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Life below the surface: Bank lending in a negative interest rate environment

Master Thesis Financial Economics
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Abstract

In this thesis I study the transmission of negative policy rates to banks' credit supply. I use data from the syndicated loans market augmented with firm-specific accounting data and bank balance sheet data. I replicate the estimates of Bittner et al. (2020) and show that high-deposit banks increase their lending to low-quality borrowers in response to negative policy rates. In line with the rationale, I do not find significant effects for low-deposit banks. In addition, I test whether liquid asset holdings play a role in the transmission of negative policy rates. I do not find evidence of liquid asset holdings affecting bank lending as the main results prove not to be robust. The effects described are only significant at the intensive margin.

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1 Introduction

In response to the Great Financial Crisis (GFC) major central banks lowered their policy rates to stimulate the economy. Although interest rates were at the zero lower bound (ZLB), economic growth was lacking. To further stimulate the economy and adhere to the inflation objective, the European Central Bank (ECB) started buying longer-term securities to lower longer-term yields and thereby stimulate the economy. One way through which policy rates and central bank balance sheet operations (Quantitative Easing or QE) impact the economy is through credit. The policy rates set the costs of short-term financing which banks use to fund their long-term liabilities. QE provides liquidity to the banking sector. The effectiveness of early liquidity injections through QE has been documented (Rodnyansky & Darmouni., 2017; Chakraborty et al., 2019; Kuang et al., 2020). However, with the introduction of the negative interest rate policy (NIRP) by the ECB in 2014, traditional transmission mechanisms for positive policy rates are proven to be insufficient. Since the introduction of the NIRP, several studies documented effects of deposit holdings on bank lending under the NIRP (Heider et al., 2019; Bittner et al., 2020). Although the amount of liquid assets in the form of reserves ballooned since the GFC, it's interaction with negative policy rates has been studied by few (Bottero et al., 2019; Arseneau, 2020; Demiralp et al., 2021).

In this thesis I add to this emerging strand of literature by using a dataset on syndicated loans. By applying the methodology of Acharya et al. (2018) I study the effects of the NIRP on bank lending. I analyze (a) whether the supply of credit is impacted by the NIRP through deposit holdings or liquid asset holdings; (b) whether lending is extended to high- or low-quality borrowers and (c) whether existing borrowers or new borrowers are affected. My sample is constructed using data on syndicated loans from Thomson Reuters LPC's DealScan. This set is augmented with firm-specific data from Bureau van Dijk's Amadeus database and with bank-specific data from Orbis Bankfocus. Following Acharya et al. (2018), firms are clustered based on observable characteristics to generate; (a) enough time series and (b) to control for loan demand by using fixed effects. The sample spans from 2010 until 2019.

To assess the impact of the NIRP, I focus on two channels. According to the adjusted bank capital channel (Bittner et al., 2020), when interest rates move below zero, banks are affected depending on their funding structure. As deposit rates are downward sticky, high-deposit bank's net-interest margins are squeezed leading to less costly screening and monitoring of borrowers. High-deposit banks are thus more affected relative to low-deposit banks. Demiralp et al. (2021) add bank's excess reserves holdings to the rationale of the adjusted bank capital channel. With NIRP, banks are penalized for holding safe (liquid) reserves as these negatively impact profitability (Bottero et al., 2019). Demiralp et al. (2021) argue that banks with relatively more deposit holdings and excess reserves are more affected by NIRP, as the profitability gets squeezed from both sticky deposit rates and charges on excess liquidity.

The analysis starts with a validation of the *NIRP* time dummy variable by comparing its effect to the QE (*APP)* dummy. As theory predicts, I expect a positive effect of the liquid asset holdings interacted with the *APP* dummy on bank lending. However, the *APP* dummy interacted with liquid assets has a significant negative coefficient, which indicates that the *APP* dummy does not capture exposure to liquidity injections. Moreover, the *NIRP* dummy interacted with liquid asset holdings also has a significant negative effect on bank lending. The *NIRP* dummy thus captures exposure to negative interest rates rather than exposure to QE. To further validate my time dummy variable, I compare the results of EU banks' credit supply to US banks' credit supply. According to the rationale, no significant outcomes are expected as US banks are not directly influenced by ECB monetary policy (Heider et al. 2019). The outcomes show that US

bank lending is not significantly affected by the interacted time dummies, which confirms the reasoning.

Then, I replicate the estimates of Bittner et al. (2020) at the intensive margin. For that reason, I test two hypotheses on the effect of deposit holdings. My first hypothesis states that negative policy rates lead to greater risk taking by high-deposit banks relative to low-deposit banks. The second hypothesis states that there is no effect of deposit holdings on bank lending during the NIRP for low-deposit banks. In line with my first hypothesis, I find a positive and significant coefficient of my treatment variable *NIRP*Deposit ratio* for low-quality firms. Additionally, the treatment term remains positive and significant after adding *ln(Liquid assets)* as a control variable. The results for high-deposit banks indicate that a 1% increase in the *Deposit ratio* leads to a 0.251% increase in credit supply to low-quality firms. To test my second hypothesis, I replicate the estimates for low-deposit banks. Firstly, I only include *NIRP*Deposit ratio* and control variables. These results indicate an insignificant effect of deposit holdings on bank lending. Next, I add *ln(Liquid assets)* as an additional control variable to my estimates. The treatment term remains insignificant, therefore I also confirm my second hypothesis.

Finally, I test my hypothesis on the effect of liquid asset holdings during the NIRP period. According to my third hypothesis, the treatment variable *NIRP*ln(Liquid assets)* has a significant positive effect on bank lending for high-deposit banks caused by the squeeze in net-interest margins. The results are not in line with my third hypothesis, as they show a negative and significant effect of the treatment variable for all borrower quality specifications. After adding *Deposit ratio,* the results remain negative and significant. However, these results prove not to be robust.

To test the validity of my results, I use two robustness tests. In my first robustness test, instead of using the S&P ratings table to split my sample into high- and low-quality firms, I use a 3-year country specific median IC ratio. Outcomes from my first robustness test underwrite my first and second hypothesis. In my second robustness test, I follow Acharya et al. (2019) and use an equal weights approach instead of an asset-weighted approach to divide a facility among lenders. Results for my first and second hypothesis prove to be robust as I find a significant positive effect of deposit holdings on bank lending for high-deposit banks. The outcomes remain insignificant for low-deposit banks. Results on my third hypothesis prove not to be robust as the coefficients of the treatment variable *NIRP*ln(Liquid assets)* are insignificant for the equal-weights approach.

To test whether new borrowers are affected, I replicate the estimations at the extensive margin. I start by validating my time dummy variables. Then I compare the outcomes for EU banks to US banks. Contrary to the results at the intensive margin, I do not find any significant effects. I continue by analyzing the impact of my treatment variables on bank lending. The estimates for both the *NIRP*Deposit ratio* and *NIRP*ln(Liquid assets)* treatment term are insignificant. This implies that my results only hold at the intensive margin.

2 Literature review

This thesis contributes to the existing literature in several ways. In general, it contributes to the literature on the bank lending channel. Specifically, it adds to the emerging literature on the role of deposit holdings and liquid assets during the NIRP.

Recently, literature has emerged on the transmission of monetary policy in a negative policy rate environment through the bank capital channel. Heider et al. (2019), show that banks with greater reliance on deposit funding lend less and take more risk in response to the negative policy rates. In their preferred specification the researchers

compare high-household deposit banks to low-household deposit banks. I use a similar dataset as Heider et al. (2019), composing of syndicated loan information from DealScan and firm specific information from van Dijk's Amadeus. Additionally, I also exploit the granularity on syndicated loans to control for loan demand. Bittner et al. (2020), use credit-registry data from German and Portuguese banks to disentangle the transmission in a high-rate and low-rate environment. Before the rate cut in 2014, Portuguese banks operated in a high-rate environment while their German counterparts operated in a low-rate environment. Because of this, the pass-through of policy rates to the cost of funding differs for Portuguese banks and German banks, as the latter are already bounded by the ZLB. This enables the researchers to examine bank lending behavior in both a setting of pass-through of policy rates (Portugal) and squeezed net-interest margins (Germany). Bittner et al. (2020) find that German banks increase their lending to risky firms at both the intensive and extensive margin, which is in line with the rational of reduced screening and monitoring once net-interest margins are squeezed. Their results indicate that with a strong pass-through (Portuguese banks), there is little risk-taking and the tightness of the external-financing constraint is more pronounced. My thesis resembles this paper, as I also use firm-time fixed effects exploiting the multiple bank-firm relationships. Moreover, I follow Bittner et al. (2020) and separate the high- and low-deposit banks as these are impacted differently by the negative policy rate.

One of the few studies with a focus on the liquidity channel was done by Kuang et al. (2020). With data from Call Reports of US banks, the researchers empirically test the changes of banks' credit supply in response to the three rounds of QE by the Federal Reserve (Fed). Their results show that QE has a stronger impact on bank lending of high-liquidity banks compared to liquidity-constraint banks. Significant effects are found for commercial, industrial and real estate lending. Similar to this study my variable of interest is the commercial bank's overall liquidity level. In their main specifications Kuang et al. (2020) address potential endogeneity between bank's liquidity and loan cyclicality by using an instrument variable. My approach only resembles their robustness test as I use fixed effects to control for loan demand. While Kuang et al. (2020) focus on the role of bank liquidity in a positive interest rate environment, Bottero et al. (2019) focus on the role of bank liquidity in the transmission of negative policy rates. By using data from the Italian credit register augmented with firm- and bank-level balance sheet data, the researchers find evidence for portfolio rebalancing from liquid assets to (illiquid) loans with the introduction of the NIRP. They show that banks with relatively higher interbank positions or liquid positions expand their credit supply to riskier and smaller firms. In line with these findings, Demiralp et al. (2021) show that banks with relatively more excess reserve holdings and greater reliance on retail deposit funding increase their lending to firms and households in reaction to the NIRP. Their results are in contrast with the paper by Heider et al. (2019), who find that high-deposit banks reduce their bank lending in response to the NIRP. Demiralp et al. (2021) argue that the differences are due to their wider sample containing balance sheet data for 252 euro area banks. Heider et al. (2019), only use data on the syndicated loans market, as I do in this thesis.

Rodnyansky & Darmouni (2017) exploit heterogeneity in holdings of Mortgage Backed Securities (MBS) at the bank level to study the effects of QE on bank lending. By using a difference-in-difference approach, they compare lending before and after the rounds of QE and find significant positive effects after the first and third round of QE. Chakraborty et al. (2020) take a different approach as they separate the effects of MBS purchases from Treasury purchases. They argue that banks have different exposures which implies a different effect. With a quarterly panel dataset on assets purchases by the Fed, they find that MBS purchases increase mortgage lending and reduce commercial lending while Treasury purchases do not impact bank lending. Both of these

papers focus on the net-worth channel of QE, which differs from the liquidity channel as the impact of QE differs according to the channel studied (Kuang et al., 2020).

An early empirical study on the effects of monetary expansion applying the fixed effects approach was done by Morais et al. (2015). Using regulatory reporting data on Mexican loans, they show that European and US banks increase their lending to local Mexican firms during periods of balance sheet expansion by the ECB or Fed. While in this study the researchers do not discuss any specific channel of transmission, Gräb and Zochowski (2017) use regulatory bank-level data of balance sheet items from the ECB to assess three bank-specific transmission channels. They find that euro banks increase lending abroad in a reaction to ECB unconventional monetary policy. Moreover, their results show that euro banks increase lending domestically in response to unconventional monetary policy in the United States. These results support the theory on the international bank lending channel. Besides, in line with literature their results indicate that the spillover effects are stronger for the liquidity constrained banks. My thesis differs from both papers as they use a combination of macro-economic variables and fixed effects to control for credit demand factors, while I only use interacted fixed effects to capture credit demand.

