have a higher market-to-book ratio compared with firms on the intensive margin within both bank risk groups while coverage is higher and tangibility lower in the low-bank risk group, and size and leverage are lower and the current ratio higher in the high bank risk group. Investigating the differences in borrower characteristics between bank risk groups, we show that high-risk bank borrowers are smaller, have a lower tangibility and a somewhat lower market-to-book ratio (Table 7, Panel B), significant at the 10% level.

We also investigate whether borrower-lender matching along the intensive and extensive margins is not substantially different between bank risk groups in a multivariate setup. To do

this, we regress an indicator variable, which is one if the borrower does not switch between 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. We use an OLS, a probit, and a logit regression without fixed effects, as well as an OLS regression with bank, time, bank risk-time, borrower industry and rating, and loan type, loan purpose, and loan currency fixed effects.[28] Panel C of Table 7 shows the results. It confirms that bank characteristics and bank risk are not correlated with the decision of firms to switch between bank risk groups. Our bank risk indicator variable nor any of the banks' characteristics are generally significant. This implies that borrowing along the intensive and the extensive margins is not driven by bank risk.

5.2.2. Intensive Margin

Table 8 shows the effect of central bank liquidity on loan spreads by bank risk only for borrowers on the intensive margin in the full allotment period. Column (1) shows a pooled OLS regression model, column (2) reports the results of a Heckman selection model using the model as shown in column (3) of Panel C of Table 7 as the first stage. The regression results confirm the results presented in Table 6. In both models, higher amounts of central bank liquidity translate 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 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, higher amounts of central bank liquidity reduces loan spreads of borrowers of low-risk banks more relative to high-risk banks in the full allotment period.

[28] We only use an OLS regression together with these fixed effects because we are concerned about the incidental parameters problem in non-linear regressions (e.g., Green, 2004).

[Insert Table 8 near here]

To ensure that our results are not driven by differences in borrower characteristics between high- and low-risk banks in the full allotment period, we employ PSM models following the approach outlined in Rosenbaum and Rubin (1983).

We use different estimation methods: nearest neighbor matching with 10, 50, and 100 neighbors and kernel matching using both the Gaussian and the Epanechnikov kernel.[29] 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 employ bootstrapped standard errors.[30]

[Insert Table 9 near here]

Panel A of Table 9 shows that in the full allotment period borrowers of high-risk banks pay on average 100 bps more than borrowers of low-risk banks when we use the kernel matching methods and 120 bps more when using the nearest neighbor matching methods. This difference is significant at the 1% level in almost all cases.

To further investigate the transmission of monetary policy, we focus on borrowers matched via PSM also in multivariate regressions along the intensive margin. For both the nearest neighbor and the kernel matching, we use the nearest match to each treated firm within the defined caliper or bandwidth. Panel B of Table 9 shows the results of regressions of loan spreads on bank risk, central bank liquidity and bank control variables. We find that in the full allotment period, higher central bank liquidity in general only reduces the interest rates of the loans of low-risk banks. This reinforces our earlier result that the loan spread differential reflects

[29] 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.

[30] 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 treated 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, as it is the case in Table 9 Panel B.

an impaired transmission channel of monetary policy because the banking system is weak.[31]

5.2.3. Monetary Policy and Loan Maturity

The ECB's monetary policy targets the short end of the yield curve providing short-term liquidity. However, economic decisions are long-term decisions (such as building houses or a new plant) and affected by 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.

To investigate this, we differentiate between short-, medium-, and long-term loans. These loans have maturities of smaller/equal to one year, one-to-five years or more than five years, respectively. We run our tests both on the full sample (column (1) and (2) of Table 10) and on the intensive margin (column (3) of Table 10).

[Insert Table 10 near here]

We find 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 show that the reduction is not significantly different between either 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. Finally, Table 10 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. In other words, investment decisions by firms of high-risk banks could be affected by banks' decision not pass on lower funding costs, an issue

[31] 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. However, given the small number of observations these regressions are almost fully determined.

we turn to next.

6. Capital Structure and Real Effects of Bank Loan Supply

The transmission of monetary policy through bank balance sheets is impaired because some banks are weak. High-risk banks do not pass on funding advantages associated with central bank liquidity to their borrowers. We next examine how this ultimately affects their borrowers' financial and investment decisions.

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 imply differences in borrower decisions. For example, Chodorow-Reich (2014) shows that borrowers with a higher exposure to riskier banks experience negative real effects during financial crises.

To investigate whether banks' decision not to pass on better funding terms to borrowers affects borrowers' capital structure and investment decisions, we collect additional (capital structure related) data over the 2005 to 2013 period from Capital IQ. This data includes the relative percentage of term loans and revolving loans within a firm's capital structure, along with the notional amount of debt outstanding.

We use additional data from Compustat over 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 a borrower's total liabilities, payouts, capital expenditures, asset growth, investment, as well as the number of employees.

We focus on borrowers along the intensive margin and investigate changes in firm characteristics over a period of one, two, and three years after a firm received a loan in the full allotment period.[32] We include the same borrower accounting control variables as in Table 6, as well as year, borrower industry, and borrower rating fixed effects in all regressions. Moreover, we distinguish between (1) borrowers who receive a loan only from high-risk banks in our observation period and (2) borrowers who receive a loan from a high-risk bank in the full allotment period and received a loan from a high-risk and a low-risk bank prior to the full allotment period.

[Insert Table 11 near here]

We observe in Table 11 that the portion of term loans of borrowers of high-risk banks decreases (Panel A) while the portion of revolving loans increases (Panel B). Interestingly, the total amount of debt outstanding increases (Panels C and D), suggesting that borrowers of high-risk banks draw down their loan commitments. Our results are consistent with Ivashina and Scharfstein (2010) and Cornett et al. (2011), who show that loan commitments are an important source of financing for borrowers of high-risk banks during financial crises.

We also find that high-risk bank borrowers have lower payouts (Panel E), lower capital expenditures (Panel F), and exhibit lower asset growth (Panel G) over the three years after loan origination in the full allotment period compared with borrowers of low-risk banks. We do not observe differences in investment or employment between borrowers of low- and high-risk banks (Panels H and I). A possible explanation might be the number of large firms in our sample. Chodorow-Reich (2014) documents that investments and employment decrease for small- and

[32] 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. We provide these results in an Online Appendix.

medium-sized, but not for large borrowers.

7. 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 from June 2006 to June 2010, we document that an increase in central bank 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. We also show that borrowers of high-risk banks refinance expiring term loans with loan commitments. They decrease (increase) the percentage of term loans (commitments) in their capital structure and experience negative real effects in the years after having received a loan from a high-risk bank.

Our paper has several important policy implications. First, our results offer the interpretation that the previous programs (such as the Long-Term Refinancing Operations (LTRO) or Securities Market Program (SMP)) that were supposed to increase lending and growth across the euro area after the sovereign debt crisis might not have been successful. Europe was struggling with a weak banking system and regulators and governments have not decisively dealt with this weakness. On the contrary, the regulatory response to the 2008-2009 financial crisis included largely debt guarantees and hardly any recapitalization what might even have contributed to additional risk-taking, e.g. European banks purchasing risky sovereign bonds (Acharya and Steffen, 2015a). Moreover, a series of stress tests in Europe since March 2010 did not help to strengthen the banking system and regulators did not ask banks to raise much capital.

Second, it casts doubt on the effectiveness of the newly initiated quantitative easing (QE) program by the ECB in March 2015. The ECB is supposed to purchase sovereign debt and other

fixed income instruments for more than EUR 1 trillion until end of 2016. Before the start of QE the ECB conducted a comprehensive assessment.[33] This assessment involved an Asset Quality Review (AQR) to identify problem assets in Europe's largest 130 banks using a common evaluation scheme and a stress test to test the resilience to shocks over a 3-year period. Overall, these tests resulted in about €20 billion in capital shortfalls across all tested banks and might not have ultimately improved the health of European banks.[34]

Third, the actions of the ECB to support the euro area economy through various programs provide support to a troubled financial system, thereby making it possible for the ECB and national regulators to delay dealing with troubled banks. It is effectively providing assistance to banks that likely have solvency problems. This facilitates forbearance because national regulators may have even more incentives to defer actions as the problems are partly addressed by the ECB's policy (Hellwig, 2014a, 2014b). Some banks thus might become fully dependent on ECB liquidity.

Fourth, differences in banks' creditworthiness across the Eurozone suggests that there are possible distributional consequences of ECB liquidity provision. Countries with a rather healthy banking system benefit from extraordinary liquidity provision while countries with weak banks do not benefit or even suffer. The situation might actually get worse because of moral hazard and risk shifting incentives of under-capitalized banks (Acharya and Steffen, 2015a).

In sum, our results suggest that for monetary policy to be effective during or following a financial crisis, it should be accompanied by a policy that strengthens the health of the banking

[33] The comprehensive assessment was conducted before the start of the Banking Union. One pillar is a common Single Supervisory Mechanism (SSM) which stipulates that the ECB takes over the direct supervisory function of the largest banks in the euro area. The comprehensive assessment was supposed to clean up European banks' balance sheet and deal with non-performing assets accumulated during the pre-2007 credit boom. Detailed discussions related to the credibility of the assessment can be found in Acharya and Steffen (2014 a,b).

