Is There a Zero Lower Bound? The Effects of Negative Policy Rates on Banks and Firms

Carlo Altavilla, Lorenzo Burlon, Mariassunta Giannetti and Sarah Holton*

This version: September 2019

Exploiting confidential data from the euro area, we show that sound banks pass negative rates on to their corporate depositors without experiencing a contraction in funding and that the tendency to charge negative rates becomes stronger as policy rates move deeper into negative territory. The negative interest rate policy (NIRP) provides stimulus to the economy through firms' asset rebalancing. Firms with high current assets linked to banks offering negative rates appear to increase their investment in tangible and intangible assets and to decrease their cash holdings to avoid the costs associated with negative rates. Overall, our results challenge the commonly held view that conventional monetary policy becomes ineffective when policy rates reach the zero lower bound.

JEL: E52, E43, G21, D22, D25.

Keywords: monetary policy, negative rates, lending channel, corporate channel

* Altavilla and Burlon are with the European Central Bank; Giannetti is with the Stockholm School of Economics, CEPR, and ECGI; and Holton is with the Central Bank of Ireland. We thank Gabriel Chodorow-Reich, José Dorich, Farzad Saidi, and seminar participants at the NBER Summer Institute Corporate Finance Meeting, the Barcelona Graduate School of Economics Summer Forum Workshop on Financial Shocks, Channels, and Macro Outcomes, the CSEF-IGIER Symposium on Economics and Institutions, the Workshop on Institution, Individual Behavior and Economic Outcomes, the University of Amsterdam, the Bank of France, the Bank of France Research Workshop of the Monetary Policy Committee Task Force on Banking Analysis for Monetary Policy, the Joint CEMLA-ECB-FRBNY-BCRP Conference on Financial Intermediation, Credit and Monetary Policy in Lima, and the Irish Economic Association Annual Conference for comments. Giannetti gratefully acknowledges financial support from the Jan Wallander and Tom Hedelius Foundation and the Riksbankens Jubileumsfond. The opinions in this paper are those of the authors and do not necessarily reflect the views of the European Central Bank or the Eurosystem.

1. Introduction

A tenet of modern macroeconomics is that monetary policy cannot achieve much with standard interest rate policies once rates reach the so-called zero lower bound (ZLB) (see, e.g., Keynes, 1936; Krugman, 1998; Eggertsson and Woodford, 2003; Christiano, Eichenbaum, and Rebelo, 2011; Correia, Farhi, Nicolini, and Teles, 2013; Rogoff, 2017). Banks would not be able to lower interest rates on deposits, their main source of funding, below zero, because market participants would rather hoard cash. Thus, when short-term interest rates approach zero, central banks would not be able to stimulate lending and demand by lowering short-term interest rates.

This paper challenges this conventional wisdom by showing that banks can charge negative rates on a significant portion of their deposits if they have sound balance sheets. A ZLB may instead be more binding for household deposits, which, being relatively small, may be easily withdrawn and held as cash.[1] However, corporations cannot conduct their operations (that is, pay wages and suppliers or receive payments from customers) without deposits as easily. Also, small firms, having fewer external financing alternatives, cannot risk jeopardizing their bank relationships and access to credit by withdrawing when banks charge negative yields on their deposits.

Consistent with these considerations, this paper shows, using confidential data, that sound banks in the euro area started to charge negative rates on corporate deposits after the European Central Bank (ECB)'s Deposit Facility Rate (DFR) became negative in June 2014. A few banks even lowered the interest rate on corporate deposits below the DFR. On average, interest rates became negative for around 5% of total deposits and around 20% of corporate deposits in the euro area as a whole. However, the incidence of negative rate deposits is unevenly distributed

[1] Banks are also able to raise fees on deposits, which makes lowering interest rates unnecessary when deposits are small. The question of whether banks can transfer negative rates on deposits is therefore crucial only for large deposits, such as corporate deposits.

over euro area countries and between banks within a country: in Germany, for example, deposits remunerated below zero account for 15% of total deposits and around 50% of enterprises' deposits, indicating that the effects are economically relevant. Independently from the aggregate magnitudes of the effects, it is of crucial importance to ascertain cross-sectional differences in banks' ability to charge negative rates on deposits, to understand the transmission mechanism below the ZLB.

We conjecture that the transmission from policy to deposit rates below the ZLB is not impaired if banks are sound for the very reasons that are believed to lead to safety traps (Caballero and Farhi, 2017). Negative policy interest rate periods coincide with low investment and consumption and with high demand for safe assets, meaning that depositors' preferences for sound banks are particularly strong (Calomiris and Kahn, 1991; Goldberg and Hudgins, 2001). Since economic agents with large cash holdings, such as corporations, cannot easily switch to paper currency, sound banks can respond to the demand for safe assets by offering negative interest rates on deposits.

We show that, consistent with this conjecture, banks in euro area countries less affected by the sovereign crisis are more likely to offer negative rates. Within countries, banks with lower CDS spreads and lower non-performing loans (NPL), in other words sound banks, are more inclined to offer negative rates once the ECB policy rates turn negative. In addition, the propensity of sound banks to offer negative rates became more pronounced as the ECB moved further into negative territory.

Importantly, sound banks do not experience deposit outflows even if they offer negative rates. On average, deposits increase during the negative interest rate policy (NIRP) period, as is consistent with high demand for liquidity and safe assets. Deposits appear to increase to a

somewhat larger extent in sound banks, which tend to offer negative interest rates on deposits during this period.

These findings have important implications for the transmission mechanism of monetary policy. The transmission mechanism is not impaired when banks are able to transfer negative rates on deposits. Since there has been no broad-based outflow of deposits from banks offering negative rates, the overall cost of funding of these banks has decreased. Thus, banks offering negative rates do not curtail lending. These results suggest that the ECB has not yet reached the reversal rate, at which the negative effect of a lower interest rate on bank profits may lead to a contraction in lending and economic activity (Brunnermeier and Koby, 2016).

More importantly, we highlight a novel *corporate channel* of monetary policy. Firms that have relationships with banks that offer negative rates on deposits are more exposed to negative rates if they hold lots of cash. These firms appear to lengthen the maturity of the assets to improve their profitability. Thus, they decrease their short-term assets and cash and increase their fixed investment.

In summary, our findings suggest that the constraints typically associated with a ZLB arise only if agents lack confidence in the banking system. Not only do sound banks pass the negative rates onto corporate depositors and keep lending, but the transmission mechanism is enhanced by the fact that firms with large cash-holdings more exposed to negative rates decrease their liquid asset holdings and invest more in fixed assets. Thus, in contrast to conventional wisdom, we find that, when banks are sound, the NIRP can provide stimulus to the real economy by influencing the behaviour of both banks and firms.

While we cannot exclude that for even lower policy rates corporations may start hoarding cash, our results indicate that the ECB has not yet met an effective lower bound (ELB). Our

findings are therefore consistent with the implications of theoretical models highlighting that for low levels of the elasticity of currency demand, monetary policy can be effective below the zero lower bound (Ronglie, 2016).

To the best of our knowledge, this is the first paper to question the existence of a ZLB for bank deposits. While a rich theoretical literature explores the effects of liquidity traps emerging when monetary policy approaches the ZLB, empirical studies on the effect of negative rates are scant because this was largely untested territory before 2014. Heider, Saidi, and Schepens (2019) highlight that banks with a higher proportion of funding from households' deposits have lower propensity to lend to safe borrowers in the syndicated loan market, when rates turn negative. Using aggregate Swedish data, Eggertsson, Juelsrud, Summers, and Wold (2019) also document that deposit and lending rates do not follow policy rates, when the latter turn negative.[2] However, Bottero et al. (2019) find that Italian banks with more liquid assets increased the supply of credit following the start of the NIRP.[3] Consistent with this lending behaviour, Altavilla, Boucinha, and Peydro (2018) and Lopez, Rose and Spiegel (2018) find that low and negative rates do not adversely affect bank profitability. Using a comprehensive sample of banks and firms, we show that the most important determinant of the strength of the pass-through is the bank's soundness and highlight positive effects of monetary policy below the ZLB on firm investment.

Our paper also contributes to a growing literature scrutinizing the transmission mechanism of monetary policy. A large literature shows that banks cut the supply of credit when monetary policy conditions become tighter: the so-called bank lending channel of monetary policy (e.g., Bernanke and Blinder 1988; 1992). Typically, weak banks, being financially constrained, are

[2] Evidence from Riksbanken reports, however, suggests that monetary policy has been effective even at negative policy rate levels (see Erikson and Vestin, 2019).
[3] Demiralp, Eisenschmidt, and Vlassopoulos (2017) and Basten and Mariathasan (2018) provide similar evidence for the euro area and Switzerland, respectively.

expected to have stronger reactions both to conventional and unconventional monetary policy interventions (Kashyap and Stein, 2000; Jimenez, Ongena, Peydro, and Saurina, 2012; Altavilla, Canova, and Ciccarelli, 2019). Below the ZLB, the high demand for safe assets implies that healthier banks are able to pass-through changes in policy rates onto depositors. Thus, the transmission mechanism is enhanced for stable banks.