3 Theory

The bank lending channel works through the balance sheet of commercial banks. Bernanke and Gerlter (1995) argue that monetary tightening drain bank deposits from the system, leading to a decrease in the supply of loanable funds which in turn affects the banks' loan supply. The underlying assumption is that banks are unable to replace the losses in deposits by other sources of loanable funds. Early evidence on the existence of a bank lending channel by Bernanke and Blinder (1992), Gertler and Gilchrist (1994) and Kashyap and Stein (1995) prove that monetary contraction has a significant negative effect on bank deposits and bank lending.

Policy rates have an impact on a bank's balance sheet through the external-finance premium. When the policy rate is above the ZLB, a cut in the policy rate increases banks' credit supply as it reduces the external-finance premium. The banks cost of funding namely decreases as a lower policy rate reduces costs on the banks' short-term liabilities which are used to fund their long-term assets. As a result of the lower funding costs, banks' net-worth increases leading to more "skin-in-the-game" which incentivizes them to screen and monitor borrowers more carefully (Heider et al., 2019). Once interest rates are cut below zero the balance sheet is affected differently as not all short-term rates react similar. The negative policy rate does translate to lower market rates on short-term debt, however as banks are unwilling to charge negative rates to depositor, the deposit rate remains above or at the ZLB (Bittner et al., 2020). With policy rates below zero, a bank's funding structure impacts the outcome of the rate cut. Banks with a high deposits-to-assets-ratio experience less reduction in their cost of funding relative to low-deposit banks. As a result, high-deposit banks' net-worth is impacted more negatively relative to low-deposit banks. Resulting in less "skin-in-the-game" and worse screening and monitoring of borrowers.

In line with the predictions of Bittner et al. (2020), I test the following hypotheses: (1) negative policy rates lead to greater risk taking by high-deposit banks relative to low-deposit banks; and (2) there is no effect of the deposit-to-assets ratio on bank credit supply during the NIRP for low-deposit banks.

According to the model of Kuang et al. (2020), the effect of liquidity injections through QE on bank lending depends on the loanability of excess reserves. When a central bank expands its balance sheet through QE, the central bank buys securities from its primary dealers by offering newly created reserves. The reserves enter the

commercial banks' balance sheet as an asset. Through QE, commercial banks gain both new reserves and corresponding customer deposits. Prior to the GFC, reserves were unloanable due regulatory requirements. However, with the extensive QE programs in reaction to the GFC, commercial banks hold considerable amounts of excess reserves which form loanable funds, leading to the documented increase in banks' loan supply (Jiménez et al., 2014; Butt et al., 2014; Rodnyansky & Darmouni, 2017). In a negative interest rate environment, banks are penalized for holding safe (liquid), negative-yield assets as these put downward pressure on profitability (Bottero et al., 2019). This incentivizes banks to rebalance their portfolio from negative- or low-yield (liquid) assets to riskier high-yield (illiquid) assets. Demiralp et al. (2021) extend this reasoning by arguing that banks with relatively more retail deposit holdings are more affected by the charges on excess liquidity as their net-interest margin is squeezed.

Based on the previous, I derive my third hypothesis: liquidity asset holdings increase bank lending to risky firms during the NIRP for high-deposit banks.

4 Unconventional Monetary Policy

4.1 Asset Purchase Programme

The Asset Purchase Programme (APP) is part of the unconventional monetary policy measures conducted by the ECB. It was announced in September 2014 and started a few months after. The APP program was introduced as economic growth and HICP inflation remained below target for a prolonged period of time (Gambetti & Musso, 2017). The program can be split in four different sub-programs; (1) the third covered bonds purchase programme (CBPP3); (2) asset backed securities purchase programme (ABSPP); (3) public sector purchase programme (PSPP) and (4) the corporate sector purchase programme (CSPP). CBPP3 follows the two previous CBPP programs which started in 2009. Under the CBPP programs, central banks across the eurozone buy euro-denominated covered bonds from both the primary and secondary market (European Central Bank, 2021). In harmony with the CBPP program, central banks implemented the ABSPP program and bought asset-backed securities from banks. Both programs were installed to enhance liquidity in the interbank market and thereby stimulating bank lending to both corporates and households. In 2015 the central banks also started buying European government bonds and bonds issued by recognized agencies such as local governments, international institutions and multilateral developments banks (European Central Bank, 2020). Of the PSPP, around 90% of the bonds purchased are governments bonds. The allocation of purchase volumes is guided by the ECB capital key. This guidance dictates that the total purchase volume is divided equally among eurozone members based on the size of their economy proportionate to the eurozone (DeSantis & Holm-Hadulla, 2017). Moreover, the central bank is only allowed to buy sovereign bonds from the secondary market to prevent direct government financing. Finally, with the CSPP central banks started buying investment-grade euro-denominated corporate bonds in both the primary and secondary market. Monthly purchases under the APP varied over time with its peak between April 2016 and March 2017 during which monthly purchases amounted €80 billion. Due to QE, the ECB balance sheet expanded from roughly €1.5 trillion before the GFC to almost €5 trillion in 2019. Figure 1 shows the central bank balance sheet expansion during the Asset purchase programme. Besides, a steep increase is shown in response to the Pandemic emergency purchase programme (PEPP) which started in the first quarter of 2020.

4.2 Negative Interest Rate Policy

To steer short-term interest rates, the ECB sets 3 policy rates for the euro area (European Central Bank, 2016). The fist policy rate through which the ECB influences the price of liquidity is the main refinancing rate. The main refinancing rate forms the minimum interest rate for the main refinancing operations. In these operations, banks can participate in tenders where they indicate the amount and against which interest rate they want to borrow. The ECB divides the predefined amount of liquidity among the highest bidders. The second policy rate, the marginal lending rate sets the interest paid on overnight facilities. Banks that are unable to fulfill their liquidity needs can obtain overnight facilities if they pledge collateral and are willing to pay a higher interest rate vis-à-vis the main refinancing operations. Finally, the ECB sets the deposit facility rate which is the interest paid on deposits (excess liquidity) stalled at the central bank.

Before the GFC, the deposit facility rate (DFR) fluctuated between 1.00% and 3.75%. With the Lehman collapse and the start of the GFC in September 2008, the ECB lowered the DFR gradually till it reached 0.25% in April 2009. It wasn't until 2012 when the DFR hit the ZLB. As the inflation remained below target (Schnabel, 2020), the ECB lowered the DFR from 0.00% to -0.10% in June 2014. In what followed, the ECB kept lowering the DFR stepwise by 10 basis points till it reached -0.50% in September 2019. The DFR forms an important policy instrument as together with the marginal lending facility it sets the lower and upper bound between which the money market rates (short-term interest rates) fluctuate. Figure 2 shows the "corridor" of policy rates and includes the fluctuation of the Euribor 3-month rate.

5 Data

5.1 Data collection

Following the approach of Acharya et al. (2018), my dataset consists of bank-firm relationships derived from the Thomson Reuters LPC's DealScan dataset on syndicated loans. This data is augmented with firm-level accounting information obtained from Bureau van Dijk's Amadeus database. As this firm-level data and the data from DealScan do not have a common identifier, the datasets are hand-matched based on the company name. In line with Acharya et al. (2018), banks are only included in the sample if they act as a lead arranger of the syndicated loan. By definition, this means that banks are only included if they are classified as "mandated arranger", "mandated lead arranger", or "bookrunner". Moreover, the syndicated loans are assigned to the bank's parent as described by Sufi (2007). Firms in the Amadeus database are categorized by size, ranging from "Small" to "Very Large". The size of firms included in the final hand-matched sample is either "Large" or "Very Large". Firms included in the dataset are incorporated in France, Germany, Italy, Spain or the United Kingdom. Table 2 shows the differences between high- and low-quality borrowers. On average, high-quality borrowers are slightly larger, hold less tangible assets to total assets and have a higher solvency ratio. Finally, annual commercial bank data is obtained from Orbis Bankfocus. To properly measure the effect of ECB monetary policy, parent banks are only included in the sample if the bank is headquartered in the EU. To validate my outcomes for EU banks, I also construct a dataset consisting of parent banks headquartered in the US. Table 1 shows that US banks are on average larger, have higher returns and less impaired loans compared to EU banks. My sample includes 75 banks, lending to 801 firm clusters. The sample time period spans from 2010 till 2019.

5.2 Descriptive statistics

Table 1 presents the descriptive statistics for commercial banks grouped by their central bank. As shown in the table, European banks are on average smaller, have lower returns and have a higher level of impaired loans than US banks. Moreover, European banks are less capitalized compared to their US competitors. Figure 3 shows that EU bank deposit holdings increase over the sample period. On the contrary, figure 4 shows that the amount of liquid asset holdings fluctuates rather than following a clear trend. Descriptive statistics at the firm level in table 2, show that besides having a higher IC ratio, high-quality firms also have a higher net-worth, are less leveraged and have higher EBITDA-to-assets margins. Table 4 shows the descriptive statistics per sample. In line with the descriptive statistics from table 1, European banks are on average smaller, more leveraged and have less net income compared to their US counterparts. In addition, US banks have on average higher deposit ratios.

6 Methodology

6.1 Empirical strategy

My empirical research is based on the methodology of Acharya et al. (2018). In this paper, the researchers employ a novel method to the Khwaja and Mian (2008) bank lending regression. The Khwaja and Mian (2008) approach exploits multiple bank-firm relationships to control for loan demand and other observed and unobserved borrower characteristics. However, the original approach is unsuitable for my data because of two reasons. Firstly, the DealScan data only provides information on the origination of the loan and secondly, the syndicated loans have long maturities. Because of these two features the original data is unsuitable as one cannot generate enough time series. Acharya et al. (2018) circumvent these issues by forming firm clusters based on: (1) the country of incorporation; (2) industry; and (3) firm rating. The clusters enable me to track the lending volume from a bank to different firm clusters, ensuring enough variation for my analysis. Aggregating firms based on country and industry is done as these firms share characteristics and are thus similarly affected by macroeconomic circumstances (Acharya et al., 2018). A firm's industry is derived from the first two digits of its SIC code. Acharya et al. (2018) argue that firm's credit quality is the final clustering criterion as research has proven it to be a driving force behind a firm's loan demand. Using the Standard & Poor's rating table, firms are categorized based on their three-year interest coverage (IC) ratio medians.

My main objective is twofold. Firstly, I want to test whether there is an effect of NIRP on bank lending through the deposit holdings. Secondly, I want to extend my research and estimate the impact of the NIRP on bank lending through liquid assets. To capture the effects of the NIRP through deposit holdings, I follow Heider et al. (2019) and take the deposit holdings over total assets. For the effect of liquid asset holdings on bank lending, I follow Kuang et al. (2020) and take overall bank balance sheet liquidity measured by the total amount of liquid assets. In line with Kuang et al. (2020), my liquid assets include cash and reserves. This definition is different from the previous literature for two reasons. First, liquid assets are those that can be converted on the short-term to pay-off creditors. Accordingly, cash and reserves are thus included. Second, cash holdings were excluded as it would mainly reflect required reserves (Kashyap & Stein, 2000). However, due to the increase in excess reserves this assumption is not applicable anymore (Kuang et al., 2020). The effect of mergers and acquisitions is eliminated by excluding banks with a yearly asset growth larger than 25 %.