[34] Acharya and Steffen (2015b) describe the risks for the European financial system in more detail.

system. An alternative interpretation is that easy monetary policy in such times is an indirect way of keeping loan margins high for risky banks and thereby recapitalizing them over time (Brunnermeier and Sannikov, 2015). Our results highlight, however, that such indirect recapitalization of weak banks has distributional consequences for their borrowers who are forced to make compensating real-sector adjustments.

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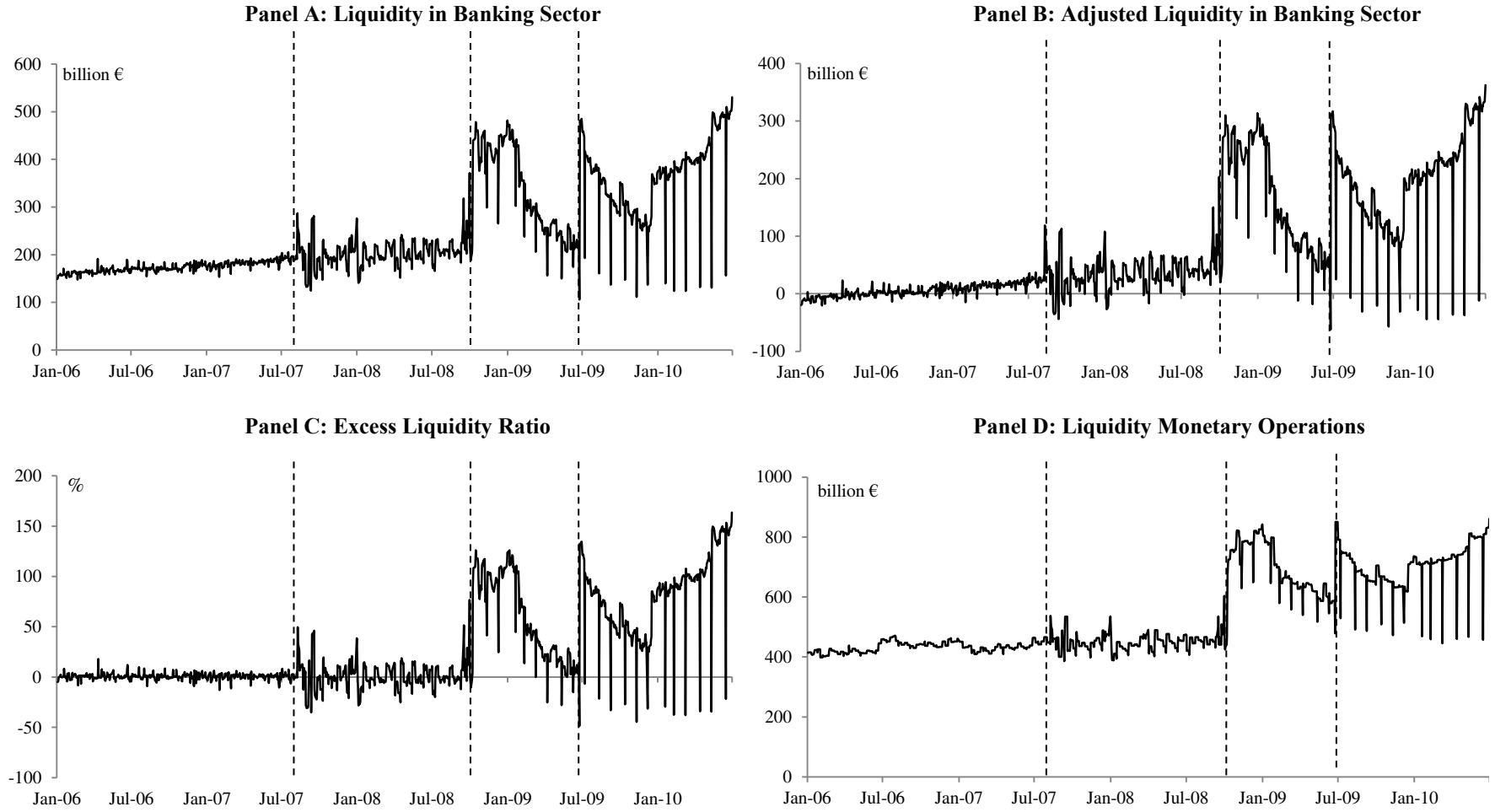
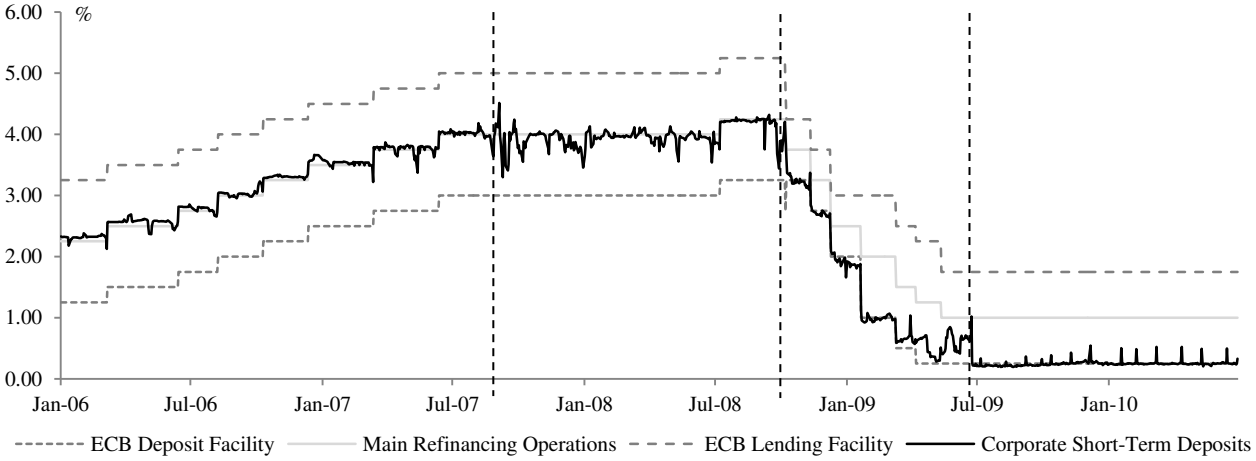


Fig. 1. Central Bank Liquidity. The figure shows four measures of aggregate market liquidity provided to the banking sector by the ECB ("central bank liquidity") during the January 2006 to June 2010 period without taking logarithms. The first vertical dashed line in each figure indicates the start of 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.