2. Institutional Background

From 2012 to 2016, central banks in Switzerland, Sweden, Denmark, Japan and the euro area reduced their key policy rates below zero for the first time in economic history. These policies allow us to test the ZLB assumption, which is central to macroeconomic theory. In particular, the ECB, which is at the core of our analysis, reduced the DFR from 0 to -0.10% in June 2014, to -0.20% in September 2014, to -0.30% in December 2015, and to -0.40% in March 2016.[4] The DFR is the rate on the deposit facility, which banks use to make overnight deposits with the Eurosystem.

While the ECB also sets the rate on the marginal lending facility (MLF) and the rate on the main refinancing operations (MRO), the DFR becomes the key policy rate during periods of ample central bank liquidity provision, as unsecure money market yields, notably the Eonia fixing, move from values close to the MRO to values close to the DFR. The introduction of the ECB's expanded Asset Purchase Programme (APP) at the beginning of 2015 further increased the volume of excess liquidity in the system thereby reinforcing the key role of the DFR. While banks can adjust their individual holdings of excess liquidity by shifting into alternative assets, in the aggregate, the programme has increased liquidity in the system. A bank that has excess liquidity can either deposit it with the ECB or lend it to another bank in the system, and, for this

[4] The ECB further decreased the DFR to -0.50% in September 2019, which is outside our sample period.

reason, the interbank interest rate (Eonia) moves towards the DFR.[5] The interest rate at which banks are able to deposit their excess liquidity is therefore the relevant variable in determining banks' costs.

The euro area represents an ideal environment to explore whether a troubled banking system lies at the core of the problems generated by low interest rates for the transmission of monetary policy. Such a hypothesis has been advanced to explain the persistence of the liquidity traps in the US during the Great Depression, as well as in Japan, following the bubble burst of the late nineties (Bernanke, 1983; Krugman 1998). However, while in the US and Japan most banks were troubled (preventing cross-sectional analysis), the euro area features ample cross-sectional heterogeneity also driven by the different economic conditions of the countries where they operate following the sovereign crisis in Cyprus, Greece, Ireland, Italy, Portugal, Slovenia, and Spain (hereafter, the "stressed" countries).[6]

Starting in 2009, the stressed countries drifted into a severe crisis as anxiety about their high indebtedness made it increasingly difficult to refinance their outstanding debt. This deterioration in the countries' creditworthiness fed back into the financial sector due to banks' large domestic sovereign exposures (see, e.g., Acharya, Drechsler, and Schnabl, 2014; and Acharya and Steffen, 2015). The drop in the price of domestic sovereign bonds represented a negative valuation shock for the balance sheets of banks in the stressed countries. As a consequence, banks contracted lending causing large negative effects on domestic borrowers (Altavilla, Pagano, and Simonelli, 2017; Acharya, Eisert, Eufinger, and Hirsch, 2018). The sovereign crisis had opposite effects on

[5] Excess liquidity is defined as deposits at the deposit facility net of the recourse to the marginal lending facility, plus current account holdings in excess of those contributing to the minimum reserve requirements. In periods of neutral liquidity allotment, i.e. the liquidity management framework of the Eurosystem used before the crisis, the unsecured overnight interbank rate (Eonia) fluctuated around the MRO rate, thereby making this rate the key policy interest rate for the transmission of monetary policy to the money market.

[6] We define as "stressed" the countries whose 10-year sovereign yield exceeded 6% (or, equivalently, four percentage points above the German yield) for at least one quarter in our sample period.

German government bonds and the bonds of countries that were perceived as financially sounder, whose prices surged as a result of investors' flight to safety. Therefore, most banks in non-stressed countries were less affected than banks in stressed countries by the sovereign crisis. The resulting large heterogeneity in banks' health at the beginning of the NIRP enables us to explore how these cross-sectional differences affect bank reactions to negative rates.

3. Data

Our empirical analysis relies on several data sources. We obtain bank level information from the Individual Balance Sheet Indicators (IBSI), a proprietary database maintained by the ECB, which reports at monthly frequency the main asset and liability items of over 300 banks resident in the euro area from August 2007 to September 2018. This dataset provides information on the amount of outstanding loans, household and corporate deposits, and other relevant bank balance sheet information.

We complement IBSI with information on CDS spreads, which we obtain from Datastream, and on deposits and lending rates from the Individual Monetary and Financial Institutions Interest Rates (IMIR), another proprietary dataset maintained by the ECB, which contains information on deposits and lending rates charged by banks for different maturities and different loan sizes.

Panel A of Table 1 summarizes the rich set of bank characteristics that we obtain from merging the above datasets. Covering a total of 202 banks, our sample provides comprehensive coverage of banks in the euro area and has more extensive coverage than the stress tests of 2014, which only covered about 100 banks.

We also obtain firm level data from Bureau Van Dijk's Orbis, which provides financial information for listed and unlisted companies worldwide. Importantly, Orbis provides information on the names of the most important banks of a firm in the following 12 euro area countries: Austria, Estonia, France, Germany, Greece, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, and Spain. We exclude euro area countries, such as Italy, for which firms do not report the main banks in Orbis.

As noted by Giannetti and Ongena (2012) and Kalemli-Ozcan, Laeven, and Moreno (2018), Orbis obtains information on firms' main banks from Kompass, which collects data using information provided by chambers of commerce and firm registries, but also conducts phone interviews with firm representatives. Firms are also able to voluntarily register with Kompass. Kompass directories are mostly sold to companies searching for customers and suppliers. Hence the banks reported are most likely to be the ones in which firms have deposits and receive payments. Since they tend to have numerous customers and suppliers, firms are unlikely to switch these banks. Firms are also likely to be reluctant to switch banks because they typically obtain credit from these banks besides having deposits. In fact, banks' ability to take deposits and deal with the customers' payments is considered to be at the origin of banks' information advantage (Fama, 1985). Fears of endangering lending relationships may make firms particularly reluctant to withdraw deposits from sound banks. Furthermore, main banks also tend to provide firms with a wide range of services besides deposits and credit (Santikian, 2014), which further increases switching costs. Thus, even if we do not observe firms' actual deposits and outstanding credit, we expect firms to have both deposits and credit lines with their main banks.

Our final firm level sample consists of an unbalanced panel of 465,860 firms for 11 years from 2007 to 2017, and 89 banks, 715 4-digit NACE2 core industry classifications, and 27,598 city locations.[7] Panel B of Table 1 summarizes the main variables of the firm-level dataset.

Overall, our sample is highly representative of aggregate and cross-sectional patterns in the euro area. In this respect, it allows us to analyze the real effects of monetary policy, relying on a sample with unprecedented coverage when considering the effect of the financial crisis and the ECB's policies. Other work, which has attempted to do so considering several countries in the euro area (see, for instance, Acharya, Eisert, Eufinger, and Hirsch, 2019; Heider, Saidi, and Schepens, 2019) relies on borrowers in the syndicated loan market, thus considering only few large firms.

While we do not exploit direct issuance of loans in the syndicated loan market, we are able to evaluate the real effects of monetary policy in a much broader and representative sample.[8] We also do not observe how much deposits or credit a firm has with a particular bank. We assume that firms that report institutions that offer negative rates on deposits as main banks are more exposed to the NIRP.

Not observing actual credit exposure is not a big limitation in our context. As will be clear later, there is limited evidence that the real effects of the NIRP arise from more credit. Rather, firms with ex ante large cash holdings decrease their current assets and cash holdings and invest more in tangible and intangible assets if they face negative rates. This suggests that, under the NIRP, there exists a direct corporate channel in the transmission mechanism of monetary policy. Our firm-level dataset is well suited to explore this mechanism.

[7] The composition and construction of our sample is similar to Kalemli-Ozcan, Laeven, and Moreno (2018).
[8] Syndicated loans extended to firms in the euro area represent less than 10% of the outstanding amount of bank loans. Our sample of banks covers, instead, around 70% of the total bank loan outstanding in the euro area.