Following Bittner et al. (2020), I split my sample into high-deposit and low-deposit banks. The split is based on the median level of deposit holdings over the sample period. Furthermore, to test which type of borrowers are affected, I follow Acharya et al. (2019) and split my sample into high- and low-quality borrowers based on the debt servicing capacity proxied by the IC ratio. A firm is categorized based on their 2012-2014 IC median. If according to the Standard & Poor's rating table a company's rating is "BB" or below, a firm is classified as low-quality. If it's rating is above the "BB" rating, the firm is classified as high-quality.

6.2 Econometric specifications

To test my hypotheses, I use panel regression to analyze banks' lending behavior both at the intensive and extensive margin. At the intensive margin, I estimate the quarterly change in loan volume by bank *b* in country *j* to firm cluster *m* in year *t*. I only include firms which had a pre-2014 relation with the bank. $\Delta Volume_{bmt+1}$ is the dependent variable and is calculated using the assets-weighted shares of lead arrangers. My baseline specification is:

$$\Delta Volume_{bmjt+1} = \beta \cdot Exposure_{bt-3} \cdot NIRP + \delta \cdot X_{bjt-3} + Firms\ Cluster_m \cdot Quarter\text{-}Year_{t+1} + Firms\ Cluster_m \cdot Bank_{bj} + u_{bmjt+1} \quad (1)$$

To measure the effect at the extensive margin, the clusters only consist of firms which had no relation prior to 2014. The dependent variable at the extensive margin is a dummy equal to one if a new loan is issued by bank *b* in country *j* to firm cluster *m* at time *t*, also shown in equation 2.

$$NewLoan_{bmjt+1} = \beta \cdot Exposure_{bt-3} \cdot NIRP + \delta \cdot X_{bt-3} + Firms\ Cluster_m \cdot Quarter\text{-}Year_{t+1} + Firms\ Cluster_m \cdot Bank_{bj} + u_{bmjt+1} \quad (2)$$

My variable of interest is the $Exposure_{bt-3} \cdot NIRP$, which is the interaction of either the lagged deposit ratio or the logarithm of lagged liquid assets and a time dummy equal to 1 if the quarter falls into NIRP period. To control for differences in banks' characteristics, I use X_{bt-3}, which is a set of lagged bank control variables including log of total assets, leverage ratio (liability-to-assets), net income to total assets and impaired loans to equity. To ensure I use lagged bank-level variables, bank-specific variables are lagged by 3 periods as I only have yearly accounting data. The lagged log of total assets is included as bank size may influence banks' loan supply (Kashyap & Stein, 2000). Moreover, small banks' lending is more sensitive to monetary policy shocks (Kuang et al., 2020). Leverage is included as according to Kuang et al. (2020) highly leveraged banks' credit supply is more affected in economic downturns. Net income and impaired loans are included as these affect bank capital adequacy (Acharya et al., 2019). The control variables and exposure variables are winsorized at the 5% level.

To disentangle credit demand from credit supply I include fixed effects. The $Firm\ Cluster_m$ fixed effects allows to control for unobserved time-invariant firm fundamentals to proxy for credit demand (Khwaja & Mian, 2008). Bank fixed effects $Bank_b$ control for unobserved time-invariant lender characteristics. Time fixed effects like $Quarter\text{-}Year_{t+1}$ allow to control for shocks shared by banks in the sample. Following Acharya et al. (2018), I interact time fixed effects with firm cluster fixed effects to control for observed and unobserved time-varying firm fundamentals. In addition, I interact firm-cluster with bank fixed effects to control for unobserved time-invariant firm and bank heterogeneity. This interaction allows me to control for the relationship between banks and firms in the same cluster.

7 Results

I present my results in three steps. First, I present the outcomes at the intensive margin by showing the results of various equation (1) estimations. Then, I discuss the outcomes at the extensive margin by estimating different versions of equation (2). For the results at the intensive and extensive margin, I start by validating my time dummy variable. I estimate my specifications by using two bank-exposure variables, the deposits-to-assets ratio and the logarithm of liquid assets. Finally, I conduct robustness tests to ensure the validity of my results.

7.1 Intensive margin

In the first two columns of table 5, I start by validating my time dummy variable *NIRP* by comparing its effect with the *APP* dummy. In line with the theory and empirical evidence on liquidity injections (Jiménez et al., 2014; Butt et al., 2014; Rodnyansky & Darmouni, 2017; Kuang et al., 2020), the expected sign of the treatment *APP*ln(Liquid assets)* is positive. However, as shown in column 1, the interacted dummy *APP*ln(Liquid assets)* has a significant negative impact on bank lending. Indicating that the time dummy *APP* does not capture bank exposure to liquidity injections. I compare this outcome with the interacted dummy *NIRP*ln(Liquid assets)* in column 2, which also has a significant negative impact on bank lending. These outcomes imply that my *NIRP* time dummy captures exposure to negative policy rates, rather than exposure to liquidity injections. In column 3 I include the *Deposit ratio* and its interaction with the *NIRP* time dummy. The results show that for all banks, there is no significant effect of the interacted term on bank lending. Then, in the last 3 columns of table 5, I follow Heider et al. (2019) and use a falsification test by comparing EU banks to US banks. As US banks are not directly affected by ECB monetary policy, I expect the EU monetary policy dummies *NIRP* or *APP*, to have a non-significant effect on bank lending by US banks to EU firms. The results in column 4 confirm the rational as the interaction term *APP*ln(Liquid assets)* has a non-significant effect on bank lending by US banks to EU firms. In line with the previous finding, the outcomes of the interacted terms *NIRP*ln(Liquid assets)* and *NIRP*Deposit ratio* in column 5 and 6 neither show a significant effect on bank lending. The results for US banks confirms the rational as no significant effects are found.

To test my first and second hypothesis, I split my sample into high- and low-deposit banks, lending to either (1) all firms; (2) high-quality firms or (3) low-quality firms. In table 6, I assess the effect of deposit-holdings on bank lending at the intensive margin by estimating equation (1) using *NIRP*Deposit ratio* as the exposure term. The first three columns in table 6 show the estimates of equation 1 for high-deposit banks. Column 1 shows a significant positive effect of the treatment variable on bank lending to all firms at the 1% level. When I split my sample into high- and low-deposit banks in column 2, I find a non-significant effect for high-deposit banks' lending to high-quality firms. In line with the first hypothesis, I find a significant positive effect for high-deposit banks' lending to low-quality firms in column 3. I continue my analysis in column 4 by focusing on low-deposit banks and show that there are insignificant effects of the interaction term *NIRP*Deposit ratio* on bank lending. For the quality split among firms, the results in column 5 and 6 neither show significant results for the variable of interest. This suggests that only high-deposit banks respond to negative interest rates by increasing lending to low-quality firms.

To refine my estimates, in table 7 I add *ln(Liquid assets)* as a control variable. While the R^2 remains unchanged, the results from table 6 continue to hold as the coefficient of *NIRP*Deposit ratio* is positively significant at the 1% significance level in

absence of the quality-split and at the 5% level for low-quality firms when I distinguish between lending to high- and low-quality firms. In terms of economic magnitude, a one percent increase in *Deposit ratio* leads to a 0.251% increase in credit supply by high-deposit banks to existing, low-quality borrowers. Column 4, 5 and 6 show no significant effects from the variable of interest for the low-deposit banks. These results confirms that the NIRP impacts high-deposit banks through deposit holdings. The significant positive effects of the treatment variable for high-deposit banks and the absence of effects for low-deposit banks from table 7 lend support for my first and second hypothesis.

Then, in table 8 I focus on testing my third hypothesis by estimating the impact of liquid asset holdings on credit supply. Column 1 shows a negative and significant impact at the 1% level in absence of a quality split. When I introduce the quality split in column 2 and 3, the results are significant at the 10% for high-quality firms and at the 1% level for low-quality firms. These results indicate that high-deposit banks decrease lending to both high- and low-quality firms at the intensive margin. Column 4, 5 and 6 show no significant effects of the treatment variable for low-deposit banks. Meaning that the treatment variable only has a negative impact on bank lending for high-deposit banks during the NIRP.

In table 9 I add the *Deposit ratio* as a control variable. The results from table 8 continue to hold for the all firms sample at the 1% level significance level and for low-quality firms at the 1% significance level. The results show no significant effects for high-quality firms. Based on the estimate for high-deposit banks in column 3, a 1% increase in a bank's liquid asset holdings would decrease lending to low-quality firms by 0.016%. Columns 4, 5 and 6 of table 9, show no significant effects of the treatment variable on bank lending by low-deposit banks. The results for high-deposit banks do not lend support for the third hypothesis.

Concluding, the results on the *Deposit ratio* treatment at the intensive margin confirm my first hypothesis as high-deposit banks increase lending to low-quality firms in response to the NIRP. Moreover, the results also lend support for my second hypothesis as the deposit-to-assets ratio has no significant effect on bank lending for low-deposit banks. The estimates on the *ln(Liquid assets)* treatment variable are conflicting with my third hypothesis, as the interaction term indicates a significant negative effect on bank lending.

7.2 Extensive margin

To test whether negative interest rates impact bank lending at the extensive margin, I estimate equation (2) by using a sample only consisting of firms which had no bank relation prior to 2014. In table 10, I use the same falsification test as at the intensive margin. In column 1, I include the interaction *APP*ln(Liquid assets)* to test whether bank lending is impacted by the QE policy of the ECB. The results show no significant effect of the interaction term on bank lending. I continue the falsification test in column 2 which shows no significant results for the *NIRP*ln(Liquid assets)* treatment variable. In column 3, I neither find a significant effect of the *NIRP*Deposit ratio* interaction. Following Heider et al. (2019), I compare the outcomes of EU banks to US banks. As shown in column 4, 5 and 6, there are no significant effects of the ECB monetary policy dummies on the US credit supply, which is in line with the rationale. However, the absence of significant effects for EU banks makes comparing impossible. The lack of significant results indicates there is no significant effect of the monetary policies at the extensive margin for all firms.

In table 11 I further investigate whether there is no significant effect of my treatment variables on bank lending. In column 1, 2 and 3, I estimate equation (2) using

the *Deposit ratio* as my exposure variable and add *ln(Liquid assets)* as a control variable. Column 1 shows no significant effect of the treatment variable for all firms. The result for the quality split in table 2 and 3 neither show significant effects. In column 4, 5 and 6, I use the sample of low-deposit banks. The coefficient on my treatment *NIRP*Deposit ratio* remains insignificant. These results indicate that the *Deposit ratio* does not impact bank lending at the extensive margin. To finalize my analysis at the extensive margin, in table 12 I estimate equation (2) using the *ln(Liquid assets)* as my exposure variable and add *Deposit ratio* as a control variable. In column 1 of table 12, the coefficient of the treatment variable has a positive and significant effect at the 10% level. However, when I split the sample based on firm-quality in table 2 and 3, the *NIRP*ln(Liquid assets)* coefficients remain insignificant for both and high- and low-quality firms. For low-deposit banks, the outcomes for all firms in column 4 and for both high- and low-quality firms in column 5 and 6 show insignificant coefficients for my treatment variable. The insignificance of the coefficients of both exposure variables in table 11 and table 12 indicate that the NIRP does not affect bank lending at the extensive margin.

7.3 Robustness tests

In the first two robustness tests shown in table 13 and 14, I test the robustness of my results using a different classification for my firm-quality split. Additionally, I use an alternative method to calculate the credit supplied by a bank in a certain facility. Robustness test are only at the intensive margin.