Panel A: Short-term Interest Rates



Panel B: Central Bank Liquidity and Deposit Spread

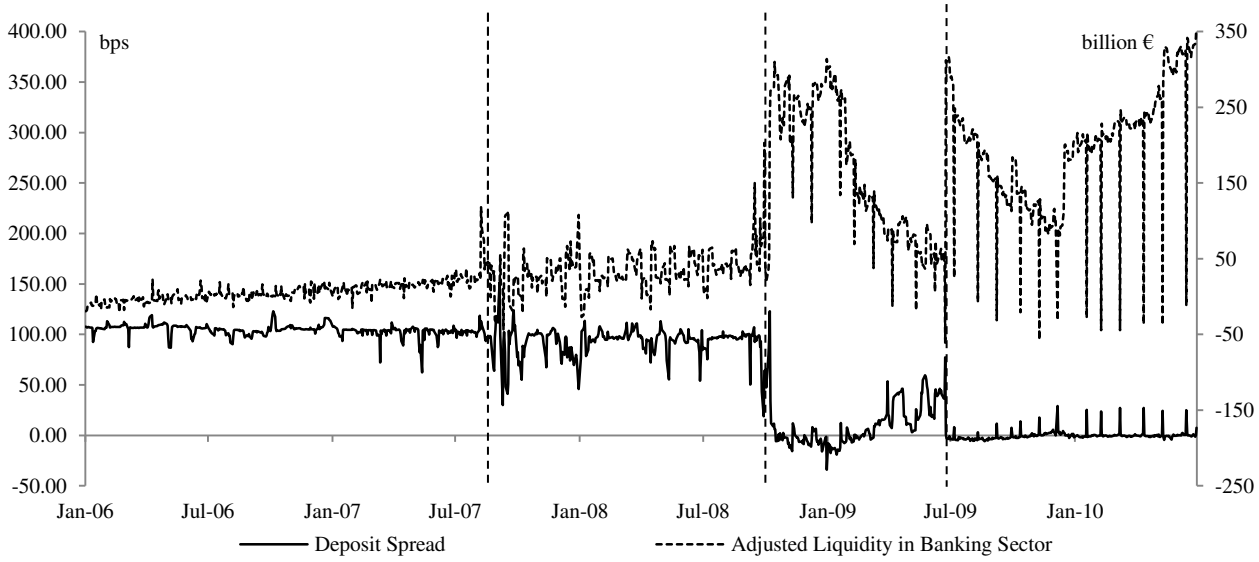
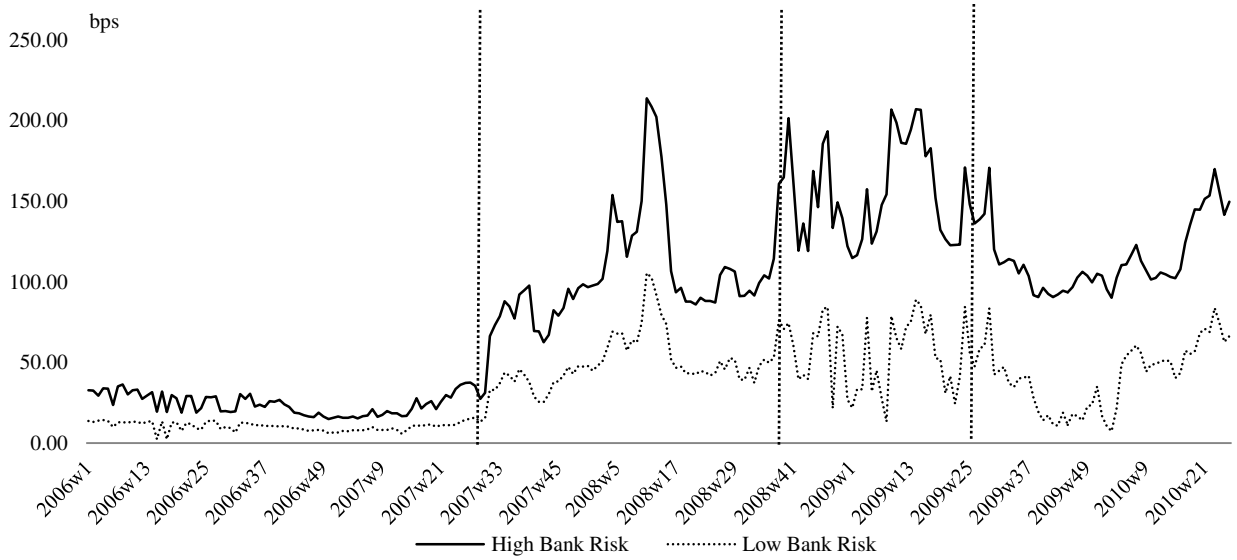
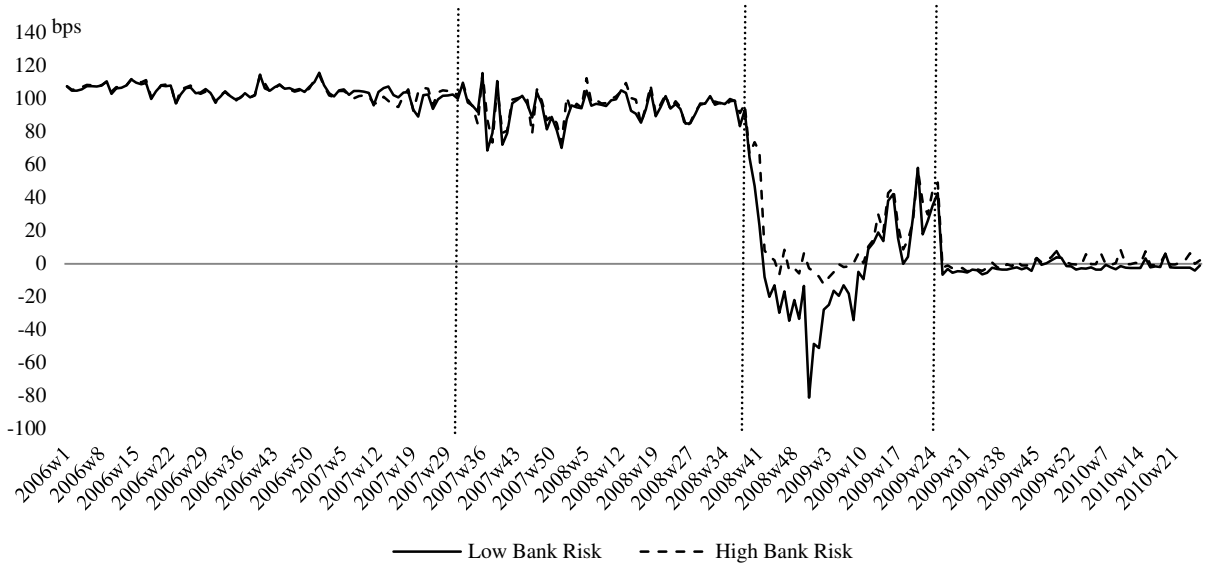


Fig. 2. Short-term Interest Rates and Central Bank Liquidity. Panel A shows the development of the interest rates for the *ECB Deposit Facility*, the *ECB Main Refinancing Rate*, and the *ECB Marginal Lending Facility*, together with the average daily *Corporate Short-Term Deposit Rate* in percent over the period 2006 to June 2010. 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



Panel C: Loan Spread Difference between Low and High Bank Risk Borrowers (Intensive Margin)

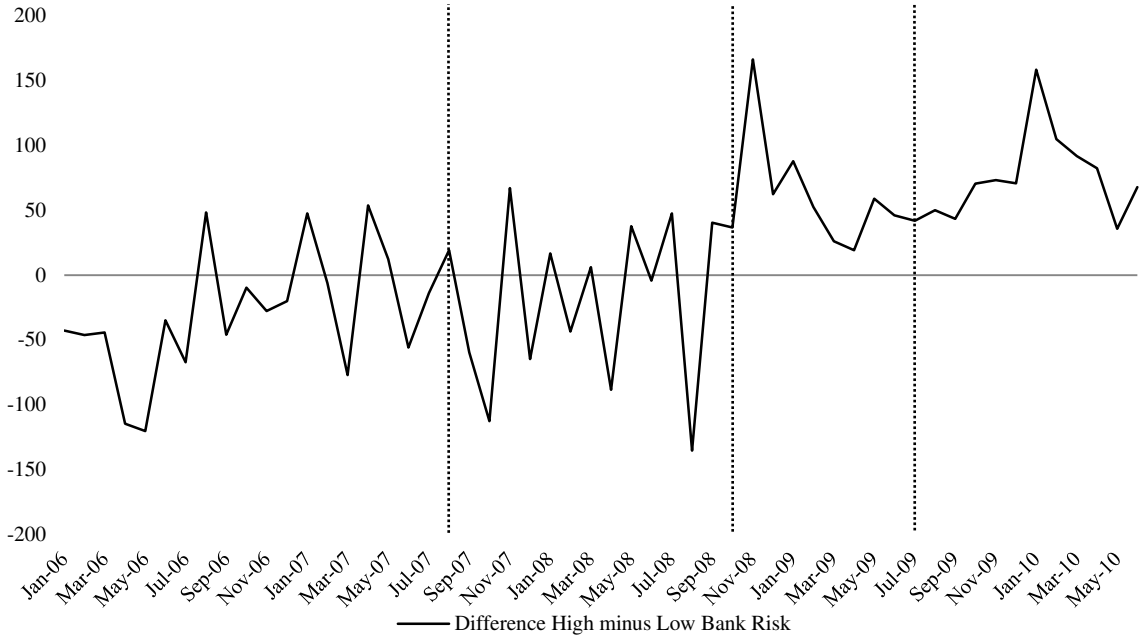


Fig. 3. Bank Risk and Deposit and Loan Spreads. Figure 3 shows banks' average five-year CDS spread by bank risk (Panel A), the *Deposit Spread* by bank risk (Panel B), and the *Loan Spread* difference of borrowers on the intensive margin by bank risk (Panel D) in basis points from 2006 to 2010:Q2. Panel 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 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	3.16	3.55	3.29	2.91

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
All in Spread Drawn (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
	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%

Panel D: Bank Characteristics

	Total Period	Pre-Financial Crisis	Crisis until Full Allotment	Full Allotment Period
Number of Banks	43	31	35	40
Low Bank Risk	49.59	13.401	61.955	71.315
High Bank Risk	109.87	26.625	110.2	126.849
Total Assets (€ million)	764,962	637,928	778,176	810,502
Leverage (%)	96.067	96.338	95.824	96.098
Off-Balance-Sheet Exposure (%)	21.638	20.642	21.988	21.847
Return on Assets (%)	0.185	0.462	0.447	-0.09
Total Asset Growth (%)	7.72	12.818	14.68	1.695
Net Interest Margin (%)	1.005	1	0.907	1.067
Cost/Income Ratio (%)	70.622	62.1	65.32	77.871
Net Loans/Customer Deposits (%)	143.903	137.593	145.935	145.338
NPL/Loans (%)	2.874	2.53	2.38	3.284
Net Derivative Exposure (%)	-0.173	-0.152	-0.483	0.006
Liquid Assets / Short-Term Funding (%)	57.032	55.455	62.394	54.475
Total Deposits/Total Assets (%)	55.343	57.441	55.503	54.364

Panel E: Borrower Characteristics

	Total Period	Pre-Financial Crisis	Crisis until Full Allotment	Full Allotment Period
Number of Firms	566	314	208	221
Total Assets (€ million)	7,944	7,641	8,046	8,413
Leverage	0.554	0.56	0.526	0.571
Current ratio	1.685	1.729	1.631	1.657
Coverage	17.962	14.25	28.439	14.145
Market to Book	1.685	1.71	1.916	1.396
Tangibility	0.388	0.392	0.36	0.41
Borrower IPO (years)	10.615	9.553	10.424	12.195
Credit Rating				
Investment Grade Rating	32.97%	30.27%	38.34%	32.53%
Non-Investment Grade Rating	34.95%	38.33%	26.94%	36.83%
Not Rated	32.08%	31.40%	34.72%	30.65%

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 4 different regression specifications over different time periods, indicated at the top of each regression. *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. The bank accounting and further control variables are as in Table 2. 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. Constant term is included but omitted. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level using heteroscedasticity-robust standard errors clustered at the bank-level (unreported for brevity).