4. The Transmission Mechanism at Negative Rates

4.1 Stylized Facts

Figure 1 describes the evolution of the main sources of financing of euro area banks. In the aggregate, deposits are the most important source of financing for European monetary financial institutions (MFIs) and have been growing even during the period of negative interest rates. The importance of deposits for bank funding in Europe makes concerns regarding the impairment of the transmission mechanism of monetary policy at negative rates particularly relevant. Banks being fearful of losing their most important source of funding may be wary of lowering the interest rate on deposits below zero (e.g., Heider, Saidi, and Schepens, 2019; Eggertsson, Juelsrud, and Wold, 2017). Negative rates could then impair bank profitability leading to a contraction in lending.

Figure 2 shows that there is a wide range of bank reactions to the drop in the DFR below zero. It reports the mean interest rate on the deposits of non-financial corporations within different percentiles. We distinguish between interest rate adjustments on the stock of all deposits (Panel A) and interest rates on new deposits with agreed maturity up to 1 year (Panel B). Not only do a few banks appear to offer negative rates on deposits following the ECB's decision to lower the DFR below zero, but a few also charge interest rates that are below the DFR on new deposits from non-financial corporations, as shown in Panel B of Figure 2.

Even more banks lowered the interest rates on deposits of non-financial corporations below zero following the extension of other unconventional monetary measures, such as the APP and additional cuts of the DFR at the end of 2015. Thus, while the adjustment is gradual, banks' propensity to offer negative rates on deposits increases when the ECB moves further into negative territory. This is unsurprising as in June 2014, when the ECB started to move into

negative territory, most banks could still adjust deposit interest rates without having to offer negative rates. More importantly, the evidence that banks' reaction is stronger as the ECB moves more into negative territory suggests that the NIRP has yet to meet an ELB. Rather it appears that the incentives to lower interest rates on deposits below zero may have been enhanced by the large liquidity injections that started at the beginning of 2015 with the implementation of the APP. Also, the NIRP may have become more credible with the further interest rates cut below the ZLB.[9]

The conventional wisdom that interest rates on deposits do not fall below zero appears to still hold for the median bank in the euro area. Nevertheless, the interest rates appear to turn negative on an economically significant fraction of deposits of banks in the euro area, as shown in Panel A of Figure 3. Panel B of Figure 3 shows that there is a gradual increase in the proportion of deposits with negative rates.[10] While at the end of 2014, a few months after the ECB had lowered the DFR below zero, less than 10 percent of the deposits of non-financial corporations in the euro area had negative rates, this proportion increases to about 20 percent in 2018.

Overall, when including household deposits, the proportion of deposits with negative rates remains below 10 percent (as shown by the proportion of deposits of the non-financial private sector), indicating that there could be important cross-sectional differences in the transmission of monetary policy. Therefore, irrespective of the aggregate proportion of deposits affected, to understand under what conditions the NIRP can be effective, it is important to ask which banks

[9] Anecdotal evidence from Denmark and Switzerland suggests that the gradual tendency to lower interest rate on deposits below zero, as it becomes clear that policy rates are likely to persist below zero for long periods of time, is not limited to the euro area.

[10] Around 80% of the deposits of non-financial corporations in the euro area are overnight deposits. The segment of deposits with agreed maturity has been progressively shrinking as monetary policy interventions flattened the yield curve. Lower interest rates at longer maturities eliminated the advantage of holding deposits with agreed maturity and consequently firms opted for overnight deposits. All the effects we highlight can therefore be ascribed to overnight deposits.

are able to lower the interest rates on deposits below zero and whether differences in bank behaviour have any real effects.

Figure 4 offers a few initial insights on this issue. It plots the percentage of banks with negative rates over time in stressed and non-stressed countries, respectively. It shows that non-financial corporations' deposits with negative rates increase considerably over the sample period in non-stressed countries, while they remain relatively stable and at a much lower level in the stressed countries.

Because sovereign debt problems in stressed countries are intertwined with the state of the banking system, this evidence suggests that bank health may play a significant role in the transmission of monetary policy when rates turn negative.

4.2 Which Banks Decrease their Deposit Rates below Zero?

The descriptive evidence discussed so far indicates that some banks especially in non-stressed countries gradually decrease the interest rate offered on deposits of non-financial corporations below zero. Table 2 explores the characteristics of the banks that pass through negative rates to their clients. We consider how bank characteristics in our monthly panel are associated with the probability that a bank starts charging negative rates after June 2014. Since we are interested in cross-sectional differences, we cluster errors at the bank level. We also cluster errors at the time level to account for the fact that banks respond to the same monetary policy shocks. For the same reason, we include time fixed effects in all specifications.

Column 1 confirms the evidence in Figure 4 that on average banks in non-stressed countries are more likely to offer negative rates on the deposits of non-financial corporations. The effect is not only statistically significant, but also economically large. The probability is expressed in

percentage points. Overall, during our sample period, which starts in 2007, well before the NIRP, 0.8% of the observations correspond to banks that charge negative rates. Being in a stressed country thus decreases the probability of charging negative rates by over 100% relative to the sample mean.

This effect appears crucially related to bank health, which we proxy in columns 2 and 3, respectively, using NPL and the CDS spread. Only banks that are more solid, as captured by a lower proportion of NPL or lower default risk, are able to offer negative interest rates on the deposits of financial corporations. The fact that weak banks tend to offer higher rates on deposits is consistent with previous literature (e.g., Martinez Peria and Schumkler, 2001). Crucially, we document for the first time that the risk premium can become negative for the safest banks indicating that these banks can pass negative rates on to their corporate depositors.

The effects are both statistically and economically significant. A one-standard-deviation increase in the share of NPL (amounting to an increase of 10 percentage points) implies a decrease in the probability of starting to charge negative rates of 0.5 percentage points, which is an over 60% decrease relative to the average of the sample. Similarly, a one-standard-deviation increase in CDS spreads decreases the probability that a lender starts charging negative rates during the sample period by almost 40%.

The economic relevance of our proxies for bank health is even more evident in Figure 5, in which we explore the probability that the CDS spread and the NPL ratio are associated with negative interest rates on deposits dynamically, by estimating repeated cross-sections. It is evident that the effect becomes particularly large in the months following the fourth interest rate cut below zero in March 2016. Thus, this figure confirms that the effects of the NIRP are gradual and that the ECB has yet to meet an ELB.

In the rest of Table 2, we control for time-varying bank characteristics and in addition include country fixed effects in columns 6 and 7. Our conclusion that bank health is an important determinant for the pass through of monetary policy on depositors when rates turn negative is also robust to the inclusion of bank fixed effects (column 8 and 9).

Interestingly, more profitable banks have a lower probability of offering negative rates on non-financial corporations' deposits suggesting that banks that are less able to absorb the interest rate shock pass it on to their clients in the attempt to preserve their profitability.

In columns 6 to 9, we also control for the deposit ratio, a variable that plays a significant role for the transmission mechanism when rates turn negative in previous literature (Heider, Saidi, and Schepens, 2019). The deposit ratio appears unrelated to banks' probability of offering negative rates on corporate deposits. This is the case whether we consider the proportion of corporate deposits over bank assets (columns 6 to 8) or the proportion of total deposits over bank assets (column 9). The effect of the proportion of NPL is qualitatively and quantitatively unaffected when we include this control.

We also control for the banks' excess liquidity. Consistent with the fact that the profits of banks with high excess liquidity are more negatively affected when the DFR drops, these banks are more likely to offer negative rates. In our sample, healthier banks tend to have higher excess liquidity and may therefore be better able to offer negative rates on deposits. The effect of our proxies for bank health is however unchanged when we control for excess liquidity in column 6, indicating that, holding constant incentives to offer negative rates to safeguard profits, healthy banks are able to do so to a larger extent.

Such an intuition is confirmed in Column 7, which illustrates in a more direct way the importance of bank health. The negative effect of a bank's NPL on the probability of charging

negative rates becomes stronger with the bank's excess liquidity. In principle all banks with high excess liquidity would want to offer negative rates on deposits. The negative coefficient on the interaction term between NPL and excess liquidity, however, suggests that unhealthy banks are less able to do so, as is consistent with our earlier interpretation of the empirical evidence.

Overall, Table 2 suggests that, when policy interest rates turn negative, bank health is crucial for the transmission of monetary policy. This conclusion contrasts with what emerges for the transmission of monetary policy to lending rates when policy rates are positive, as typically less healthy banks, whose balance sheets and borrowing capacity benefit to a larger extent, are found to respond more to monetary policy interventions by reducing lending rates (e.g., Jimenez, Ongena, Peydro, and Saurina, 2012; Altavilla, Canova, and Ciccarelli, 2019).