To test the robustness of my firm-quality split, in table 13 and 14 I alter the classification criterium for high- and low-quality banks by using the 3 year median IC ratio from the firm's country of incorporation. I replicate the estimations from table 7 and 9, using one exposure variable and adding the remaining variable of interest as a control variable. A firm is classified as low-quality (high-quality) when it's 3 year (2012-2014) IC median is below (above) the 3 year (2012-2014) country specific IC ratio. Results for the deposit ratio are shown to be robust as for the all firms sample the coefficient is significant and positive at the 1% level. At the quality-split, shown in column 2 and 3, banks significantly increase lending to both high- and low-quality firms. Based on these outcomes, a one percent increase in the *Deposit ratio* would lead to a 0.121% increase in credit supply to high-quality firms and to a 0.348% increase in credit supply to low-quality firms. For low-deposit banks the coefficients of the interaction terms for both the all firms sample and the quality split in column 4, 5 and 6 are insignificant, which underwrites that only high-deposit banks are affected by the NIRP.

The outcomes from table 14 show a similar image as for liquid asset holdings the results from table 9 prove to be robust. In the first column, the coefficient of the estimate on the whole sample shows a significant and negative impact at the 1% level. Column 2 and 3 also show negative and significant outcomes at the quality split. Low-deposit bank lending is also shown to be robust for the all firms sample in column 4 and for high-quality firms as the coefficients of the treatment term are insignificant. In contradiction to the results of table 9, for low-deposit banks, the coefficient of the interaction term shows a significant and negative impact on bank lending to low-quality firms.

Finally, to test the robustness of my results at the intensive margin, I follow Acharya et al. (2019) and use an equal weights approach. By employing equal weights, I divide the facility amount by the number of lenders such that bank's size does not affect the amount allocated to a lender. This approach rules out the possibility that bank size drives lending decisions. In table 15, I replicate the estimations of table 7 and use *NIRP*Deposit ratio* as exposure variable and *ln(Liquid assets)* as an additional control variable. The outcomes for high-deposit banks' lending to all firms prove to be robust as in coefficient of the treatment variable in column 1 is significant at the 10% level. At the

quality-split, the results for low-quality firms also prove to be robust as the treatment variable is significant at the 10% level. For low-deposit banks, the coefficient *NIRP*Deposit ratio* is close to zero and remains insignificant for both all firms and at the quality split. The findings for both high-deposit and low-deposit banks are in line with the results from table 7 and prove robustness.

Building on the equal weights approach, in table 16 I assess the robustness of the findings on the *NIRP*ln(Liquid assets)* coefficient from table 9. Shown in column 1, for high-deposit banks, only the treatment variable for all firms remains significant at the 10% level. At the quality-split, the coefficients of the treatment variable in column 2 and 3 are insignificant and close to zero. Results for the treatment *NIRP*ln(Liquid assets)* in table 14 show that the findings from table 9 are not robust as only for all firms there is a significant negative effect at the 10% level. Contrary to the previous outcomes, the coefficient of the treatment variable for low-quality firms is insignificant. Judging from these results, commercial banks' liquid asset holdings do not impact bank lending in response to the NIRP.

On the whole, the robustness tests verify the results regarding the positive effect of the deposit-to-assets ratio on bank lending for both high- and low-deposit banks. Thereby supporting my first and second hypothesis. As the robustness tests for liquid asset holdings are inconsistent with the main results, I do not find support for my third hypothesis.

8 Conclusion

With drivers as an ageing population and less capital intensive technologies, a low natural interest rate is here to stay. Because of this, negative policy rates will remain an important tool for central bankers. In this thesis, I focus on the effects of negative policy rates on bank lending. I show that the NIRP has a significant effect on bank-lending operating through deposit holdings. Firstly, I replicate the estimations of Bittner et al. (2020) and show that high-deposit banks increase lending to low-quality firms in response to the NIRP. In addition, no significant effects are found for low-deposit banks. Both findings are robust and in line with my first and second hypothesis. Secondly, I reject my third hypothesis on the effect of liquid asset holdings during NIRP. The results from my robustness test indicate that liquid asset holdings do not impact bank lending in a negative interest rate environment. Opposed to Bittner et al. (2020), significant effects are solely found at the intensive margin, which implies that banks respond to the NIRP by rebalancing towards existing low-quality borrowers.

A limitation of my thesis is the narrow focus on the syndicated loans market which only accounts for 3% of the euro area loans (Demiralp et al., 2021). Moreover, I only find results at the intensive margin, while literature also documents results at the extensive margin. Albeit I try to include liquid assets into the rationale of bank lending in a negative interest rate setting, my thesis and broader literature still lacks a bank lending model which properly includes the role of liquid assets in a negative interest rate environment. Future studies should point out how liquid assets affect bank lending under a NIRP.

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10 Figures

Figure 1: European Central Bank - Balance Sheet - Assets

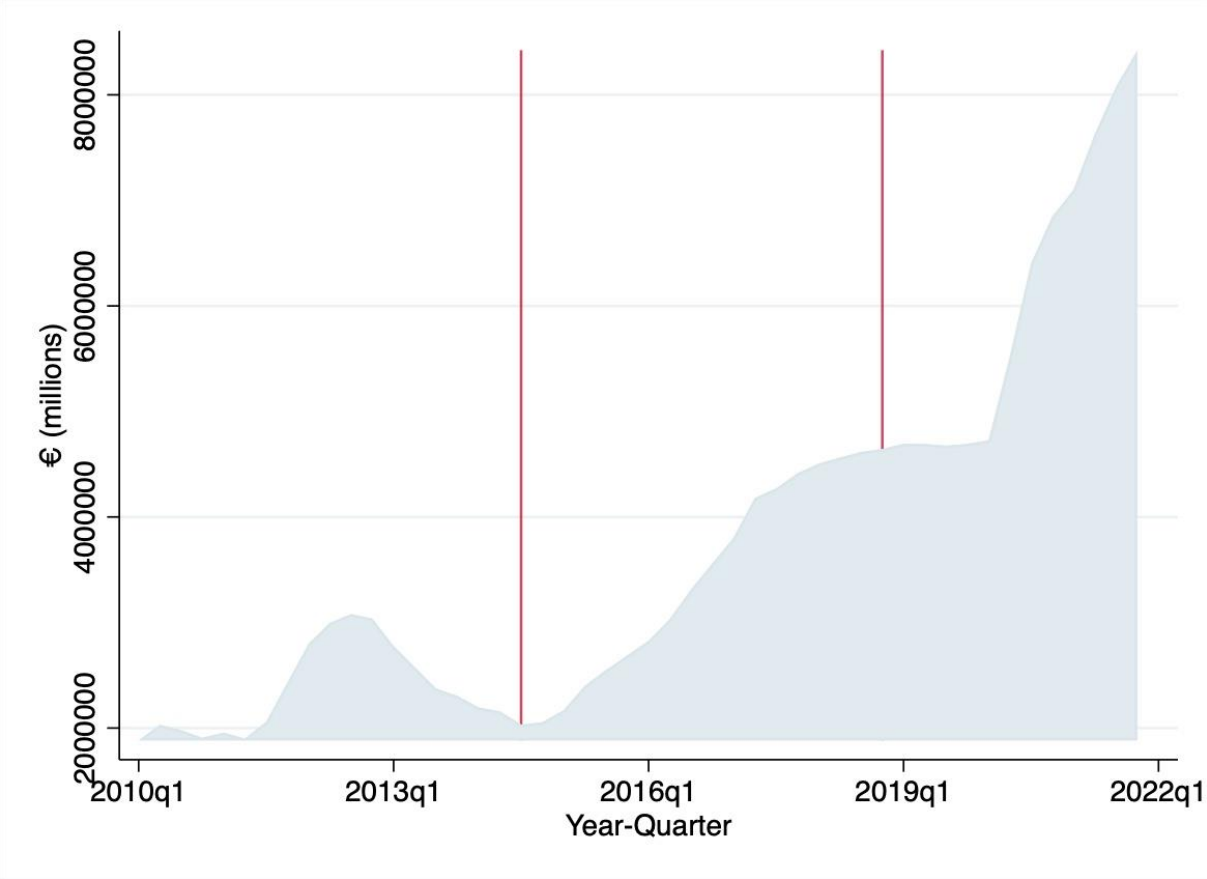

Figure 1 shows the ECB assets in millions of euros over time. The two vertical lines indicate the start and the end of the Asset Purchase Programme, starting in the fourth quarter of 2014 till the last quarter of 2018.

Figure 2: European Central Bank - Interest Rates

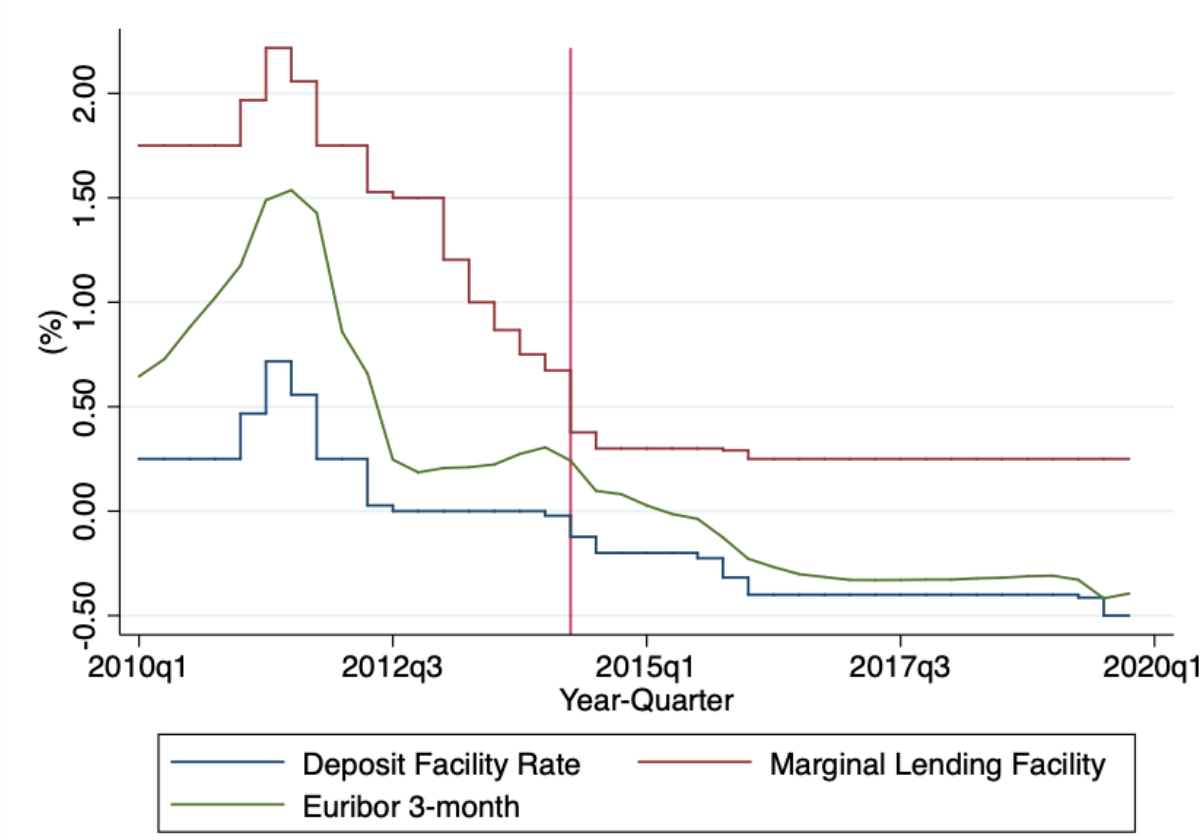

Figure 2 shows the key interest rates for the ECB. The vertical red lines indicates the second quarter of 2014, the start of the NIRP. This picture shows the "corridor" between which the short-term market rate (3-month Euribor) fluctuates. The deposit facility rate is the interest rate paid (or received) by commercial banks when overnight deposits are placed with the central bank. The marginal lending facility is the interest rate against which commercial banks can borrow from the central bank.