	Total Period (1)	Pre-Financial Crisis (2)	Crisis until Full Allotment (3)	Full Allotment Period (4)
Central Bank Liquidity	-28.997***	0.406	-21.687***	-35.648***
Bank Risk				
High Bank Risk	-0.115	-0.11	1.683	0.162
Bank Accounting Variables				
log(Total Assets)	-4.319***	-0.347	-2.172*	-4.681***
Leverage	0.128	0.416**	0.311	-0.762
Off-Balance-Sheet Exposure	-0.006	0.028**	0.019	-0.082
Return on Assets	-1.212	-4.720*	-0.232	-0.511
Total Asset Growth	0.039**	-0.021***	0.007	0.032
Net Interest Margin	-3.409	1.854**	-2.308	-6.674*
Cost/Income Ratio	-0.009	-0.104*	-0.03	-0.021
Net Loans/Customer Deposits	-0.036**	-0.013	-0.001	-0.032
Non-performing Loans/Total Loans	0.511	-0.178	-0.406	1.180*
Net Derivative Exposure / Total Assets	0.113	-0.068	-0.083	0.511**
Liquid Assets/Short-Term Funding	-0.005	-0.019	-0.001	-0.001
Total Deposits/Total Assets	0.019	-0.070***	0.025	-0.015
Further Control Variables				
log(Notional Deposit Amount)	-0.194	0.16	0.069	-0.694**
Deposit Duration	0.704***	0.295***	0.724**	0.660***
Bank Competition	0.427***	-0.04	0.414**	0.592***
3 Month EURIBOR-EONIA Swap Spread	-15.717***	56.222***	-29.075***	-5.255
End of Reserve Maintenance Period	-8.239***	-6.834***	-6.633***	-14.102***
Crisis Until Full Allotment	-1.984			
Full Allotment Period	-52.048***			
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	0.288	0.531

Table 3

The Transmission of Central Bank Liquidity to Deposit Spreads by Bank Risk

The table reports OLS regression results of the *Deposit Spread* of corporate deposits with a maximum maturity of 7 days on *Central Bank Liquidity*, bank risk and further control variables. It shows 6 different regression specifications over different time periods, indicated at the top of each regression. *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 term is included but omitted. Constant term is included but omitted. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level using heteroscedasticity-robust standard errors clustered at the bank-level (unreported for brevity).

	Financial Crisis Period		Crisis until Full Allotment		Full Allotment Period	
	(1)	(2)	(3)	(4)	(5)	(6)
ECB Market Liquidity						
Central Bank Liquidity	-30.062***		-21.814***		-36.173***	
*Central Bank Liquidity*High Bank Risk*		-31.392***		-10.720*		-35.761***
*Central Bank Liquidity*Low Bank Risk*		-26.991***		-24.868***		-38.511***
Fixed Effects (FE) and Clustering						
Bank Risk * Time (quarter) FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time (quarter) FE	Yes	Yes	Yes	Yes	Yes	Yes
Accounting Standard FE	Yes	Yes	Yes	Yes	Yes	Yes
Wald Test of Interaction Terms		0.196		0.0064		0.3356
Observations	26,238	26,238	10,179	10,179	16,059	16,059
R-squared	0.899	0.899	0.301	0.303	0.535	0.535

Table 4

The Transmission of Central Bank Liquidity to Deposit Spreads - Robustness

The table reports OLS regression results of the *Deposit Spread* of corporate deposits with a maximum maturity of 7 days on *Central Bank Liquidity*, bank risk and further control variables. It shows different regression specifications over different time periods, indicated at the top of each regression. *Central Bank Liquidity* is measured as the adjusted liquidity in the banking sector. Panel B includes lagged values of *Central Bank Liquidity* as shown at the top of each column. *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. A secular term of *High Bank Risk* is included but omitted. All control variables as shown in Table 2 are included. A constant term is included but omitted. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level using heteroscedasticity-robust standard errors clustered at the bank-level.

Panel A

	Crisis until Full Allotment				Full Allotment Period			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Central Bank Liquidity	-26.722***		-25.887***		-38.898***		-38.572***	
*Central Bank Liquidity * High Bank Risk*		-2.814		-4.961		-38.805***		-38.401***
*Central Bank Liquidity * Low Bank Risk*		-33.062***		-31.780***		-39.485***		-39.632***
Bank Risk * Time FE	Yes	Yes	No	No	Yes	Yes	No	No
Bank * Time FE	No	No	Yes	Yes	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Accounting Standard FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald Test of Interaction Terms		0.0019		0.002		0.8409		0.49
Observations	10,179	10,179	10,179	10,179	16,059	16,059	16,059	16,059
R-squared	0.342	0.348	0.416	0.422	0.574	0.574	0.747	0.747

Panel B: Central Bank Liquidity lagged

	Crisis until Full Allotment				Full Allotment Period			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Lag 1 Day		Lag 1 week		Lag 1 Day		Lag 1 week	
Central Bank Liquidity	-34.821***		-6.121***		-12.360***		-8.231***	
Central Bank Liquidity * *High Bank Risk*		-17.102		-2.647		-11.423***		-8.001***
Central Bank Liquidity * *Low Bank Risk*		-40.149***		-14.783***		-16.863***		-9.477***
Bank * Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Accounting Standard FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald Test of Interaction Terms		0.0005		0.0021		0.1657		0.6713
Observations	10,179	10,179	10,179	10,179	16,059	16,059	16,059	16,059
R-squared	0.4426	0.4469	0.4021	0.4024	0.7133	0.7138	0.7064	0.7064

Table 5

Notional Deposit Amounts and Deposit Spreads

The table reports two-stage least squares (2SLS) regression results. In the first stage, the logarithm of the notional deposit transaction amount is instrumented with the number of all outstanding corporate short-term deposit market transactions of the firm at the time the new deposit transaction is initiated. In the second stage, the table shows regression results of the *Deposit Spread* of corporate deposits with a maximum maturity of 7 days on the instrumented logarithm of the notional deposit transaction amount as well as on *Central Bank Liquidity*, bank risk and further control variables. *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 models incorporate firm fixed effects (FE), time (quarter) FE, time*bank risk FE, and bank accounting standard FE. The latter are either the general accepted accounting principles (GAAP) of the respective country of the bank or the international financial reporting standards (IFRS). Constant term is included but omitted. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level using heteroscedasticity-robust standard errors clustered at the bank-level.

	Crisis until Full Allotment	Full Allotment Period
	(1)	(2)
	First Stage	First Stage
Dependent Variable	log(Notional Deposit Amount)	log(Notional Deposit Amount)
Instrument		
Number Outstanding Transactions of Firm	-0.019***	-0.018**
Control Variables from 2nd Stage	Yes	Yes
Observations	10,179	16,059
R-squared	0.763	0.712

	Second Stage	Second Stage
Dependent Variable	Deposit Spread	Deposit Spread
Instrumented Variable		
log(Notional Deposit Amount)	0.49	-2.97
*Central Bank Liquidity * High Bank Risk*	-10.968	-35.467***
*Central Bank Liquidity * Low Bank Risk*	-24.624***	-38.288***
Control Variables		
High Bank Risk	6.834	5.804
Bank Accounting Variables	Yes	Yes
Further Control Variables	Yes	Yes
Bank Risk * Time (quarter) FE	Yes	Yes
Firm FE	Yes	Yes
Time (quarter) FE	Yes	Yes
Accounting Standard FE	Yes	Yes
Wald Test of Interaction Terms	0.0087	0.324
Observations	10,179	16,059
R-squared	0.303	0.534

Table 6

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 further control variables. It shows 6 different regression specifications over different time periods, indicated at the top of each regression. *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. 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.

	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
3 Month 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
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
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)		0.1052		0.231		0.0268
Observations	1,156	1,156	533	533	623	623
R-squared	0.752	0.753	0.812	0.813	0.721	0.724

Table 7

Intensive and Extensive Margin – Summary Statistics

Table 7 reports descriptive statistics of how borrowers and lenders match (Panel A), borrower and lender characteristics by bank risk (Panel B), and regression results of borrowers along the intensive margin (Panel C) in the full allotment period. Intensive margin is defined as a borrower having received a loan from one bank risk category prior to the full allotment period, that is from January 2006 until October 7, 2008, and receiving a loan from the same bank risk category in the full allotment period. Extensive margin is defined as a borrower who receives a loan from a bank risk category in the full allotment period but did not receive a loan from this bank risk category or did not receive any loan prior to the full allotment period over our observation period. *High Bank Risk* is a dummy variable defined using banks' CDS spreads and explained in detail in Appendix A1. Panel B reports differences in means. The statistical significance of the differences is determined using a t-test for unpaired data with unequal variance. The dependent variable in Panel C is an indicator variable which is one if the loan is an intensive margin loan and zero otherwise. All other 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. Standard errors are heteroscedasticity-robust and clustered at the firm-level. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level.