One may wonder whether less healthy banks and banks in stressed countries rely to a larger extent than other banks on fees and commissions as a way to compensate for the higher interest rates on deposits they offer. Non-interest income is typically a low share of bank revenues, especially in the euro area, and is unlikely to substitute for interest rate pass through, especially for large corporation deposits. Table 3 relates bank characteristics to the ratio of fees and commissions over the deposits of non-financial corporations before and after the implementation of the NIRP. We also present results in which we divide fees by the total deposits. Fees do not appear to be a substitute for deposit rates for less sound banks. Only banks with high excess liquidity appear to increase their deposit fees after the implementation of the NIRP (column 8), as is consistent with the fact that their profitability is more negatively affected by the negative rates. NPL and the other measure of bank health do not appear to be related to the extent to which banks charge fees. Finally, banks with a large proportion of deposits appear to charge lower fees and do not change their behaviour after the implementation of the NIRP.

Overall, while all banks appear to be able to increase fees on deposits, bank health appears to be crucial for the transmission of monetary policy to deposits rates below the zero lower bound. The transmission mechanism is however not impaired. This conclusion is reinforced by the evidence in Figure 6, where we report the correlation between deposit rates offered by each bank in the sample during a month and the DFR. We distinguish between normal periods and periods of negative interest rates. It is evident from the reported estimates of a spline regression that the deposit rates are more strongly related to the DFR in periods of negative rates. The effect arises not only from banks that lower the interest rate on deposits below zero, but also from the ones that offer high interest rates and progressively lower them. It is thus relevant to ask how the NIRP is transmitted to the real economy.

5. Effects of Negative Rates on Bank Assets and Liabilities

The evidence so far indicates that sound banks succeed in passing negative rates through to their corporate depositors. Figure 7 shows how negative rates are associated with the evolution of deposits and credit. It appears that some banks are able to offer negative rates on their deposits without experiencing withdrawals. Following the start of the NIRP, banks that offer negative rates on corporate deposits, if anything, experience higher deposit growth than other banks.

Table 4 shows that deposit growth is higher at banks that offer negative rates on deposits. The effect of the negative rates bank dummy is statistically insignificant up to September 2015 (column 1), but becomes positive and statistically significant in columns 2 and 3, where we consider the effect on deposits up to September 2018. Consistent with the conjecture that bank health is important, we find that high-NPL banks experience lower deposit growth in the months

following the implementation of the NIRP. In column 5, we find no evidence that negative rates banks had different deposit growth in the period leading to the NIRP, between 2012 and 2014.

Because sound banks can pass on negative rates without experiencing withdrawals, the NIRP may have succeeded in lowering funding costs. The lower funding costs and the increase in the opportunity cost of holding excess reserves with the central bank could consequently stimulate lending. Evidence in Figure 7 suggests that banks offering negative rates on deposits indeed lend more.

One may wonder whether differences in lending are really driven by banks' supply of credit or if instead banks that offer negative rates on deposits have stronger demand for credit. Stronger demand for credit could arise from the fact that these banks are healthier and may therefore serve firms with stronger growth opportunities (Schwert, 2018).

Figure 8 suggests that differences in bank lending are not driven by differences in the demand for credit faced by different banks. We plot banks' self-reported estimates of the changes in demand for credit they face, which we obtain from the euro area Bank Lending Survey (BLS). We distinguish between banks that never offer negative rates on deposits and banks that sometimes do so to evaluate whether banks offering negative rates on deposits lend less because their customers demand less credit. We find no evidence that this is the case. The evolution in the demand for credit is pretty similar for the two groups of banks. If anything, the demand for credit from banks that never offer negative rates seems to have grown faster. The quality of borrowers demanding credit from negative rates banks may be higher explaining the different propensity to extend bank loans. For these reasons, in what follows, we use firm level data to explore the effects of negative rates banks on borrowers' ability to access bank loans.

6. The Real Effects of Negative Rates

6.1 Main Results

Negative rates may affect firms through their assets and liabilities. Banks that manage to transfer negative rates to their depositors may be more inclined to extend credit. Negative rates can however affect firms also through their asset composition because they increase the cost of holding deposits. When interest rates on deposits are sufficiently low, the cost of holding cash and procrastinating investment due to precautionary behaviour may increase to the point that firms might start investing (Bernanke, 1983b). Put differently, negative rates may give firms incentives to take more risk by investing. We label this mechanism of transmission as the corporate channel of monetary policy.

Hereafter, we use firm level data to evaluate both mechanisms. Importantly, our large panel of firms allows us to control for differences in shocks faced by different firms similarly to Acharya, Eisert, Eufinger, and Hirsch (2018), who in turn apply a modified Khwaja and Mian (2008) methodology. In particular, we conjecture that shocks affect firms in a cluster, based on industry and location. Overall, our sample includes firms in 715 industries and 27,598 cities. We saturate our specifications including interactions of four-digit industry and time fixed effects as well as city and time fixed effects. Our identifying assumption is that any shocks affect firms in the same cluster similarly.

Table 5 explores whether more lending by banks offering negative rates on corporate deposits had positive real effects. Column 1 tests whether following the NIRP (as captured by the dummy variable *Post*) firms that report a relationship with at least one bank offering negative rates have higher access to financial loans. We include firm fixed effects to absorb persistent differences in

leverage and interactions of country and year fixed effects to control for country level shocks affecting firms' credit-worthiness, demand for credit etc.

The estimates in column 1 indicate a positive effect of the NIRP on access to financial debt for clients of banks that transfer the negative rates on to their corporate depositors. The leverage appears to increase by about one percentage point for borrowers of these banks following the NIRP. The result is robust as we saturate the equation with an increasing number of fixed effects, including interactions of industry, country, and time effects in column 2 and also interactions of city and time effects in column 3. These results suggest that demand shocks related to industry or geographical growth opportunities are unlikely to drive our findings and that the increase in the use of financial debt by firms associated with banks offering negative rates is likely to be supply-driven.

In columns 4 to 6, however, we fail to identify an analogous positive effect on investment, measured as the annual growth rate of fixed assets. This finding would suggest that while negative rates banks extend more credit, there are no real effects associated with the lending channel. Firms facing uncertain times prefer to hold cash on their balance sheet rather than investing or use loans to meet their past obligations.

Nevertheless, the NIRP may have real effects. Because firms typically also have deposits at their main banks, we can explore whether there are any differential effects related to the fact that clients of banks offering negative rates on deposits are taxed on their deposits. This channel may have a large impact on firm behaviour. To evaluate this effect, we consider a firm to be highly exposed to the NIRP if it has high cash holdings, as measured by the ratio of current assets, and at least one bank that starts offering negative rates on deposits following June 2014, when the DFR first turns negative. We define a variable, *Exposure*, which captures the proportion of

current assets, that is, cash holdings, of firms associated with banks that offer negative interest rates on deposits. These firms are taxed for their cash holdings and not only may they be less inclined to borrow when the NIRP starts, but they may also want to rebalance their assets to decrease their cash holdings and avoid the negative rates.

When we include *Exposure* and the interaction of *Exposure* with *Post* in our empirical models in columns 7 to 9 of Table 5, we find that firms with higher cash holdings react differently to the NIRP if they are associated with at least one bank offering negative rates. Importantly, high exposure firms rebalance their assets by investing more (column 8). Columns 7 and 9 show that firms, which are associated with negative rates banks and have low cash holdings before the implementation of the NIRP, tend to increase their leverage and their proportion of current assets, respectively. This indicates that these firms have greater access to credit and liquidity thanks to their relationships with banks that provide more loans. Quite to the contrary, firms with ex ante high cash holdings that are associated with negative deposit rate banks decrease their financial loans (column 7) and current assets (column 9) and increase their investment.

Importantly, this result is unlikely to be driven by the fact that firms with more current assets are different, as we control for the differential effect of the proportion of current assets before and after the NIRP. We only capture the differential reaction of firms that have high current assets and are associated with negative rates banks to the NIRP.

Since the real affects appear to be driven by the increase in the cost of holding cash, rather than by the increase in access to financial loans, in what follows, we concentrate on the direct effects of negative rates on deposits, abstracting from the lending channel. We label this channel as the *corporate channel of monetary policy*. To abstract from the lending channel, we include in all specifications interactions of bank and time fixed effects. We thus fully absorb banks'

increased ability to provide credit, and explore how the clients of a given lender react to the NIRP depending on their cash holdings and the lender's propensity to charge negative rates on deposits.

Columns 1 to 3 in Panel A of Table 6 provide further evidence on our conjecture that firms with more cash holdings, which are subject to negative rates on their deposits, rebalance towards fixed assets by investing more. We continue to find that firms that turn out to have higher exposure to the NIRP increase their investment after we control for interactions of bank and time fixed effects. The effect is not only statistically, but also economically significant. A one-standard-deviation increase in current assets, increases investment for the average firm associated with a negative rate bank by over 20%.