Figure 3: European Banks - Distribution of Deposit Holdings

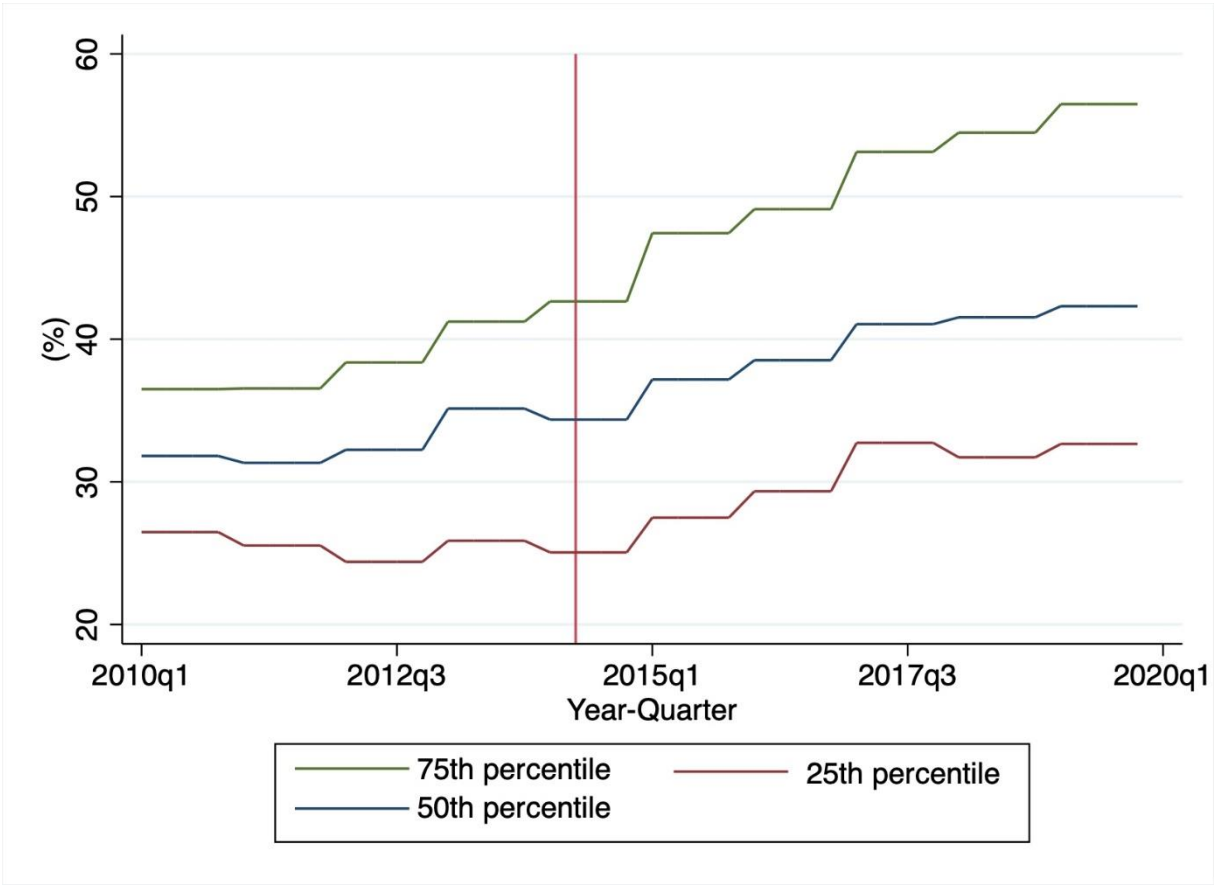

Figure 3 shows the distribution of deposit holdings in percentage among European banks from the first quarter of 2010 until the last quarter of 2019. The vertical red lines indicates the second quarter of 2014, the start of the NIRP.

Figure 4: European Banks - Distribution of Liquid Assets

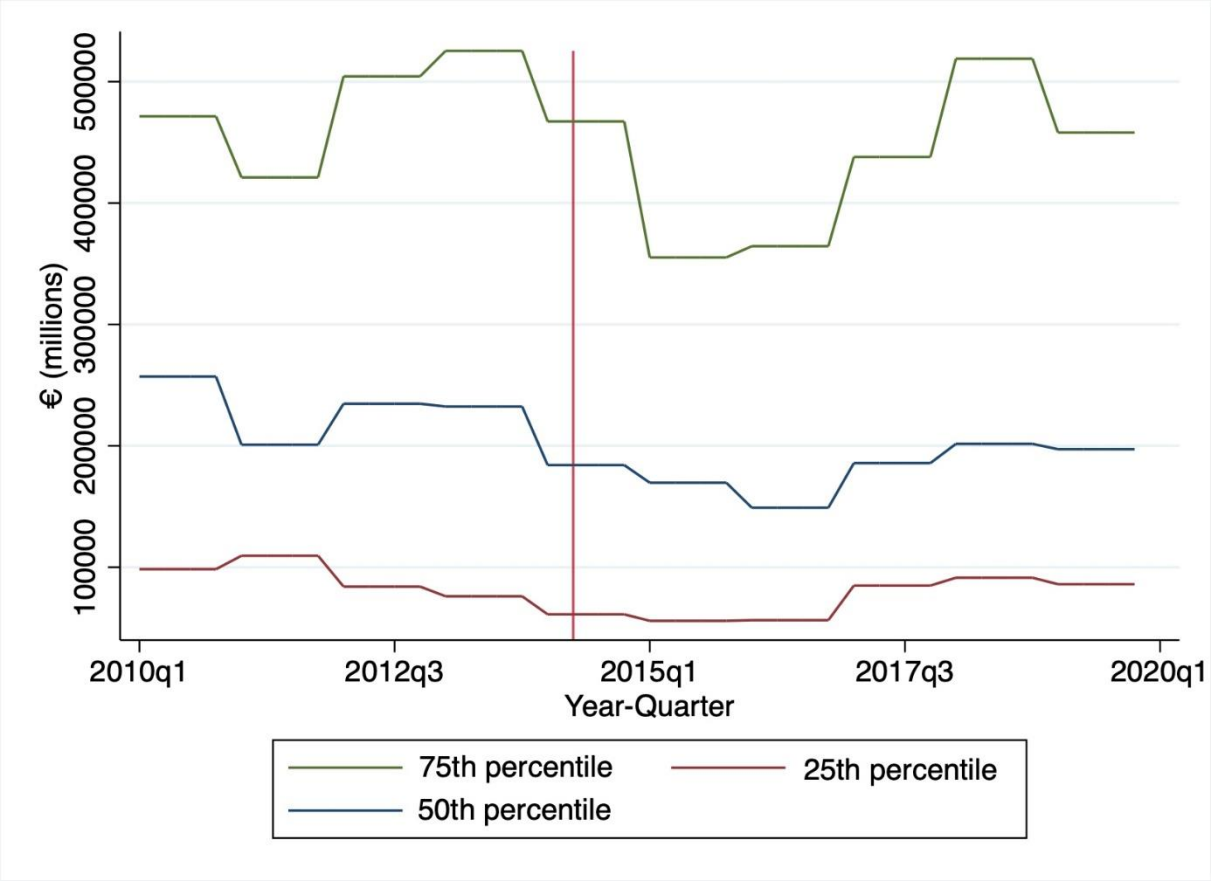

Figure 4 shows the distribution of liquid assets in millions of euros from the first quarter of 2010 until the last quarter of 2019. The vertical red lines indicates the second quarter of 2014, the start of the NIRP.

11 Tables

Table 1: Descriptive Statistics - Commercial Banks

		Total Assets (mn)	Return on Assets	Impaired loans / Equity	Capital Ratio
European Central Bank	Mean	1060	.041	.452	.156
	Median	758	.033	.358	.150
	Std. Dev.	809	.055	.383	.025
Federal Reserve	Mean	1260	.107	.037	.168
	Median	917	.085	.031	.163
	Std. Dev.	654	.180	.032	.023

Table 1 presents the descriptive statistics of banks included in the sample. Banks are included if they are headquartered in either Eurozone countries or in the United States. The sample spans from 2010 until 2019 and is based on yearly balance sheet information.

Table 2: Descriptive Statistics - Firms

	High-Quality	Low-Quality
Tangibility	.543	.633
Net Worth	.288	.209
Leverage	.349	.419
EBITDA / Assets	.116	.070
Total Assets (th EUR)	1110	1020
IC Ratio (%)	24.671	2.892
Net Debt / EBITDA	.539	1.083
Solvency Ratio (%)	38.634	27.761

Table 2 presents an overview of the borrower quality within the sample. A firm is classified as high-quality (high-IC) if its firm ratio is BBB or higher based on the S&P ratings table. Firm is classified as low-quality (low-IC) if rating is BB or lower. Firm's IC ratio is calculated by taking the 2012-2014 median.

Table 3: Variable Definition

Variable	Definition
Dependent variables	
$\Delta Volume$	$\ln(Volume_{t+1}) - \ln(Volume_t)$
Newloan	Dummy equal to 1 if loan is provided to firm cluster which had no prior 2015 relation with bank
Variables of interest	
ln(Liquid assets)	Logarithm of liquid assets
Deposit ratio	Total deposits / Total assets
Bank control variables	
ln(Total assets)	Logarithm of total assets
Net income	Net income / Total assets
Leverage ratio	Total liabilities / Total assets
Impaired loans	Impaired loans / Total equity
Time dummies	
APP	Dummy equal to 1 if observation falls in the APP period by the ECB, starting in the 3st quarter of 2014 till the 4th quarter 2018
NIRP	Dummy equal to 1 if observation falls in the Negative interest rate period by the ECB, starting from the 2th quarter of 2014

Table 4: Summary Statistics - Independent Variables

Variable	Mean	SD	Min	Max
Intensive margin Eurozone banks				
ln(Liquid assets)	11.962	1.389	6.671	13.677
Deposit ratio	.366	.146	.006	.86
ln(Total assets)	13.424	1.103	9.551	14.845
Net income	.002	.005	-.132	.052
Leverage ratio	.945	.02	.738	1.021
Impaired loans	.439	.361	.05	2.473
Intensive margin US banks				
ln(Liquid assets)	13.292	.733	8.439	13.965
Deposit ratio	.450	.189	.042	.852
ln(Total assets)	14.290	.556	11.203	14.804
Net income	.007	.004	-.004	.017
Leverage ratio	.898	.013	.862	.932
Impaired loans	.07	.072	0	.301
Extensive margin Eurozone banks				
ln(Liquid assets)	11.719	1.468	6.778	13.677
Deposit ratio	.394	.147	.013	.86
ln(Total assets)	13.296	1.147	9.282	14.798
Net income	.002	.007	-.132	.068
Leverage ratio	.943	.019	.732	1.021
Impaired loans	.531	.589	.035	4.869
Extensive margin US banks				
ln(Liquid assets)	13.099	1.149	7.468	13.965
Deposit ratio	.463	.212	.042	.922
ln(Total assets)	14.174	.749	10.535	14.804
Net income	.008	.004	-.004	.017
Leverage ratio	.900	.013	.862	.952
Impaired loans	.075	.077	0	.413

Table 4 presents the summary statistics for the independent variables over the different samples. Both dependent and independent variables are winsorized at the 5% level.