Panel A: Borrower-Lender Matching

	Full Allotment Period
Existing Firms borrowing in Full Allotment Period	96
New Firms borrowing in Full Allotment Period	+125
Number of Firms	=221
Firms dropping out in Full Allotment Period	345
Loans	
Loans (intensive margin)	345
Loans (extensive margin)	+430
Total Loans	=775
Loans (intensive margin)	
High Bank Risk only	20.30%
Low Bank Risk only	4.90%
Borrowed from both risk types before	74.80%
Loans (extensive margin)	
New Borrower, High Bank Risk	64.20%
New Borrower, Low Bank Risk	13.50%
Switching from Low to High Bank Risk	17.70%
Switching from High to Low Bank Risk	4.70%

Panel B. Descriptive Lender and Borrower Characteristics by Bank Risk and Extensive Margin

	Low Bank Risk		High Bank Risk		Total Sample
	Difference Switching vs. Intensive Margin	Difference New vs. Intensive Margin	Difference Switching vs. Intensive Margin	Difference New vs. Intensive Margin	Difference High vs. Low Bank Risk
	(1)	(2)	(3)	(4)	(5)
Borrower Accounting Variables					
log(Total Assets)	0.737	0.227	-0.237	-0.841***	-0.455***
Leverage	0.031	-0.006	0.036	-0.047**	0.01
Current ratio	-0.478	-0.687	-0.008	0.165**	0.002
Coverage	1.319	3.923***	-5.798*	5.099	1.736
Market to Book	-0.352***	0.624***	0.032	0.366***	-0.044*
Tangibility	-0.267***	-0.137***	0.165***	-0.033	-0.045**

Panel C: 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	-0.11	-0.558	-0.341	0.083
Borrower Accounting Variables				
log(Total Assets)	0.080**	0.402**	0.234**	0.070**
Leverage	-0.161	-0.88	-0.553	-0.427*
Current ratio	0.04	0.22	0.14	0.061
Coverage	0	-0.002	-0.001	-0.002
Market to Book	-0.078	-0.529	-0.321	0.03
Tangibility	0.346**	1.751**	1.065**	0.417**
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	0.01
Total Asset Growth	0	0.003	0.001	0.001
Non-performing Loans/Total Loans	-0.022	-0.116	-0.065	0.029
Further Control Variables				
log(Maturity in Months)	-0.08	-0.429*	-0.260*	-0.109**
Secured	-0.141	-0.720*	-0.438*	-0.149*
log(Facility Size)	-0.047	-0.214	-0.128	0.013
log(Number of Loans of Borrower)	0.061	0.297	0.18	0.103***
Performance Pricing	-0.136*	-0.675**	-0.419**	0.042
3 Month EURIBOR-EONIA Swap Spread	-0.122	-0.594	-0.325	-0.177
Bank Risk * Time FE	No	No	No	Yes
Bank FE	No	No	No	Yes
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

Table 8

Central Bank Liquidity and Loan Spreads – Intensive Margin

Table 8 reports OLS regression results of loan spreads on *Central Bank Liquidity*, bank risk and further control variables focusing on borrowing on the intensive margin (column (1)). Intensive margin is defined as a borrower having received a loan from one bank risk category prior to the full allotment period, that is from January 2006 until October 7, 2008, and receiving a loan from the same bank risk category in the full allotment period. Column (2) shows the second stage of a Heckman regression model using column (3) of Panel C in Table 7 as first stage. *Central Bank Liquidity* is measured by the average over the quarter prior to loan origination. All variables are defined in Appendix A1. A secular term of *High Bank Risk* is included but omitted. All control variables from Table 7 are included. Bank and borrower characteristics are lagged by one year. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level. Column (1) uses heteroscedasticity-robust standard errors clustered at the firm-level and column (2) standard errors derived using resampling via the jackknife method and clustered at the firm-level.

	(1)	(2) 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
Bank FE	Yes	Yes
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)	0.0335	0.0309
R-squared	0.771	

Table 9

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. Intensive margin is defined as a borrower having received a loan from one bank risk category prior to the full allotment period, that is from January 2006 until October 7, 2008, and receiving a loan from the same bank risk category 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. Borrowers of low risk and high risk banks are matched in the full allotment period based on a borrower's *log of total assets*, *leverage*, *current ratio*, *coverage*, *market to book ratio*, and *tangibility*, and 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 of a borrower*. Standard errors are reported in parentheses using 50 bootstrap replications. Panel B reports intensive margin OLS regressions of syndicated *loan spreads* of matched borrowers on *Central Bank Liquidity* split by bank risk, a *high bank risk* indicator and a constant. It only includes loans from high risk banks conditional on the same borrower also having received loans from high risk banks prior to the full allotment period, and loans from low risk banks conditional on the same borrower also having received loans from low risk banks prior to the full allotment period. Column (1) shows the results for high and low risk bank borrowers matched using the nearest neighbor via a propensity score within a caliper of 0.1 and determined via the odds ratio. Column (2) reports the results for high and low risk bank borrowers matched using kernel matching within a bandwidth of 0.1 and determined via the odds ratio. *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. 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.

Panel A: Propensity Score Matching (PSM)

	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	0.0677	0.0302	0.0825	0.0664
R-squared	0.0995	0.1644	0.1005	0.1483

Table 10

Monetary Policy and Loan Maturity

The table reports regression results of the total sample (columns (1) and (2)) and of borrowers along the intensive margin (column (3)) in the full allotment period. Intensive margin is defined as a borrower having received a loan from one bank risk category prior to the full allotment period, that is from January 2006 until October 7, 2008, and receiving a loan from the same bank risk category in the full allotment period. The table reports regressions of syndicated *loan spreads* on *Central Bank Liquidity*, bank risk, loan maturity intervals and further control variables. Column III only includes loans on the intensive margin, that is loans from high risk banks conditional on the same borrower also having received loans from high risk banks prior to the full allotment period, and loans from low risk banks conditional on the same borrower also having received loans from low risk banks prior to the full allotment period. *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. Loans are classified as short-term when maturity ≤ 1 year, medium-term when 1 year < maturity ≤ 5 years, and long-term when maturity > 5 years. All other 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. The statistical significance of results is indicated by * = 10% level, ** = 5% level and *** = 1% level. All models use heteroscedasticity-robust standard errors clustered at the firm-level.

	(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		
*(1) Central Bank Liquidity * High Bank Risk * Short-term Loan*		-265.484**	-592.328***
*(2) Central Bank Liquidity * High Bank Risk * Medium-term Loan*		-19.792	-49.226
*(3) Central Bank Liquidity * High Bank Risk * Long-term Loan*		368.907	-45.516
*(4) Central Bank Liquidity * Low Bank Risk * Short-term Loan*		-200.722*	-540.985***
*(5) Central Bank Liquidity * Low Bank Risk * Medium-term Loan*		-206.797***	-277.036**
*(6) Central Bank Liquidity * Low Bank Risk * Long-term Loan*		190.46	457.176
Bank Risk * Loan Maturity Intervals	Yes	Yes	Yes
Bank Risk * Time FE	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Borrower Rating FE	Yes	Yes	Yes
Borrower Industry Code FE	Yes	Yes	Yes
Loan Type, Purpose, Currency FE	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	0.745	0.75	0.837

Table 11

Debt Capital Structure and Firm Characteristics: Intensive Margin

The table reports OLS regressions 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 on 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. *High Bank Risk* is a dummy variable defined using banks' CDS spreads and explained in detail in Appendix A1. *High Bank Risk | only High Bank Risk* is defined as a borrower having received loans from only high risk banks prior to the full allotment period, that is from January 2006 until October 7, 2008, and receiving a loan from a high risk bank in the full allotment period. *High Bank Risk | High and Low Bank Risk* is defined as a borrower having received loans from both low and high risk banks prior to the full allotment period and receiving a loan from a high risk bank in the full allotment period. All models include a borrower's log of *total assets*, *leverage*, *current ratio*, *coverage*, *market to book ratio*, and *tangibility*, and time (i.e. year) fixed effects (FE), borrower industry code FE, and borrower rating FE. All variables are defined in Appendix A1. Borrower accounting control variables are used as stated in the annual report in the year prior to the transaction. 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.