Column 2 allows for the possibility that these firms are in industries that have higher investment opportunities. We thus include interactions of bank, time, and industry fixed effects. We continue to find that high exposure firms invest more and the effect is, if anything, doubled. In the same spirit, column 3 allows for the possibility that some firms are in industries and cities experiencing more investment opportunities. Including interactions of bank, time, industry, and city fixed effects further increases the positive effect of the NIRP on the investment of firms with high cash holdings and banks offering negative rates on deposits.

So far, we have considered all the current assets of a firm to be exposed to the NIRP if the firm reports at least one bank offering negative rates. Since the sample includes firms reporting more than one bank, in column 4, we define exposure considering the proportion of banks offering negative rates that a firm reports relationships with. This modification of the *Exposure* variable leaves our results qualitatively unchanged. Our results are similarly unchanged if we focus on the subsample of firms reporting only one bank (column 5).

Panel B explores whether there are differences in the reaction between small and large firms. Large firms need more working capital and may therefore have a harder time converting their deposits to cash. On the other hand, small firms rely more on close relationships with their banks to maintain access to credit. For the same reason, they may be at least as reluctant as large firms to withdraw their deposits, because doing so would be likely to result in worse relationships with their banks. In column 1 and 2, we consider, respectively, small and large firms (defined as firms with total assets above and below the median). If anything, small firms with high cash holdings appear to have an even stronger reaction than large firms, suggesting that considerations related to the stability of bank-firm relationships are important.

6.2 Endogeneity of Cash-Holdings

A possible concern with our results so far is that firms with high cash-holdings are inherently different. While the control sample includes high cash-holding firms with banks that do not offer negative rates on deposits, the concern remains that the control for current assets does not fully capture non linearities in the effect of cash holdings.

To address this concern, Panel C of Table 6 concentrates only on high cash-holding firms, defined as firms with current assets in the top tercile and repeats the tests in Panel A. It shows that our results are robust and if anything become stronger when we concentrate on a subsample of firms that are less heterogeneous with respect to their current assts. This mitigates the concerns that omitted firm characteristics related to their cash-holdings may drive our findings.

A related concern is that high cash-holdings firms associated with negative rates banks could differ along some unobserved dimensions and always invest more. To show that we are not capturing pre-existing trends, Panel A of Figure 9 shows the investment patterns of high and low

cash-holdings firms that are associated with negative rates banks. In particular, we plot the investment of firms with cash-holdings in the top and the bottom decile. It is evident that differences in investment behaviour emerge only after the start of the NIRP and become more accentuated over time, broadly consistent with the timing of the changes in the interest rate on corporate deposits. Crucially, Panel B shows that analogous changes in investment behavior do not emerge for firms that are not associated with negative rates banks.

6.3 Mechanisms

This subsection explores whether changes in firms' financial policies are consistent with the corporate channel of monetary policy. In particular, if greater investment is indeed due to firms rebalancing their assets away from cash we should observe that firms cash holdings, as proxied by their current assets, decrease.

Table 7 performs tests similar to Panel A of Table 6 considering the proportion of current assets. Consistent with the corporate channel of monetary policy, the increase in investment noted in Table 6 is accompanied by a decrease in firms' current assets. Further supporting our interpretation that the real effects of the NIRP arise from high cash holding firms' asset rebalancing, Table 8 shows that the increase in investment is driven by an increase in tangible and intangible assets, but that overall firms' total assets are unaffected. In results that we omit for brevity, we also find that firm employment is unaffected.

Table 9 corroborates our interpretation that the effects of NIRP on high-exposure firms are not through financial loans. It shows that current liabilities are unchanged and the cost of debt if anything increases, even if the effect estimated in Panel B of Table 9 is economically small.

One may wonder whether the changes in investment we observe are optimal or if rather the NIRP allows inefficient firms to invest to a larger extent. To answer this question, Table 10 considers how different measures of firm profitability vary after the start of the NIRP for firms with high cash holdings that are clients of banks offering negative interest rates, that is, for the firms that we have shown to invest more.

The different indicators of profitability show that after the adoption of the NIRP, the performance of firms with high cash holdings associated with banks offering negative rates improves. While the effect of the interaction between *Exposure* and *Post* on the *ROA* is not statistically significant at conventional levels, in column 2, a one-standard-deviation increase in current assets translates in a 9% increase in ROE for the average firm with a bank offering negative rates on deposits. The effects are statistically and economically significant also for other measures of profitability reported in the rest of the table.

These findings suggest that before the adoption of the NIRP, precautionary behaviour in the face of an uncertain economic environment led firms to hoard liquidity and apply a too high discount rate on investment opportunities. Negative interest rates on deposits increase the cost of holding liquid assets and tilt the decision in favour of investing. This leads to increases in profitability, which were previously constrained by the decision of holding back investment opportunities because of looming uncertainty (Bernanke, 1983).

Finally, Table 11 explores whether the corporate channel of monetary policy is specific to negative interest rate environments or is relevant following any interest rate cut. In particular, we test how high current assets and an association with banks that eventually offer negative rates on deposits (after NIRP starts) affected investment after the policy rate cuts in the period 2009-2011

and during the low, but positive, DFR period from 2012 to 2013. It appears that high exposure firms increase investment to a larger extent only following the NIRP.

These estimates are consistent with the idea that the opportunity cost of holding liquid assets becomes too high when policy interest rates are lowered to a sufficiently large extent. Increases in the cost of holding deposits in turn stimulate investment through the asset rebalancing channel, which we highlight. These results mirror the findings of Bottero et al (2019), who show that banks with high excess liquidity increase lending in times of negative rates, but not in low rates periods.

In summary, the NIRP has real effects that do not seem to be driven by access to financial loans or borrowing costs. Instead, firms with high cash holdings associated with negative rates banks invest more thus stimulating the real economy.

7. Conclusions

This paper explores the transmission mechanism of monetary policy below the ZLB, a topic that is under-researched from an empirical point of view, because central banks in Switzerland, Sweden, Denmark, Japan, and the euro area have only recently moved their policy rates into the negative territory. However, breaking the so-called ZLB is likely to become more relevant in the future, given the secular trend of lower interest rates around the world (especially in advanced economies).

We show that sound banks are able to pass negative rates on to their corporate depositors without experiencing a contraction in funding. While banks offering negative rates provide more credit than other banks, the real effects of the NIRP on firm investment are primarily associated with firms rebalancing their assets. Firms with high current assets at banks offering negative

rates appear to increase their investment in tangible and intangible assets and to decrease their liquid assets to avoid the costs associated with negative rates.

Overall, our results suggest that the transmission mechanism of monetary policy is not impaired below the ZLB, even though it works differently. In normal times, monetary policy interventions are transmitted mostly by weak banks, whose financial constraints are relaxed to a larger extent, when policy interest rates drop. However, when the ZLB has been hit, demand for safe and liquid assets is extremely high. Healthy banks are thus better able to transfer negative rates on their depositors more than other banks. Having higher balance sheet capacity, healthy banks are able to lend more.

Our results also imply that the positive effects of the NIRP on the economy are stronger if banks are healthy and can pass negative rates on deposits. Mechanisms aiming to preserve bank profitability in periods of negative rates may therefore be particularly desirable. With this goal, central banks in some jurisdictions (e.g., Japan and Switzerland) have also introduced a tiering system exempting some of the bank holdings of liquidity from negative rates in order to mitigate any consequences on bank profitability. A bank's savings associated with such a scheme would depend on the amount of excess liquidity it holds and the share of this liquidity exempted from the charge. With such a tiering system, which has been recently introduced in the euro area, the mechanisms underlying our results would not be materially affected, as only a share of the excess liquidity is exempted. To the extent that these mechanisms improve bank health even more banks may be able to transfer negative rates on corporate deposits thus indirectly stimulating investment.

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Figure 1: Main Liability Items of Euro Area Banks

The figure reports the aggregate outstanding liabilities in EUR trillions of euro area banks over time.