Table 5: Intensive Margin - Validation

	EU banks			US banks		
	(1)	(2)	(3)	(4)	(5)	(6)
	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume
ln(Liquid assets)	0.017	0.018		0.117	0.114	
	(0.92)	(0.88)		(1.02)	(0.99)	
APP*ln(Liquid assets)	-0.014***			-0.030		
	(-4.89)			(-1.25)		
NIRP*ln(Liquid assets)		-0.009**			-0.045	
		(-2.62)			(-1.06)	
Deposit ratio			0.134**			-0.302
			(2.22)			(-1.68)
NIRP*Deposit ratio			-0.014			-0.231
			(-0.34)			(-1.63)
ln(Total assets)	-0.017	-0.019	0.006	-0.368	-0.349	-0.027
	(-0.82)	(-0.82)	(0.47)	(-1.34)	(-1.27)	(-0.11)
Net income	-0.796**	-0.732*	-0.569	0.092	-0.335	0.009
	(-2.10)	(-1.83)	(-1.41)	(0.04)	(-0.13)	(0.00)
Leverage ratio	-0.442**	-0.473**	-0.447**	-1.805*	-2.136	-2.463
	(-2.12)	(-2.22)	(-2.60)	(-1.98)	(-1.40)	(-1.15)
Impaired loans	-0.001	0.000	-0.003	0.078	0.06	-0.174
	(-0.06)	(-0.00)	(-0.29)	(0.71)	(0.47)	(-0.77)
Constant	0.520**	0.554**	0.305*	5.499*	5.777	2.822
	(2.55)	(2.52)	(1.93)	(1.87)	(1.77)	(1.02)
N	77070	77070	77070	10290	10290	10290
R2	0.65	0.65	0.65	0.79	0.79	0.79
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 5 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. The dependent variable is the log loan volume granted by a bank to a firm cluster in a given quarter. Loan volume is based on asset-weighted shares. Firms are clustered based on country of incorporation, industry and rating. Firm rating is calculated from the EBIT interest coverage medians for the period from 2012 until 2014. A firm is classified as low-quality (high-quality) when it's IC median is below (above) or equal to the IC ratio of a BB rated firm provided by the S&P ratings table. Results are at the intensive margin, only firms with a pre-2014 relationship are included in the clusters. The sample in column 1, 2 and 3 consists of syndicated loans granted by European banks to European firms from the first quarter of 2010 to last quarter of 2019. The sample in column 4, 5 and 6 consists of syndicated loans granted by US banks to European firms from the first quarter of 2010 to last quarter of 2019. *ln(Liquid assets)* is the logarithm of bank's liquid assets. The *Deposit ratio* is a bank's ratio (in %) of total deposits over total assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *APP* is a dummy variable for the Asset Purchase Programme period starting in the fourth quarter of 2014 until the final quarter of 2018. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

Table 6: Intensive Margin - Deposit Split - Deposit Ratio

	High deposit banks			Low deposit banks		
Firms	All	High-quality	Low-quality	All	High-quality	Low-quality
	(1)	(2)	(3)	(4)	(5)	(6)
	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume
Deposit ratio	0.038	0.101	0.025	0.068	0.513	-0.284
	(0.65)	(0.83)	(0.40)	(0.28)	(1.52)	(-1.10)
NIRP*Deposit ratio	0.219***	0.091	0.257**	0.012	-0.195	0.174
	(2.83)	(1.11)	(2.67)	(0.11)	(-1.70)	(1.13)
ln(Total assets)	0.007	0.003	0.008	0.011	0.013	0.009
	(0.50)	(0.09)	(0.50)	(0.74)	(0.47)	(0.29)
Net income	-0.721**	-0.832	-0.725*	2.204	-3.076	6.781*
	(-2.07)	(-1.08)	(-1.97)	(0.69)	(-0.56)	(1.85)
Leverage ratio	-0.595**	-1.172*	-0.521**	-0.578*	-0.384	-0.495
	(-2.51)	(-1.89)	(-2.36)	(-1.79)	(-0.58)	(-0.95)
Impaired loans	-0.007	0.034*	-0.016	0.074	0.072	0.067
	(-0.66)	(1.72)	(-1.67)	(1.30)	(1.03)	(0.66)
Constant	0.386	0.987**	0.303	0.356	0.075	0.351
	(1.49)	(2.21)	(1.10)	(1.48)	(0.13)	(1.40)
N	33565	10885	22680	37380	17395	19985
R2	0.67	0.75	0.63	0.69	0.70	0.69
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 6 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. The dependent variable is the log loan volume granted by a bank to a firm cluster in a given quarter. Loan volume is based on asset-weighted shares. Banks are split based on the median deposit holdings over the sample period. Firms are clustered based on country of incorporation, industry and rating. Firm rating is calculated from the EBIT interest coverage medians for the period from 2012 until 2014. A firm is classified as low-quality (high-quality) when it's IC median is below (above) or equal to the IC ratio of a BB rated firm provided by the S&P ratings table. . Results are at the intensive margin, only firms with a pre-2014 relationship are included in the clusters. The sample spans from the first quarter of 2010 to last quarter of 2019 and only covers European banks lending to European firms. Column 1, 2 and 3 consists of syndicated loans granted by high-deposit banks. The sample in column 4, 5 and 6 consists of syndicated loans granted by low-deposit banks. The *Deposit ratio* is a bank's ratio (in %) of total deposits over total assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

Table 7: Intensive Margin - Deposit Split - Deposit Ratio

	High deposit banks			Low deposit banks		
Firms	All	High-quality	Low-quality	All	High-quality	Low-quality
	(1)	(2)	(3)	(4)	(5)	(6)
	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume
Deposit ratio	0.037	0.076	0.027	0.072	0.513	-0.278
	(0.64)	(0.66)	(0.43)	(0.30)	(1.52)	(-1.03)
NIRP*Deposit ratio	0.219***	0.093	0.251**	0.025	-0.195	0.202
	(2.81)	(1.15)	(2.61)	(0.26)	(-1.69)	(1.29)
ln(Liquid assets)	0.001	0.024	-0.004	0.073	0.003	0.132*
	(0.04)	(0.98)	(-0.16)	(1.50)	(0.06)	(1.98)
ln(Total assets)	0.006	-0.026	0.013	-0.051	0.011	-0.095
	(0.19)	(-0.68)	(0.39)	(-1.04)	(0.21)	(-1.53)
Net income	-0.725*	0.971	-0.709*	2.738	-3.05	7.476**
	(-1.99)	(-1.16)	(-1.90)	(0.95)	(-0.53)	(2.19)
Leverage ratio	-0.601*	-1.364**	-0.493	-0.914**	-0.393	-1.205*
	(-2.02)	(-2.23)	(-1.66)	(-2.49)	(-0.56)	(-1.76)
Impaired loans	-0.007	0.037*	-0.016	0.085	0.073	0.087
	(-0.57)	(1.88)	(-1.40)	(1.56)	(1.03)	(0.96)
Constant	0.397	1.280***	0.255	0.604*	0.083	0.785**
	(1.07)	(3.13)	(0.63)	(2.01)	(0.14)	(2.18)
N	33565	10885	22680	37380	17395	19985
R2	0.67	0.75	0.63	0.69	0.70	0.69
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 7 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. The dependent variable is the log loan volume granted by a bank to a firm cluster in a given quarter. Loan volume is based on asset-weighted shares. Banks are split based on the median deposit holdings over the sample period. Firms are clustered based on country of incorporation, industry and rating. Firm rating is calculated from the EBIT interest coverage medians for the period from 2012 until 2014. A firm is classified as low-quality (high-quality) when it's IC median is below (above) or equal to the IC ratio of a BB rated firm provided by the S&P ratings table. Results are at the intensive margin, only firms with a pre-2014 relationship are included in the clusters. The sample spans from the first quarter of 2010 to last quarter of 2019 and only covers European banks lending to European firms. Column 1, 2 and 3 consists of syndicated loans granted by high-deposit banks. The sample in column 4, 5 and 6 consists of syndicated loans granted by low-deposit banks. *ln(Liquid assets)* is the logarithm of bank's liquid assets. The *Deposit ratio* is a bank's ratio (in %) of total deposits over total assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

Table 8: Intensive Margin - Deposit Split - Liquid Assets

	High deposit banks			Low deposit banks		
Firms	All	High-quality	Low-quality	All	High-quality	Low-quality
	(1)	(2)	(3)	(4)	(5)	(6)
	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume
ln(Liquid assets)	0.007	0.033	-0.000	0.081*	0.009	0.139**
	(0.28)	(1.29)	(-0.01)	(1.82)	(0.22)	(2.42)
NIRP*ln(Liquid assets)	-0.016***	-0.013*	-0.017***	-0.01	-0.005	-0.014
	(-4.02)	(-1.91)	(-3.95)	(-1.23)	(-0.65)	(-1.18)
ln(Total assets)	-0.008	-0.055*	0.007	-0.043	0.004	-0.073
	(-0.29)	(-1.82)	(0.22)	(-0.85)	(0.08)	(-1.08)
Net income	-0.952**	-1.071	-0.912**	2.154	-1.912	5.391*
	(-2.21)	(-1.28)	(-2.20)	(0.76)	(-0.32)	(1.76)
Leverage ratio	-0.590**	-1.384**	-0.464*	-0.822**	-0.423	-1.109*
	(-2.08)	(-2.21)	(-1.69)	(-2.44)	(-0.57)	(-1.85)
Impaired loans	-0.004	0.039*	-0.014	0.085	0.080	0.070
	(-0.33)	(2.02)	(-1.10)	(1.65)	(1.15)	(0.89)
Constant	0.712*	1.751***	0.475	0.414	0.256	0.396
	(1.93)	(3.60)	(1.25)	(1.34)	(0.34)	(0.87)
N	33565	10885	22680	37380	17395	19985
R2	0.67	0.75	0.63	0.69	0.70	0.69
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 8 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. The dependent variable is the log loan volume granted by a bank to a firm cluster in a given quarter. Loan volume is based on asset-weighted shares. Banks are split based on the median deposit holdings over the sample period. Firms are clustered based on country of incorporation, industry and rating. Firm rating is calculated from the EBIT interest coverage medians for the period from 2012 until 2014. A firm is classified as low-quality (high-quality) when it's IC median is below (above) or equal to the IC ratio of a BB rated firm provided by the S&P ratings table. Results are at the intensive margin, only firms with a pre-2014 relationship are included in the clusters. The sample spans from the first quarter of 2010 to last quarter of 2019 and only covers European banks lending to European firms. Column 1, 2 and 3 consists of syndicated loans granted by high-deposit banks. The sample in column 4, 5 and 6 consists of syndicated loans granted by low-deposit banks. *ln(Liquid assets)* is the logarithm of bank's liquid assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