Panel A. Term Loans / Total Debt

	pp.Δ (t; t+1)		pp.Δ (t; t+2)		ppt.Δ (t; t+3)	
	(1)	(2)	(3)	(4)	(5)	(6)
High Bank Risk	-2.531**		-3.705**		0.346	
High Bank Risk | only High Bank Risk		-3.275		-0.069		5.047
High Bank Risk | High and Low Bank		-2.453**		-4.005**		-0.066
Observations	212	212	213	213	211	211
R-squared	0.791	0.791	0.829	0.831	0.839	0.841

Panel B. Revolving Loans / Total Debt

	pp.Δ (t; t+1)		pp.Δ (t; t+2)		ppt.Δ (t; t+3)	
	(1)	(2)	(3)	(4)	(5)	(6)
High Bank Risk	1.736		0.885		1.718	
High Bank Risk | only High Bank Risk		-2.612		-5.678		-10.149
High Bank Risk | High and Low Bank Risk		2.266**		1.658*		3.116**
Observations	191	191	195	195	195	195
R-squared	0.866	0.874	0.856	0.872	0.791	0.833

Panel C. Notional Outstanding / Total Debt

	pp.Δ (t; t+1)		pp.Δ (t; t+2)		ppt.Δ (t; t+3)	
	(1)	(2)	(3)	(4)	(5)	(6)
High Bank Risk	1.654**		1.225*		1.269	
High Bank Risk | only High Bank Risk		2.492**		1.306		7.336**
High Bank Risk | High and Low Bank Risk		1.540*		1.213*		0.439
Observations	250	250	248	248	248	248
R-squared	0.48	0.483	0.428	0.428	0.372	0.417

Panel D. Total Liabilities

	logΔ (t; t+1)		logΔ (t; t+2)		logΔ (t; t+3)	
	(1)	(2)	(3)	(4)	(5)	(6)
High Bank Risk	-0.007		0.001		-0.007	
High Bank Risk | only High Bank Risk		-0.016		-0.016		0.023
High Bank Risk | High and Low Bank Risk		-0.006		-0.006		-0.011
Observations	267	267	261	267	258	258
R-squared	0.399	0.399	0.515	0.399	0.685	0.686

Panel E. Payouts

	logΔ (t; t+1)		logΔ (t; t+2)		logΔ (t; t+3)	
	(1)	(2)	(3)	(4)	(5)	(6)
High Bank Risk	-0.370***		-0.206*		-0.334***	
High Bank Risk | only High Bank Risk		-0.087		0.251		0.475
High Bank Risk | High and Low Bank Risk		-0.401***		-0.241**		-0.370***
Observations	229	229	223	223	219	219
R-squared	0.515	0.53	0.629	0.659	0.651	0.691

Panel F. Capital Expenditures

	logΔ (t; t+1)		logΔ (t; t+2)		logΔ (t; t+3)	
	(1)	(2)	(3)	(4)	(5)	(6)
High Bank Risk	-0.144*		-0.079		-0.066	
High Bank Risk | only High Bank Risk		-0.33		0.041		0.019
High Bank Risk | High and Low Bank Risk		-0.112*		-0.099*		-0.079
Observations	267	267	261	261	258	258
R-squared	0.561	0.573	0.575	0.582	0.672	0.674

Panel G. Asset Growth

	pp.Δ (t; t+1)		pp.Δ (t; t+2)		ppt.Δ (t; t+3)	
	(1)	(2)	(3)	(4)	(5)	(6)
High Bank Risk	-1.317		-0.021		1.448	
High Bank Risk | only High Bank Risk		-19.283*		-11.552**		-10.077*
High Bank Risk | High and Low Bank Risk		1.793		1.871		3.286
Observations	267	267	261	261	258	258
R-squared	0.472	0.504	0.609	0.637	0.682	0.702

Panel H. Investments

	logΔ (t; t+1)		logΔ (t; t+2)		logΔ (t; t+3)	
	(1)	(2)	(3)	(4)	(5)	(6)
High Bank Risk	0.003		-0.004		-0.013	
High Bank Risk | only High Bank Risk		0.006		-0.022		0.024
High Bank Risk | High and Low Bank Risk		0.003		-0.001		-0.019
Observations	267	267	261	261	258	258
R-squared	0.381	0.381	0.565	0.565	0.677	0.679

Panel I. Employment

	Δ (t; t+1)		Δ (t; t+2)		Δ (t; t+3)	
	(1)	(2)	(3)	(4)	(5)	(6)
High Bank Risk	-1.019		-2.107		-3.502	
High Bank Risk | only High Bank Risk		1.042		3.748		4.013
High Bank Risk | High and Low Bank Risk		-1.408		-2.89		-4.473
Observations	249	249	243	243	240	240
R-squared	0.367	0.373	0.562	0.569	0.571	0.577

Appendix A1. Description of Variables

The table shows descriptions of virtually all variables used in the analyses 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 Name	Unit	Description
ECB Market 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 5 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 which ranges from overnight up to one week, i.e. 7 days.

Bank Competition	Integer	The number of valid bank bids per requested deposit transaction. Only quotes not canceled until the end of the bidding process are considered as valid. Only one valid quote per bank in each transaction is considered. Banks cannot observe other bank's bids. Higher values indicate more market competition.
Number of outstanding Deposit transactions of the Firm	Integer	Outstanding number of deposit transactions of the firm on the platform (not matured yet), 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 date 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		
All in Spread Drawn	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 will 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.
Further 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.

NOT FOR PUBLICATION

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

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Appendix A2. Liquidity in the Eurosystem and monetary policy implementation

The ECB is the only institution which has the ability to create Euro liquidity (also known as "base money").[1] It can do so by buying assets in exchange for Euro currency or by lending Euro liquidity to banks and other institutions. In a fiat money, floating exchange rate world all liquidity will eventually (after having flown through the economy) end up as either physical bank notes or as bank reserves and deposits in the Eurosystem held at the ECB.[2] The balance sheet of the ECB reflects this system. The asset side shows the creation of money by means of different operations, the liability side provides an overview of the allocation of liquidity in the Eurosystem.

Assets		Liabilities	
Autonomous liquidity factors		**Autonomous liquidity factors**	
Net foreign assets	387.1	Banknotes in circulation	285.8
		Government deposits	57.2
		Other autonomous factors (net)	92.1
			435.1
		Current account holdings	
		covering the minimum reserve system	134.9
Monetary policy instruments		**Monetary policy instruments**	
Main refinancing operations	123		
Longer-term refinancing operations	60		
Marginal Lending facility	0	Deposit facility	0.1
	570.1		**570.1**

Autonomous factors are not under direct control of the ECB

Main lever to control overall liquidity

Liquidity in the Banking Sector

Graph: Simplified ECB balance sheet as of March 1, 2002; Source: ECB.

The ECB creates a structural demand for liquidity by banks by imposing a minimum reserve requirement for each bank. To meet this reserve requirement, a bank has to hold on average sufficient funds over one month in a current account at the ECB. The imposed reserve requirement is remunerated at the interest rate of the main refinancing operations while excess reserves do not yield any interest rate. Accordingly, each bank has an incentive to hold on average exactly the imposed reserve requirement (given positive interest rates for the ECB deposit facility). If a bank

[1] The Monetary Policy of the ECB, published in 2011, p. 59
[2] FT Alphaville on July 3, 2012 – The Base Money Confusion, Author: Izabella Kaminska

has excess reserves it can hold these overnight in the ECB deposit facility. The interest rate is however much lower than the interest rate of the main refinancing operations and provides (in theory) a lower boundary for banks to deposit funds in general.

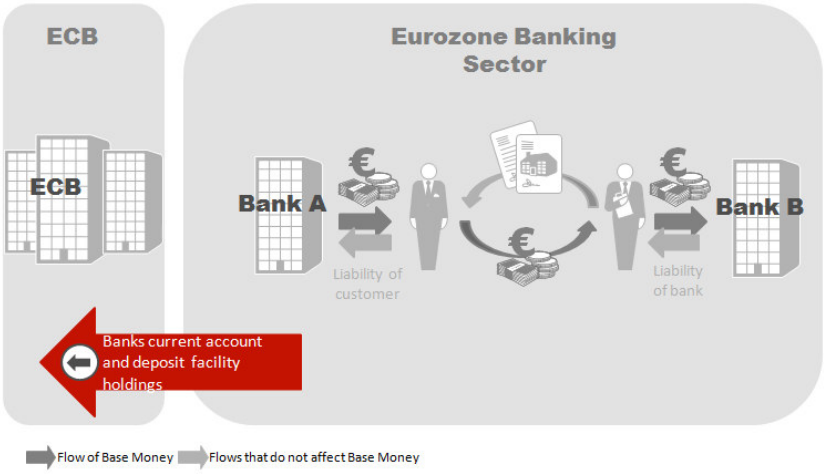
The funds required to meet the reserve requirement are provided by the ECB via the monetary policy instruments on the asset side such as the main refinancing operations (MROs), long-term refinancing operations (LTROs), and the marginal lending facility. In regular market periods, the MRO and LTRO are fixed amounts, previously determined by the ECB, which are allocated to the winning banks after a competitive bidding process. The MRO have a maturity of one week and the LTRO a maturity of three months (additional LTROs have been conducted since the crisis with maturities of up to three years). Furthermore, the ECB provides banks with overnight liquidity via the marginal lending facility at an interest rate much higher than the MRO or the LTRO interest rate. Accordingly, borrowing funds from the ECB via the marginal lending facility is very expensive and provides (in theory) an upper boundary for banks to obtain funds. With these operations the ECB ensures in regular market periods that banks are able to meet their reserve requirements while at the same time ensuring that liquidity is scarce enough to establish the targeted policy interest rate in the money market.

The only unknown for the ECB to establish the targeted policy interest rate are the autonomous factors such as banknotes in circulation, government or national central bank deposits directly held with the ECB, or foreign assets and liabilities (for example with other central banks). The ECB has to forecast the development of these.

The ECB intends to provide that amount of liquidity to banks via the refinancing operations which allows all banks to exactly hold their reserve requirement. Due to the competitive allocation mechanism funds are not optimally allocated to the individual banks immediately after allotment. Remember that borrowing at the marginal lending facility is prohibitively high while depositing at the marginal deposit facility pays only a very low (since June 11, 2014 even a negative) interest rate. Accordingly in regular time periods, the interbank market ensures an adequate allocation of central bank liquidity among banks such that each bank is able to hold its reserve requirement. If this interbank market does not function, banks might on aggregate obtain more funds via the refinancing operations than necessary to individually ensure that they are able to comply with their reserve requirement. Given that the autonomous factors do not change substantially, it should imply that banks deposit funds at the marginal deposit facility. Accordingly, holdings in the marginal deposit facility on average only reflect excess liquidity for banks and are not related to a possible credit crunch in the economy (a very common misperception).