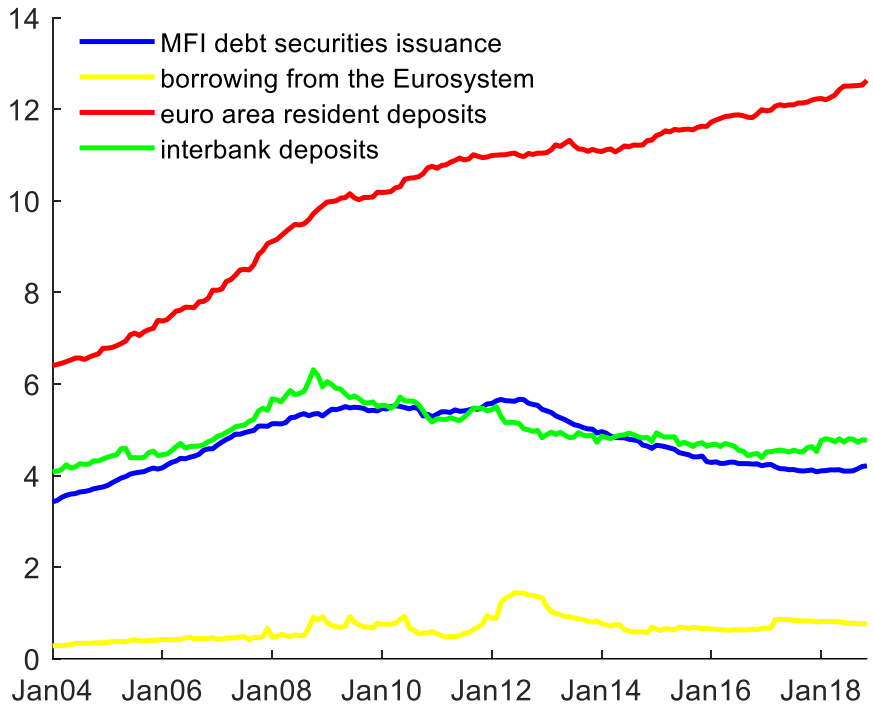
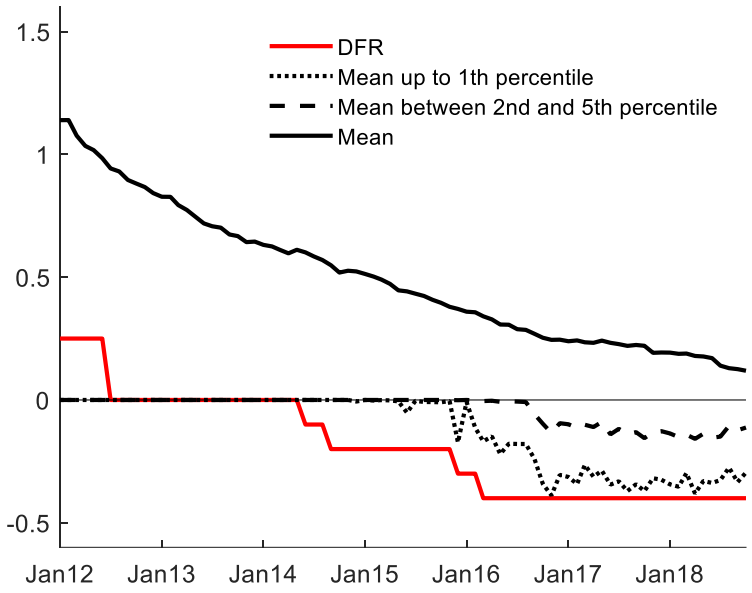


Figure 2: Evolution of Deposit Rates

The figure shows the evolution of the ECB's deposit facility rate (DFR) and the interest rates offered by banks on non-financial corporations' deposits. We the mean interest rate on the deposits of non-financial corporations distinguishing between different percentiles. Panel A reports the deposit rates on the outstanding amounts averaged across all deposit segments. Panel B reports the deposit rates on new deposits of non-financial corporations with agreed maturity up to 1 year.

Panel A: Stock of Deposits



Panel B: New Deposits with Agreed Maturity up to 1 year

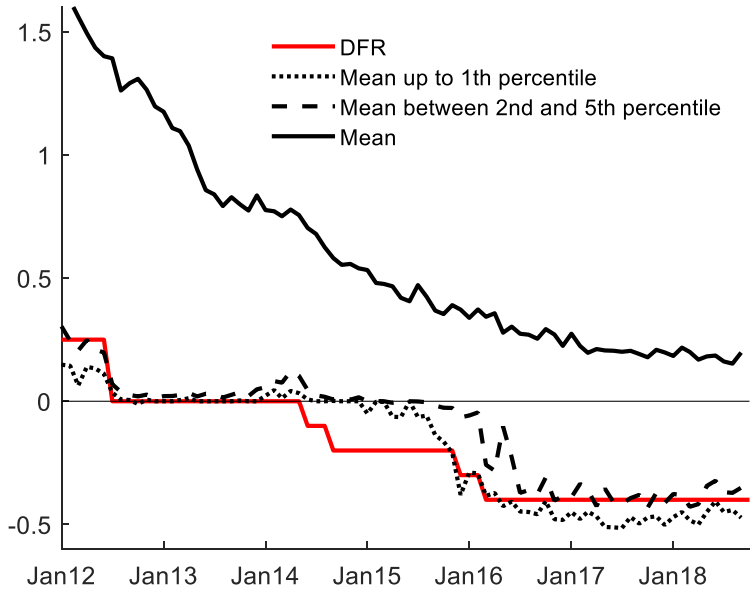
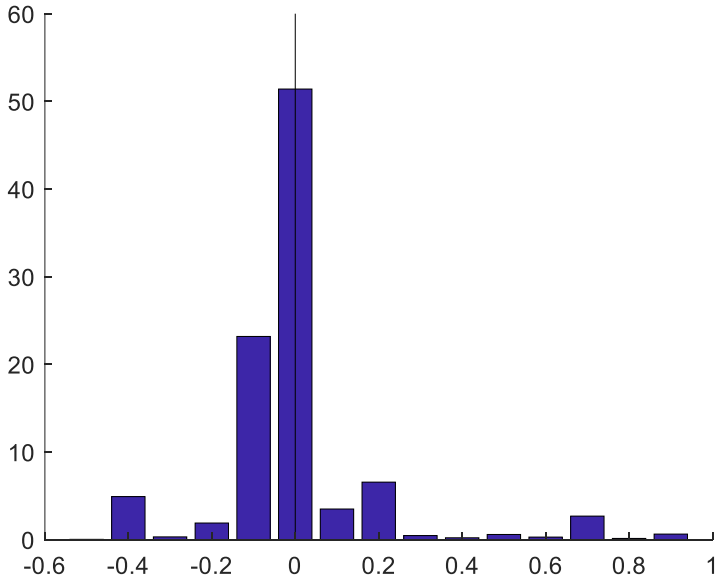


Figure 3: Deposits with Negative Rates

Panel A shows the distribution of deposit rates to NFCs across individual MFIs in January 2019, weighted by deposit volumes; the x-axis reports the deposit rates in percentages per annum, the y-axis indicates the frequencies in percentages, weighted by volumes. Panel B shows the proportion of deposits on which banks offer negative rates over time, distinguishing between proportion of deposits to non-financial corporations and proportion of deposits to the non-financial private sector.

Panel A



Panel B

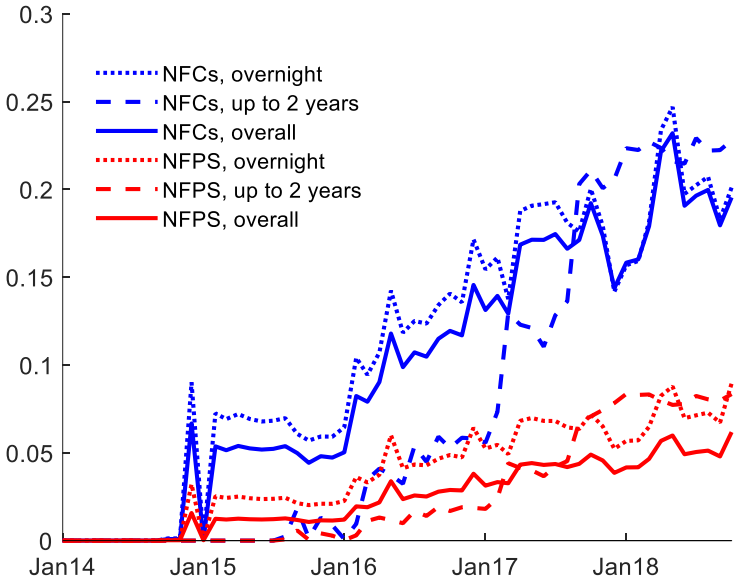


Figure 4: The Proportion of Negative Rates Banks in Stressed and Non-Stressed Countries

The figure shows the percentage of banks that report offering negative rates on average across all deposit segments distinguishing between stressed countries and non-stressed countries. The blue vertical lines indicate the four episodes of DFR cuts below zero.