Table 9: Intensive Margin - Deposit Split - Liquid Assets

	High deposit banks			Low deposit banks		
Firms	All	High-quality	Low-quality	All	High-quality	Low-quality
	(1)	(2)	(3)	(4)	(5)	(6)
	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume
ln(Liquid assets)	0.005	0.029	-0.002	0.083*	0.013	0.140**
	(0.20)	(1.11)	(-0.06)	(1.82)	(0.29)	(2.37)
NIRP*ln(Liquid assets)	-0.015***	-0.013	-0.016***	-0.011	-0.005	-0.015
	(-3.61)	(-1.66)	(-3.54)	(-1.22)	(-0.67)	(-1.16)
Deposit ratio	0.103	0.103	0.097	0.127	0.236	0.059
	(1.47)	(0.80)	(1.41)	(0.82)	(1.14)	(0.38)
ln(Total assets)	0.005	-0.029	0.016	-0.043	0.006	-0.074
	(0.17)	(-0.68)	(0.50)	(-0.82)	(0.13)	(-1.06)
Net income	-0.894**	-1.046	-0.861*	2.074	-1.984	5.345
	(-2.05)	(-1.31)	(-2.01)	(0.76)	(-0.35)	(1.70)
Leverage ratio	-0.593**	-1.417**	-0.462*	-0.910**	-0.398	-1.157*
	(-2.07)	(-2.20)	(-1.69)	(-2.49)	(-0.58)	(-1.96)
Impaired loans	-0.006	0.038*	-0.016	0.092	0.087	0.074
	(-0.46)	(1.95)	(-1.24)	(1.71)	(1.27)	(0.91)
Constant	0.502	1.424**	0.315	0.434	0.088	0.416
	(1.25)	(2.50)	(0.77)	(1.31)	(0.14)	(0.91)
N	33565	10885	22680	37380	17395	19985
R2	0.67	0.75	0.63	0.69	0.70	0.69
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 9 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. The dependent variable is the log loan volume granted by a bank to a firm cluster in a given quarter. Loan volume is based on asset-weighted shares. Banks are split based on the median deposit holdings over the sample period. Firms are clustered based on country of incorporation, industry and rating. Firm rating is calculated from the EBIT interest coverage medians for the period from 2012 until 2014. A firm is classified as low-quality (high-quality) when it's IC median is below (above) or equal to the IC ratio of a BB rated firm provided by the S&P ratings table. Results are at the intensive margin, only firms with a pre-2014 relationship are included in the clusters. The sample spans from the first quarter of 2010 to last quarter of 2019 and only covers European banks lending to European firms. Column 1, 2 and 3 consists of syndicated loans granted by high-deposit banks. The sample in column 4, 5 and 6 consists of syndicated loans granted by low-deposit banks. *ln(Liquid assets)* is the logarithm of bank's liquid assets. The *Deposit ratio* is a bank's ratio (in %) of total deposits over total assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

Table 10: Extensive Margin - Validation

	EU banks			US banks		
	(1)	(2)	(3)	(4)	(5)	(6)
	Newloan	Newloan	Newloan	Newloan	Newloan	Newloan
ln(Liquid assets)	-0.002	-0.002		-0.014	-0.015*	
	(-1.20)	(-1.27)		(-1.75)	(-1.78)	
APP*ln(Liquid assets)	0.000			0.001		
	(0.16)			(0.51)		
NIRP*ln(Liquid assets)		0.001			0.000	
		(1.12)			(0.16)	
Deposit ratio			-0.013			-0.058
			(-1.00)			(-1.49)
NIRP*Deposit ratio			0.001			0.004
			(0.39)			(0.37)
ln(Total assets)	0.004	0.004	0.000	0.037	0.037	0.008
	(1.37)	(1.39)	(0.12)	(1.27)	(1.32)	(0.36)
Net income	-0.019	-0.017	-0.021	-0.090	-0.098	0.012
	(-0.45)	(-0.41)	(-0.51)	(-0.34)	(-0.33)	(0.03)
Leverage ratio	0.003	0.003	-0.012	0.220	0.205	0.169
	(0.08)	(0.08)	(-0.32)	(1.06)	(0.94)	(0.62)
Impaired loans	-0.000	-0.000	0.000	-0.003	-0.004	0.005
	(-0.19)	(-0.22)	(0.39)	(-0.22)	(-0.25)	(0.21)
Constant	-0.023	-0.023	0.014	-0.535**	-0.510**	-0.244
	(-0.66)	(-0.66)	(0.34)	(-2.59)	(-3.43)	(-1.44)
N	118650	118650	118650	11550	11550	11550
R2	0.64	0.64	0.64	0.73	0.73	0.73
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 10 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. The dependent variable is a dummy variable equal to 1 if a new loan is issued to a firm cluster. Banks are split based on the median deposit holdings over the sample period. Firms are clustered based on country of incorporation, industry and rating. Firm rating is calculated from the EBIT interest coverage medians for the period from 2012 until 2014. A firm is classified as low-quality (high-quality) when it's IC median is below (above) or equal to the IC ratio of a BB rated firm provided by the S&P ratings table. Results are at the extensive margin, only firms with a post-2014 relationship are included in the clusters. The sample in column 1, 2 and 3 consists of syndicated loans granted by European banks to European firms from the first quarter of 2010 to last quarter of 2019. The sample in column 4, 5 and 6 consists of syndicated loans granted by US banks to European firms from the first quarter of 2010 to last quarter of 2019. *ln(Liquid assets)* is the logarithm of bank's liquid assets. The *Deposit ratio* is a bank's ratio (in %) of total deposits over total assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *APP* is a dummy variable for the Asset Purchase Programme period starting in the fourth quarter of 2014 until the final quarter of 2018. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

Table 11: Extensive Margin - Deposit Split - Deposit Ratio

	High deposit banks			Low deposit banks		
Firms	All	High-quality	Low-quality	All	High-quality	Low-quality
	(1)	(2)	(3)	(4)	(5)	(6)
	Newloan	Newloan	Newloan	Newloan	Newloan	Newloan
Deposit ratio	0.001	-0.012	0.009	-0.06	-0.04	-0.073
	(0.18)	(-0.96)	(0.71)	(-1.23)	(-0.55)	(-1.70)
NIRP*Deposit ratio	-0.004	-0.015	0.002	0.012	0.011	0.012
	(-0.78)	(-1.55)	(0.22)	(1.71)	(1.09)	(1.45)
ln(Liquid assets)	-0.002	-0.003	0.001	-0.007	-0.005	-0.009
	(-0.55)	(-0.97)	(0.56)	(-1.21)	(-0.92)	(-1.14)
ln(Total assets)	0.001	0.000	0.001	0.011*	0.009	0.012*
	(0.41)	(0.09)	(0.21)	(1.87)	(1.46)	(1.76)
Net income	-0.002	-0.047	0.014	-0.172	-0.152	-0.181
	(-0.06)	(-1.02)	(0.33)	(-0.54)	(-0.32)	(-0.71)
Leverage ratio	-0.016	-0.009	-0.027	-0.001	-0.113	0.065
	(-0.29)	(-0.18)	(-0.35)	(-0.01)	(-0.74)	(0.56)
Impaired loans	-0.001	-0.001	-0.001	0.003	0.006	0.001
	(-1.22)	(-0.69)	(-0.98)	(0.54)	(1.00)	(0.16)
Constant	0.003	0.047	-0.003	-0.044	0.054	-0.011
	(0.08)	(0.75)	(-0.05)	(-0.36)	(0.32)	(-0.65)
N	46200	16415	29785	58590	26740	31850
R2	0.69	0.72	0.68	0.65	0.67	0.64
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 11 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. The dependent variable is a dummy variable equal to 1 if a new loan is issued to a firm cluster. Banks are split based on the median deposit holdings over the sample period. Loan volume is based on asset-weighted shares. Banks are split based on the median deposit holdings over the sample period. Firms are clustered based on country of incorporation, industry and rating. Firm rating is calculated from the EBIT interest coverage medians for the period from 2012 until 2014. A firm is classified as low-quality (high-quality) when it's IC median is below (above) or equal to the IC ratio of a BB rated firm provided by the S&P ratings table. Results are at the extensive margin, only firms with a post-2014 relationship are included in the clusters. The sample spans from the first quarter of 2010 to last quarter of 2019 and only covers European banks lending to European firms. Column 1, 2 and 3 consists of syndicated loans granted by high-deposit banks. The sample in column 4, 5 and 6 consists of syndicated loans granted by low-deposit banks. *ln(Liquid assets)* is the logarithm of bank's liquid assets. The *Deposit ratio* is a bank's ratio (in %) of total deposits over total assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

Table 12: Extensive Margin - Deposit Split - Liquid Assets

	High deposit banks			Low deposit banks		
Firms	All	High-quality	Low-quality	All	High-quality	Low-quality
	(1)	(2)	(3)	(4)	(5)	(6)
	Newloan	Newloan	Newloan	Newloan	Newloan	Newloan
ln(Liquid assets)	-0.001	-0.003	0.001	-0.007	-0.005	-0.008
	(-0.10)	(-0.92)	(0.42)	(-1.09)	(-0.83)	(-1.04)
NIRP*ln(Liquid assets)	0.001*	0.000	0.000	0.000	0.000	0.000
	(1.88)	(0.41)	(1.55)	(-0.19)	(-0.22)	(-0.18)
Deposit ratio	0.001	-0.020	0.011	-0.044	-0.024	-0.057
	(0.09)	(-1.24)	(0.69)	(-1.06)	(-0.40)	(-1.57)
ln(Total assets)	0.001	0.000	0.002	0.012*	0.009	0.013
	(0.51)	(-0.10)	(0.40)	(1.98)	(1.56)	(1.51)
Net income	0.003	-0.051	0.020	-0.168	-0.147	-0.179
	(0.11)	(-1.03)	(0.49)	(-0.53)	(-0.31)	(-0.69)
Leverage ratio	-0.016	-0.011	-0.024	-0.006	-0.117	0.059
	(-0.28)	(-0.23)	(-0.33)	(-0.05)	(-0.75)	(0.50)
Impaired loans	-0.001	0.000	-0.001	0.003	0.006	0.001
	(-1.16)	(-0.48)	(-1.08)	(0.53)	(1.01)	(0.13)
Constant	-0.003	0.054	-0.013	-0.050	0.049	-0.107
	(-0.07)	(0.83)	(-0.24)	(-0.40)	(0.30)	(-0.66)
N	46200	16415	29785	58590	26740	31850
R2	0.69	0.72	0.68	0.65	0.67	0.64
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 12 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. The dependent variable is a dummy variable equal to 1 if a new loan is issued to a firm cluster. Banks are split based on the median deposit holdings over the sample period. Loan volume is based on asset-weighted shares. Firms are clustered based on country of incorporation, industry and rating. Firm rating is calculated from the EBIT interest coverage medians for the period from 2012 until 2014. A firm is classified as low-quality (high-quality) when it's IC median is below (above) or equal to the IC ratio of a BB rated firm provided by the S&P ratings table. Results are at the extensive margin, only firms with a post-2014 relationship are included in the clusters. The sample spans from the first quarter of 2010 to last quarter of 2019 and only covers European banks lending to European firms. Column 1, 2 and 3 consists of syndicated loans granted by high-deposit banks. The sample in column 4, 5 and 6 consists of syndicated loans granted by low-deposit banks. *ln(Liquid assets)* is the logarithm of bank's liquid assets. The *Deposit ratio* is a bank's ratio (in %) of total deposits over total assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

Table 13: Intensive Margin - Robustness - Deposit Ratio - Country Specific IC Ratio (Firm Quality)