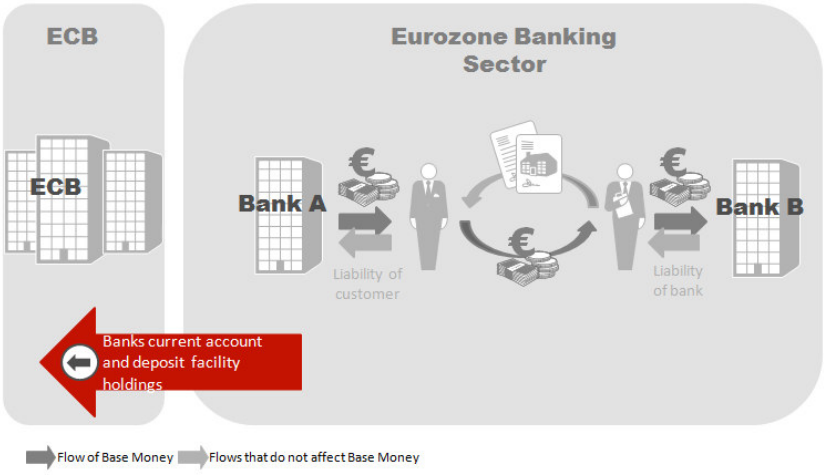
In the following, we provide examples which show that only the ECB has the ability to create Euro liquidity and that funds issued by the ECB will eventually return to an account held with the ECB if they are not held as banknotes.

Example 1: Bank liquidity is provided and deposited at the ECB or another bank



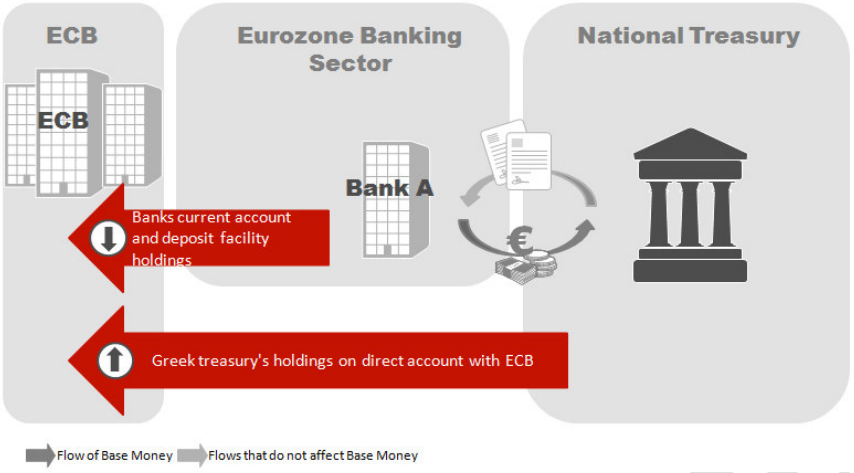
Bank A obtains liquidity via the refinancing operations from the ECB against collateral. It can deposit these funds at its account with the ECB to fulfill its reserve requirements or at the marginal deposit facility. It can also deposit the funds in the account of another bank which then has the same options as bank A. The aggregate holdings on the accounts with the ECB increase by the amount issued by the ECB via the refinancing operations.

Example 2: Bank A grants a loan to a firm which buys real estate



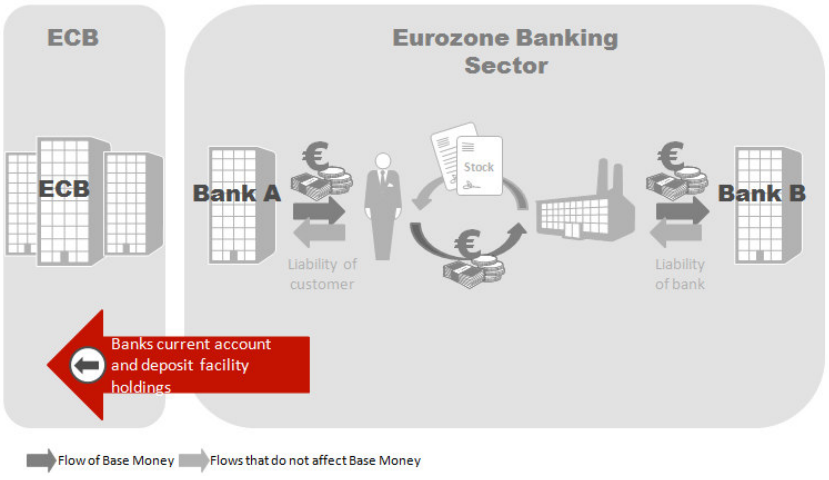
Bank A grants a loan to a firm which buys real estate from another firm which has an account at another bank. This implies that the liquidity holdings of bank A decrease by the amount transmitted to bank B. The liquidity of bank B increases by the exact same amount and accordingly the total liquidity in the banking sector as well as the aggregate holdings with the ECB remain constant. The only possibility to withdraw liquidity from the banking sector is if the money would be kept in cash. This would impact the autonomous factors to be forecasted by the ECB.

Example 3: Bank A buys government bonds in the primary market



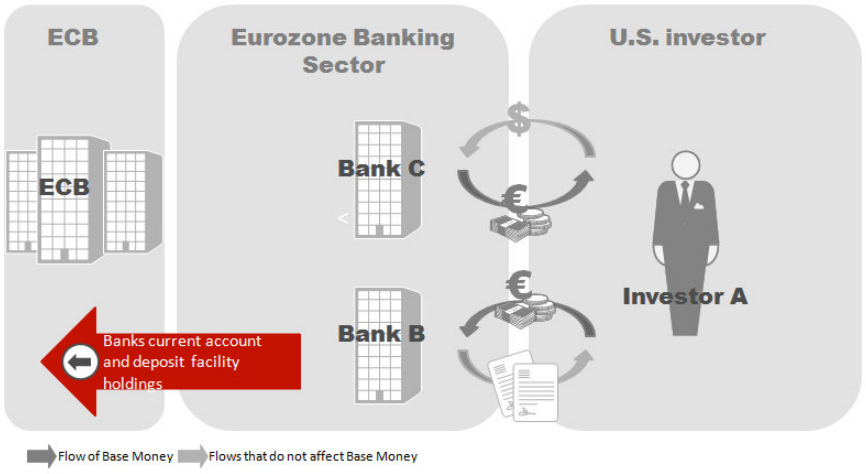
A government issues new debt and receives money from bank A against issuing claims. The government can deposit this money at a bank or buy other assets and transfer the purchase price to another bank. This increases liquidity by the same amount as it is reduced by the money bank A pays for the bonds which the latter might withdraw from its ECB account or from the account at another bank whose ECB account balance reduces. There might be a temporary reduction of liquidity in the banking sector when the government deposits the bond proceeds directly in its account at the ECB (if it has one) which should however not last very long because it is very costly.

Example 4: Investor A buys stocks of Firm B in the primary market



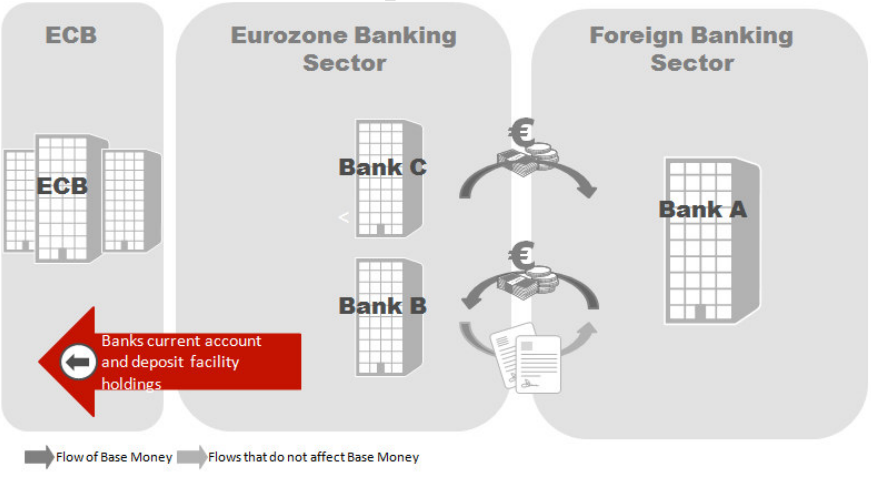
The liquidity holdings of bank A decrease by the amount the customer withdraws funds from her account. At the same time the liquidity holdings of bank B increase by the amount the issuing firm receives and transfers it to its account. The total liquidity in the banking sector as well as the aggregate holdings with the ECB remain constant.

Example 5: US investor A buys stocks of Eurozone bank B in the primary market



US investor A exchanges US$ into Euros at bank C and buys the stock of bank B. Bank B deposits these funds at the ECB or another bank. Accordingly, the (Euro) funds of bank C decrease by the same amount as they increase for bank B. The total liquidity in the banking sector as well as the aggregate holdings with the ECB remain unchanged.