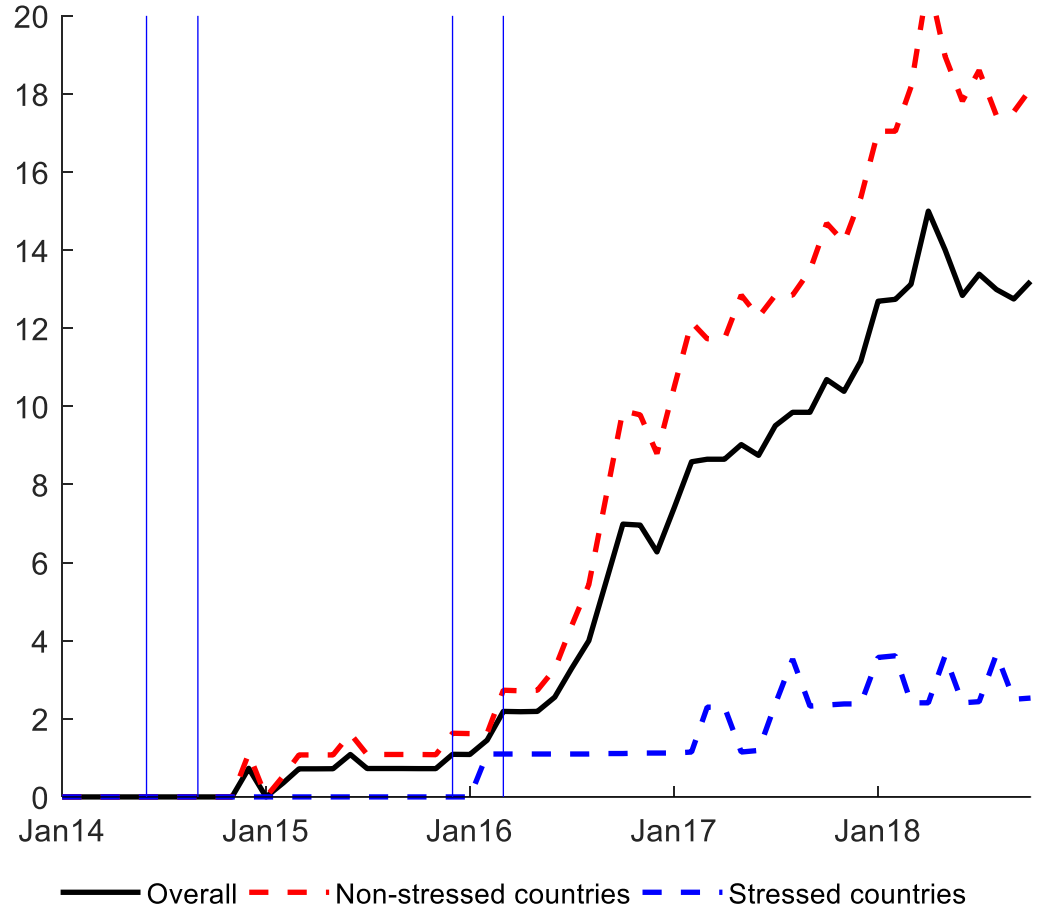
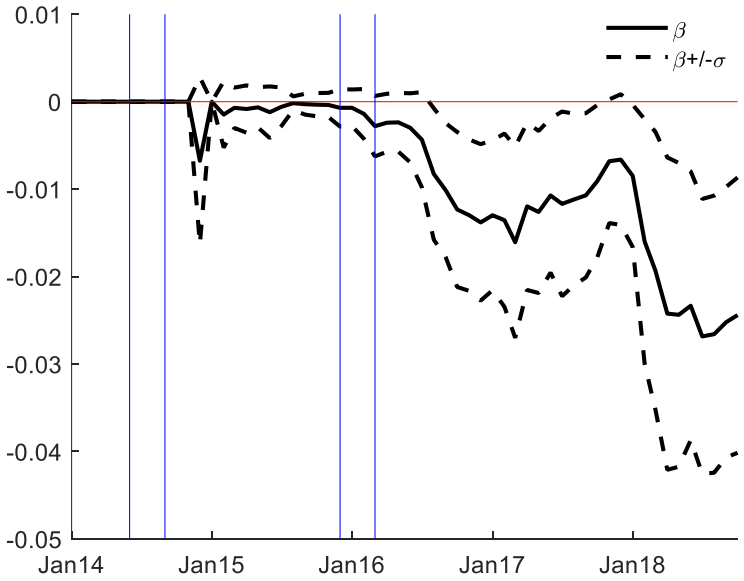


Figure 5: Estimated Cross-sectional Differences in the Probability of Negative Rates

The figure illustrates the dynamic effects of our proxies for bank health on the probability that a bank offers negative rates on non-financial corporations' deposits. We plot the estimated coefficient on the CDS spread (Panel A) and the NPL ratio (Panel B) of cross-sectional regressions in which the dependent variable is a categorical variable that takes value equal to 100 if a bank charges negative rates on deposits at a given point in time. We also plot the confidence intervals. The blue vertical lines indicate the four episodes of DFR cuts below zero.

Panel A

Effect of CDS on probability of negative rates



Panel B

Effect of NPL on probability of negative rates

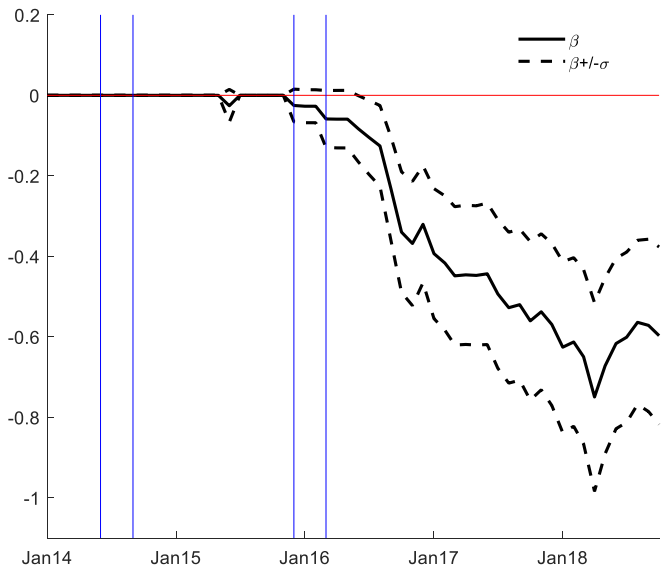


Figure 6: Pass-Through at Positive and Negative Rates

We report the coefficient of a spline regression of individual banks deposit rates on the DFR and the interaction between the DFR and a dummy variable capturing whether the DFR is negative. The spline regression includes bank fixed effects. We also report the observations for banks' deposit rates associated with different levels of the DFR.

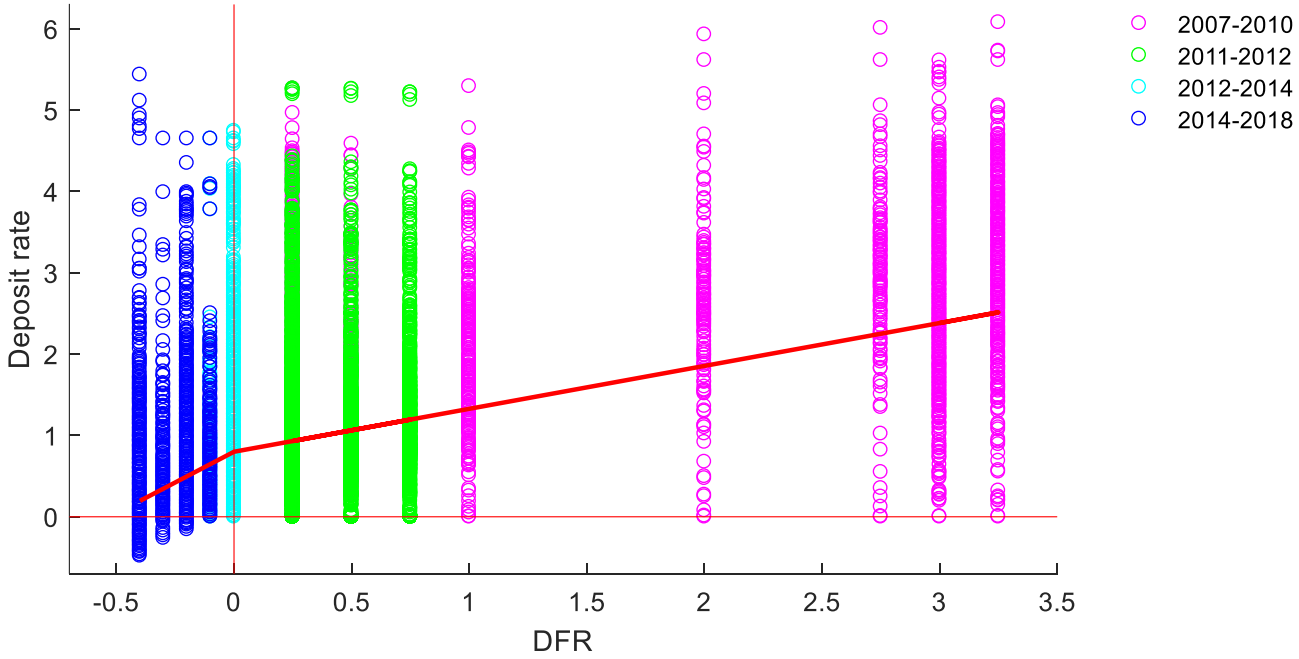
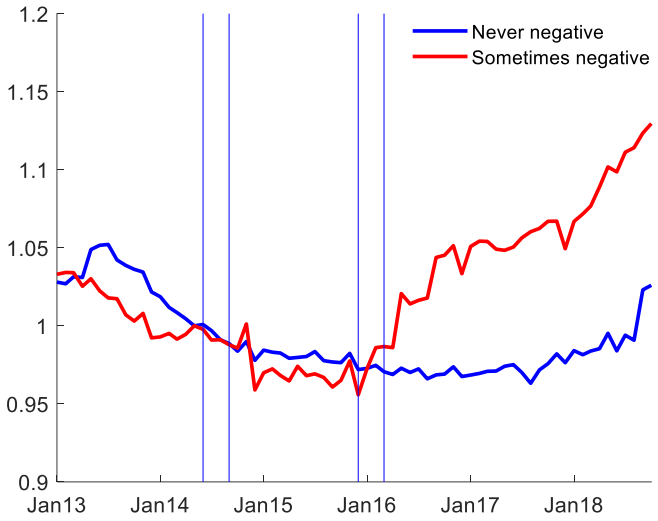