	High deposit banks			Low deposit banks		
Firms	All	High-quality	Low-quality	All	High-quality	Low-quality
	(1)	(2)	(3)	(4)	(5)	(6)
	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume
Deposit ratio	0.037	0.080	-0.055	0.072	0.301	-0.485
	(0.64)	(1.12)	(-0.55)	(0.30)	(0.93)	(-1.52)
NIRP*Deposit ratio	0.219***	0.121**	0.348**	0.025	-0.121	0.279
	(2.81)	(2.04)	(2.33)	(0.26)	(-1.09)	(1.40)
ln(Liquid assets)	0.001	0.012	-0.013	0.072	0.028	0.127*
	(0.04)	(0.78)	(-0.44)	(1.50)	(0.58)	(1.82)
ln(Total assets)	0.006	-0.012	0.016	-0.051	-0.014	-0.086
	(0.19)	(-0.29)	(0.43)	(-1.04)	(-0.29)	(-1.44)
Net income	-0.725*	-0.571	-1.471**	2.738	-0.002	9.618
	(-1.99)	(-1.52)	(-2.35)	(0.95)	(-0.00)	(1.73)
Leverage ratio	-0.601*	-0.833**	-0.553	-0.914**	-0.946**	-0.917
	(-2.02)	(-2.11)	(-1.41)	(-2.49)	(-2.19)	(-1.23)
Impaired loans	-0.007	-0.007	-0.006	0.085	0.083*	0.089
	(-0.57)	(-0.46)	(-0.51)	(1.56)	(1.89)	(1.09)
Constant	0.397	0.658	0.365	0.604*	0.658*	0.483
	(1.07)	(1.48)	(0.87)	(2.01)	(1.88)	(1.12)
N	33565	19605	13835	37380	23132	14125
R2	0.67	0.71	0.63	0.69	0.70	0.72
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 13 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. Loan volume is based on asset-weighted shares. The dependent variable is the log loan volume granted by a bank to a firm cluster in a given quarter. Banks are split based on the median deposit holdings over the sample period. Firms are clustered based on country of incorporation, industry and rating. A firm is classified as low-quality (high-quality) when it's 3 year (2012-2014) IC median is below (above) the 3 year (2012-2014) country specific IC ratio. Results are at the intensive margin, only firms with a pre-2014 relationship are included in the clusters. The sample spans from the first quarter of 2010 to last quarter of 2019 and only covers European banks lending to European firms. Column 1, 2 and 3 consists of syndicated loans granted by high-deposit banks. The sample in column 4, 5 and 6 consists of syndicated loans granted by low-deposit banks. *ln(Liquid assets)* is the logarithm of bank's liquid assets. The *Deposit ratio* is a bank's ratio (in %) of total deposits over total assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

Table 14: Intensive Margin - Robustness - Liquid Assets - Country Specific IC Ratio (Firm Quality)

	High deposit banks			Low deposit banks		
Firms	All	High-quality	Low-quality	All	High-quality	Low-quality
	(1)	(2)	(3)	(4)	(5)	(6)
	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume
ln(Liquid assets)	0.005	0.026	-0.013	0.083*	0.026	0.156**
	(0.20)	(1.03)	(-0.42)	(1.82)	(0.52)	(2.48)
NIRP*ln(Liquid assets)	-0.015***	-0.017**	-0.015**	-0.011	0.005	-0.036*
	(-3.61)	(-2.81)	(-2.09)	(-1.22)	(0.59)	(-1.76)
Deposit ratio	0.103	0.072	0.075	0.127	0.118	0.002
	(1.47)	(0.68)	(0.91)	(0.82)	(0.59)	(0.01)
ln(Total assets)	0.005	-0.026	0.030	-0.043	-0.021	-0.051
	(0.17)	(-0.67)	(0.82)	(-0.82)	(-0.43)	(-0.66)
Net income	-0.894**	-0.854*	-1.496**	2.074	0.988	5.766
	(-2.05)	(-1.78)	(-2.21)	(0.76)	(0.21)	(1.06)
Leverage ratio	-0.593**	-0.891**	-0.428	-0.910**	-0.969*	-0.901
	(-2.07)	(-2.09)	(-1.18)	(-2.49)	(-1.94)	(-1.07)
Impaired loans	-0.006	-0.005	-0.006	0.092	0.086	0.087
	(-0.46)	(-0.31)	(-0.48)	(1.71)	(1.76)	(1.01)
Constant	0.502	0.998*	0.228	0.434	0.797	-0.177
	(1.25)	(1.82)	(0.51)	(1.31)	(1.69)	(-0.21)
N	33565	19605	13835	37380	23132	14125
R2	0.67	0.71	0.63	0.69	0.71	0.72
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 14 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. Loan volume is based on asset-weighted shares. The dependent variable is the log loan volume granted by a bank to a firm cluster in a given quarter. Banks are split based on the median deposit holdings over the sample period. Firms are clustered based on country of incorporation, industry and rating. Firm rating is calculated from the EBIT interest coverage medians for the period from 2012 until 2014. A firm is classified as low-quality (high-quality) when it's 3 year (2012-2014) IC median is below (above) the 3 year (2012-2014) country specific IC ratio. Results are at the intensive margin, only firms with a pre-2014 relationship are included in the clusters. The sample spans from the first quarter of 2010 to last quarter of 2019 and only covers European banks lending to European firms. Column 1, 2 and 3 consists of syndicated loans granted by high-deposit banks. The sample in column 4, 5 and 6 consists of syndicated loans granted by low-deposit banks. *ln(Liquid assets)* is the logarithm of bank's liquid assets. The *Deposit ratio* is a bank's ratio (in %) of total deposits over total assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

Table 15: Intensive Margin - Robustness - Deposit Ratio - Equal Weights

	High deposit banks			Low deposit banks		
Firms	All	High-quality	Low-quality	All	High-quality	Low-quality
	(1)	(2)	(3)	(4)	(5)	(6)
	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume
Deposit ratio	0.05	0.022	0.044	0.051	0.413	-0.241
	(0.70)	(0.18)	(0.57)	(0.27)	(1.44)	(-1.01)
NIRP*Deposit ratio	0.165*	0.070	0.192*	0.023	-0.146	0.153
	(2.00)	(0.92)	(1.88)	(0.33)	(-1.46)	(1.26)
ln(Liquid assets)	-0.012	0.008	-0.017	0.054	-0.003	0.104*
	(-0.55)	(0.40)	(-0.67)	(1.54)	(-0.08)	(1.95)
ln(Total assets)	0.027	-0.041	0.041	-0.012	0.035	-0.046
	(0.84)	(-1.18)	(1.24)	(-0.28)	(0.73)	(-0.78)
Net income	-0.717	-0.395	-0.772	1.425	-2.679	4.762
	(-1.55)	(-0.45)	(-1.64)	(0.51)	(-0.50)	(1.52)
Leverage ratio	-0.531*	-0.775	-0.518*	-0.882**	-0.705	-1.079
	(-1.88)	(-1.58)	(-1.71)	(-2.25)	(-0.86)	(-1.60)
Impaired loans	-0.012	0.024	-0.020*	0.084	0.092	0.072
	(-1.02)	(1.35)	(-1.76)	(1.38)	(1.26)	(0.70)
Constant	0.219	1.157**	0.064	0.284	0.138	0.357
	(0.58)	(2.73)	(0.16)	(0.91)	(0.19)	(0.95)
N	33565	10885	22680	37380	17395	19985
R2	0.70	0.76	0.66	0.71	0.71	0.71
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 15 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. The dependent variable is the log loan volume granted by a bank to a firm cluster in a given quarter. Loan volume is based on equal weights. Banks are split based on the median deposit holdings over the sample period. Firms are clustered based on country of incorporation, industry and rating. Firm rating is calculated from the EBIT interest coverage medians for the period from 2012 until 2014. A firm is classified as low-quality (high-quality) when it's IC median is below (above) or equal to the IC ratio of a BB rated firm provided by the S&P ratings table. Results are at the intensive margin, only firms with a pre-2014 relationship are included in the clusters. The sample spans from the first quarter of 2010 to last quarter of 2019 and only covers European banks lending to European firms. Column 1, 2 and 3 consists of syndicated loans granted by high-deposit banks. The sample in column 4, 5 and 6 consists of syndicated loans granted by low-deposit banks. *ln(Liquid assets)* is the logarithm of bank's liquid assets. The *Deposit ratio* is a bank's ratio (in %) of total deposits over total assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

Table 16: Intensive Margin - Robustness - Liquid Assets - Equal Weights

	High deposit banks			Low deposit banks		
Firms	All	High-quality	Low-quality	All	High-quality	Low-quality
	(1)	(2)	(3)	(4)	(5)	(6)
	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume	ΔVolume
ln(Liquid assets)	-0.011	0.011	-0.017	0.059	-0.001	0.108**
	(-0.50)	(0.51)	(-0.68)	(1.65)	(-0.03)	(2.19)
NIRP*ln(Liquid assets)	-0.007*	-0.007	-0.007	-0.005	0.001	-0.009
	(-1.89)	(-1.02)	(-1.61)	(-0.51)	(0.09)	(-0.65)
Deposit ratio	0.118	0.049	0.119	0.094	0.206	0.0121
	(1.60)	(0.37)	(1.57)	(0.61)	(1.13)	(0.07)
ln(Total assets)	0.030	-0.042	0.048	-0.008	0.03	-0.031
	(0.93)	(-1.10)	(1.42)	(-0.17)	(0.63)	(-0.46)
Net income	-0.788	-0.462	-0.814	1.048	-1.696	3.233
	(-1.58)	(-0.55)	(-1.62)	(0.38)	(-0.31)	(1.05)
Leverage ratio	-0.503*	-0.804	-0.471*	-0.880**	-0.655	-1.048
	(-1.92)	(-1.56)	(-1.73)	(-2.22)	(-0.77)	(-1.71)
Impaired loans	-0.013	0.024	-0.021*	0.086	0.096	0.061
	(-1.03)	(1.38)	(-1.79)	(1.42)	(1.26)	(0.66)
Constant	0.209	1.227**	0.011	0.203	0.144	0.115
	(0.51)	(2.25)	(0.02)	(0.56)	(0.20)	(0.22)
N	33565	10885	22680	37380	17395	19985
R2	0.72	0.76	0.66	0.71	0.71	0.71
FirmCluster-Bank Fixed Effects	YES	YES	YES	YES	YES	YES
FirmCluster-Time Fixed effects	YES	YES	YES	YES	YES	YES

Table 16 presents the results of the Acharya et al. (2018) bank lending channel regressions. The level of observation is a firm cluster-bank-quarteryear. The dependent variable is the log loan volume granted by a bank to a firm cluster in a given quarter. Loan volume is based on equal weights. Banks are split based on the median deposit holdings over the sample period. Firms are clustered based on country of incorporation, industry and rating. Firm rating is calculated from the EBIT interest coverage medians for the period from 2012 until 2014. A firm is classified as low-quality (high-quality) when it's IC median is below (above) or equal to the IC ratio of a BB rated firm provided by the S&P ratings table. Results are at the intensive margin, only firms with a pre-2014 relationship are included in the clusters. The sample spans from the first quarter of 2010 to last quarter of 2019 and only covers European banks lending to European firms. Column 1, 2 and 3 consists of syndicated loans granted by high-deposit banks. The sample in column 4, 5 and 6 consists of syndicated loans granted by low-deposit banks. *ln(Liquid assets)* is the logarithm of bank's liquid assets. The *Deposit ratio* is a bank's ratio (in %) of total deposits over total assets. *ln(Total assets)* is the logarithm of bank's total assets. *Net income* is a bank's ratio (in%) of net income over total assets. *Leverage ratio* is the bank's leverage (in %) calculated by total liabilities over total assets. *Impaired loans* is a bank's ratio (in %) of impaired loans over total equity. *NIRP* is a dummy variable of the negative interest rate policy period from the second quarter of 2014 onwards. Firm cluster-time and firm cluster-bank fixed effects are included for all regressions. Standard errors are clustered at the bank level. T-statistics are in parentheses. Significance levels: * (p<0.10), ** (p<0.05), *** (p<0.01).

12 Appendix

Appendix 1: Bankfocus Definitions

Variable	Bankfocus #	Definition
Deposits	60300	Total deposits from customers Sum of; Demand deposits; Savings deposits; Time deposits; Other customer deposits
Liquidity assets	99620	Sum of cash & balances with central banks, net loans & advances to banks, reverse repos, securities borrowed & cash collateral, financial assets; trading and at fair value through P&L; fair value through other comprehensive income; available for sale, minus mandatory reserve deposits with central banks
Total assets	52600	Sum of on balance sheet assets
Total liabilities	61900	Sum of all liabilities
Net income	99470	Net income after taxes plus any net profits (losses) for the year from discontinued operations.
Impaired loans	99360	Impaired loans as a percent of total equity.