Example 6: US Bank A buys shares of Eurozone Bank B



If bank A has an account at a bank of the Eurosystem the money is again only transferred to another bank in the Eurosystem and liquidity in the banking sector as well as the aggregate holdings with the ECB do not change. The only possibility to change the amount of aggregate central bank liquidity is if US bank A holds its €-funds in cash. This changes the autonomous factors which are forecasted by the ECB. However, when these funds are transferred back to a bank in the Eurosystem due to for example a purchase of €-assets the liquidity in the banking system increases by the same amount again.

Table 11 long version. Debt Capital Structure and Firm Characteristics: Intensive Margin

The table reports OLS regressions of changes in borrower variables of intensive margin borrowers in the full allotment period on bank risk and control variables. All variables are derived on 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. Panels A to C use data from S&P's Capital IQ, Panels D to I use data from Compustat. Asset growth is the ratio of total assets in t divided by the value of total assets in t-1, minus 1. Payouts are measured by total dividends, investment is measured by 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, and t-3 to t, t-2 to t, and t-1 to t with t as the year when the loan is initiated in the full allotment period, on several control variables. High Bank Risk is a dummy variable defined using banks' CDS spreads and explained in detail in Appendix A1. High Bank Risk | only High Bank Risk Prior Full Allotment is defined as a borrower having received loans from only high risk banks prior to the full allotment period, that is from January 2006 until October 7, 2008, and receiving a loan from a high risk bank in the full allotment period. High Bank Risk | High and Low Bank Risk Prior Full Allotment is defined as a borrower having received loans from both low and high risk banks prior to the full allotment period and receiving a loan from a high risk bank in the full allotment period. All models include a borrower's log of total assets, leverage, current ratio, coverage, market to book ratio, and tangibility, and time (year) fixed effects (FE), borrower industry code FE, and borrower rating FE. All variables are defined in Appendix A1. Borrower accounting control variables are used as stated in the annual report in the year prior to the transaction. 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.

Panel A: Term Loans/ Total Debt	pp.Δ (t-3; t)		pp.Δ (t-2; t)		pp.Δ (t-1; t)		pp.Δ (t; t+1)		pp.Δ (t; t+2)		ppt.Δ (t; t+3)	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
High Bank Risk	-2.018		-0.144		-3.951**		-2.531**		-3.705**		0.346	
High Bank Risk | only High Bank Risk Prior Full Allotment		3.995		1.493		-8.332		-3.275		-0.069		5.047
High Bank Risk | High and Low Bank Risk Prior Full Allotment		-2.206		-0.200		-3.599**		-2.453**		-4.005**		-0.066
Observations	205	205	208	208	225	225	212	212	213	213	211	211
R-squared	0.875	0.878	0.802	0.802	0.695	0.699	0.791	0.791	0.829	0.831	0.839	0.841

Panel B: Revolving Loans/ Total Debt	pp.Δ (t-3; t)		pp.Δ (t-2; t)		pp.Δ (t-1; t)		pp.Δ (t; t+1)		pp.Δ (t; t+2)		ppt.Δ (t; t+3)	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
High Bank Risk	1.520		1.250		0.274		1.736		0.885		1.718	
High Bank Risk | only High Bank Risk Prior Full Allotment		6.048		0.976		-2.327		-2.612		-5.678		-10.149
High Bank Risk | High and Low Bank Risk Prior Full Allotment		1.411		1.268		0.492		2.266**		1.658*		3.116**
Observations	179	179	176	176	186	186	191	191	195	195	195	195
R-squared	0.825	0.833	0.834	0.834	0.762	0.765	0.866	0.874	0.856	0.872	0.791	0.833

Panel C: Notional Outstanding/ Total Debt	pp.Δ (t-3; t)		pp.Δ (t-2; t)		pp.Δ (t-1; t)		pp.Δ (t; t+1)		pp.Δ (t; t+2)		pp.Δ (t; t+3)	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
High Bank Risk	0.245		0.580		0.684		1.654**		1.225*		1.269	
High Bank Risk | only High Bank Risk Prior Full Allotment		-0.172		-1.139		1.042		2.492**		1.306		7.336**
High Bank Risk | High and Low Bank Risk Prior Full Allotment		0.305		0.829		0.633		1.540*		1.213*		0.439
Observations	256	256	256	256	256	256	250	250	248	248	248	248
R-squared	0.276	0.278	0.533	0.552	0.501	0.503	0.480	0.483	0.428	0.428	0.372	0.417

Panel D: Total Liabilities	logΔ (t-3; t)		logΔ (t-2; t)		logΔ (t-1; t)		logΔ (t; t+1)		logΔ (t; t+2)		logΔ (t; t+3)	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
High Bank Risk	0.063		-0.018		0.041		-0.007		0.001		-0.007	
High Bank Risk | only High Bank Risk Prior Full Allotment		-0.126		-0.251		-0.112**		-0.016		-0.016		0.023
High Bank Risk | High and Low Bank Risk Prior Full Allotment		0.102		0.031		0.073		-0.006		-0.006		-0.011
Observations	270	270	270	270	270	270	267	267	261	267	258	258
R-squared	0.618	0.638	0.637	0.677	0.544	0.579	0.399	0.399	0.515	0.399	0.685	0.686

Panel E: Payouts	logΔ (t-3; t)		logΔ (t-2; t)		logΔ (t-1; t)		logΔ (t; t+1)		logΔ (t; t+2)		logΔ (t; t+3)	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
High Bank Risk	-0.124		-0.153		-0.066		-0.370***		-0.206*		-0.334***	
High Bank Risk | only High Bank Risk Prior Full Allotment		0.141		0.270		0.141		-0.087		0.251		0.475
High Bank Risk | High and Low Bank Risk Prior Full Allotment		-0.151		-0.196		-0.089		-0.401***		-0.241**		-0.370***
Observations	226	226	226	226	231	231	229	229	223	223	219	219
R-squared	0.691	0.701	0.736	0.761	0.747	0.756	0.515	0.530	0.629	0.659	0.651	0.691

Panel F: Capital Expenditures	logΔ (t-3; t)		logΔ (t-2; t)		logΔ (t-1; t)		logΔ (t; t+1)		logΔ (t; t+2)		logΔ (t; t+3)	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
High Bank Risk	-0.009		0.022		0.000		-0.144*		-0.079		-0.066	
High Bank Risk ǀ only High Bank Risk Prior Full Allotment		-0.406		-0.283		-0.247*		-0.330		0.041		0.019
High Bank Risk ǀ High and Low Bank Risk Prior Full Allotment		0.074		0.085		0.052		-0.112*		-0.099*		-0.079
Observations	270	270	270	270	270	270	267	267	261	261	258	258
R-squared	0.576	0.614	0.453	0.489	0.386	0.420	0.561	0.573	0.575	0.582	0.672	0.674

Panel G: Asset Growth	pp.Δ (t-3; t)		pp.Δ (t-2; t)		pp.Δ (t-1; t)		pp.Δ (t; t+1)		pp.Δ (t; t+2)		pp.Δ (t; t+3)	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
High Bank Risk	6.756		-5.282		1.516		-1.317		-0.021		1.448	
High Bank Risk ǀ only High Bank Risk Prior Full Allotment		-17.349		-24.706		-8.241		-19.283*		-11.552**		-10.077*
High Bank Risk ǀ High and Low Bank Risk Prior Full Allotment		11.761		-1.249		3.542		1.793		1.871		3.286
Observations	270	270	270	270	270	270	267	267	261	261	258	258
R-squared	0.486	0.546	0.541	0.598	0.573	0.585	0.472	0.504	0.609	0.637	0.682	0.702

Panel H: Investment	logΔ (t-3; t)		logΔ (t-2; t)		logΔ (t-1; t)		logΔ (t; t+1)		logΔ (t; t+2)		logΔ (t; t+3)	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
High Bank Risk	0.084		0.015		0.010		0.003		-0.004		-0.013	
High Bank Risk ǀ only High Bank Risk Prior Full Allotment		-0.037		-0.193		-0.149*		0.006		-0.022		0.024
High Bank Risk ǀ High and Low Bank Risk Prior Full Allotment		0.107		0.056		0.044		0.003		-0.001		-0.019
Observations	268	268	267	267	264	264	267	267	261	261	258	258
R-squared	0.420	0.432	0.500	0.556	0.462	0.505	0.381	0.381	0.565	0.565	0.677	0.679

Panel I: Employment	Δ (t-3; t)		Δ (t-2; t)		Δ (t-1; t)		Δ (t; t+1)		Δ (t; t+2)		Δ (t; t+3)	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
High Bank Risk	-2.878		-3.160		-4.545*		-1.019		-2.107		-3.502	
High Bank Risk | only High Bank Risk Prior Full Allotment		-0.807		-2.475		-1.318		1.042		3.748		4.013
High Bank Risk | High and Low Bank Risk Prior Full Allotment		-3.333		-3.326		-5.278*		-1.408		-2.890		-4.473
Observations	251	251	244	244	252	252	249	249	243	243	240	240
R-squared	0.751	0.752	0.810	0.810	0.719	0.723	0.367	0.373	0.562	0.569	0.571	0.577