Figure 7: Lending and Deposit Volumes Negative Rates Banks and Other Banks

Figure 7 reports the total lending (Panel A) and total deposits (Panel B) of banks that never charge negative deposit rates as opposed to banks that do offer negative deposit rates. Total volumes for the two categories are normalized to the level in May 2014. The blue vertical lines indicate the four episodes of DFR cuts below zero.

Panel A: Lending volumes



Panel B: Deposit volumes

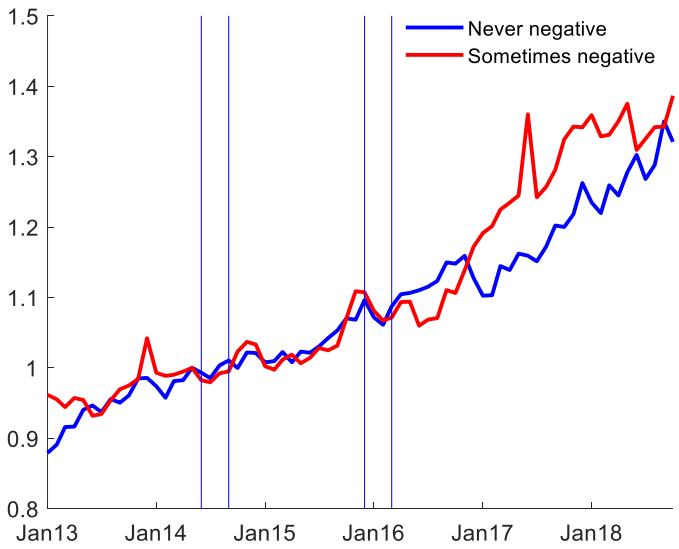


Figure 8: Evolution of the Demand for Credit of Different Banks

This figure illustrate banks' self-reported growth in the demand for credit from the Bank Lending Survey (BLS) distinguishing between banks that never offer negative rates on deposits and banks that sometimes offer negative rates on deposits. The growth is measured by an index that increases (decreases) by 1 unit if the bank reports that the demand for loans or credit lines to enterprises increased (decreased) somewhat or considerably over the previous three months. The dashed lines are the residuals of a regression of the banks' self-reported demand for credit on country FE and the controls used in column 4 of Table 4. The figure reports the indexes averaged across banks for each bank type (never negative or sometimes negative) in deviation from their levels in the second quarter of 2014.

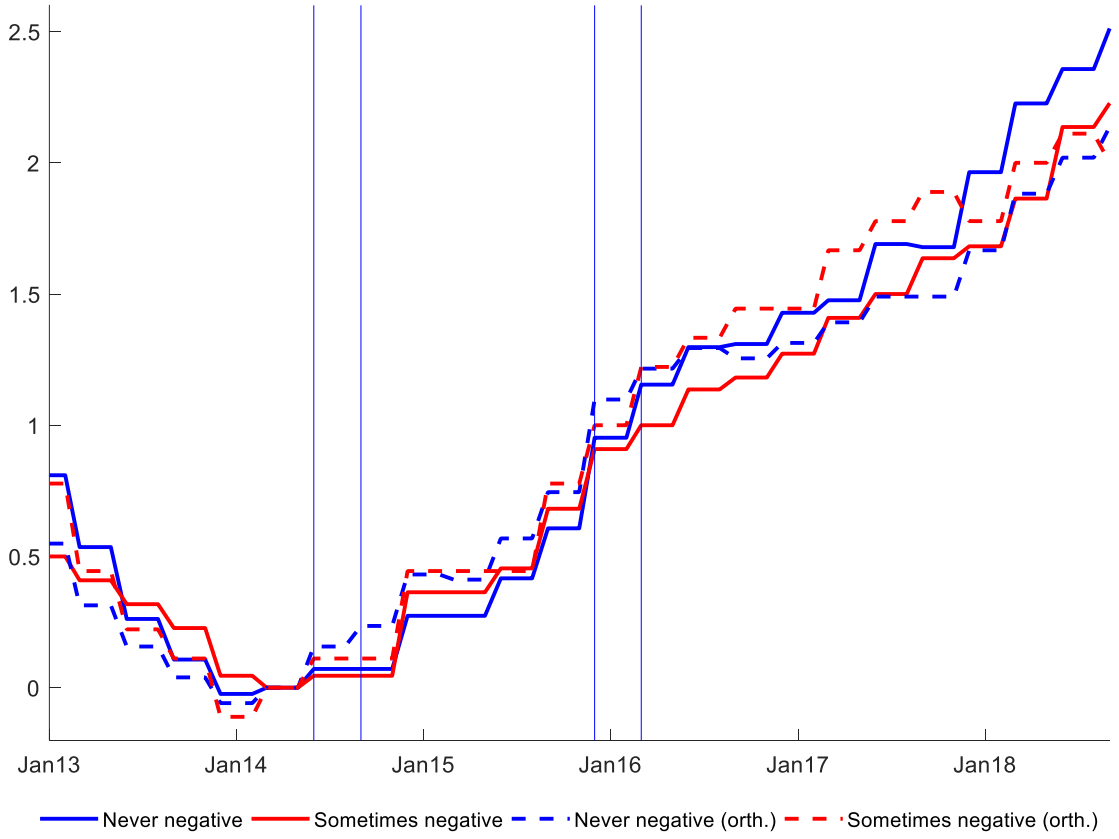
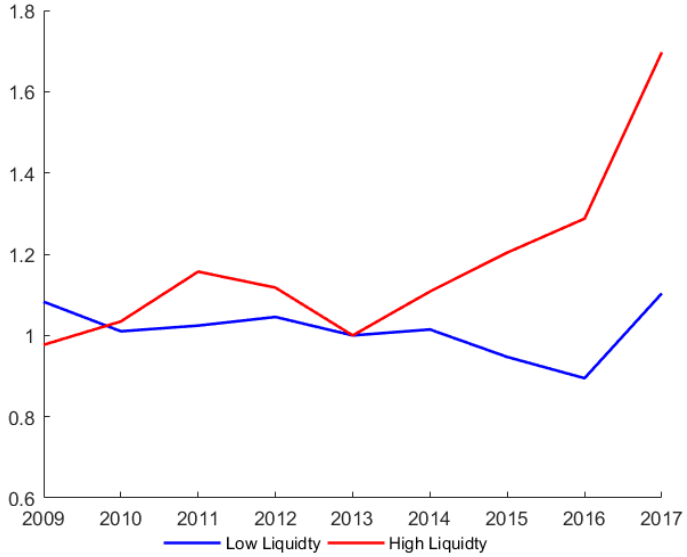


Figure 9: High and Low Cash-Holdings Customers of Negative Rates Banks and Other Banks

Panel A shows the investment patterns of the clients of banks that offer negative rates on deposits during the sample period distinguishing between firms with cash-holdings in the top decile (high cash-holdings) and in the bottom decile (low cash-holdings). Panel B reports the same evidence for firms that are not linked to negative rates banks. The lines are average investment flows that are orthogonal to firm and year fixed effects for each group, normalised to 1 at the end of 2013 (before the introduction of the NIRP).

Panel A: Firms linked to banks with negative rates



Panel B: Firms not linked to banks with negative rates

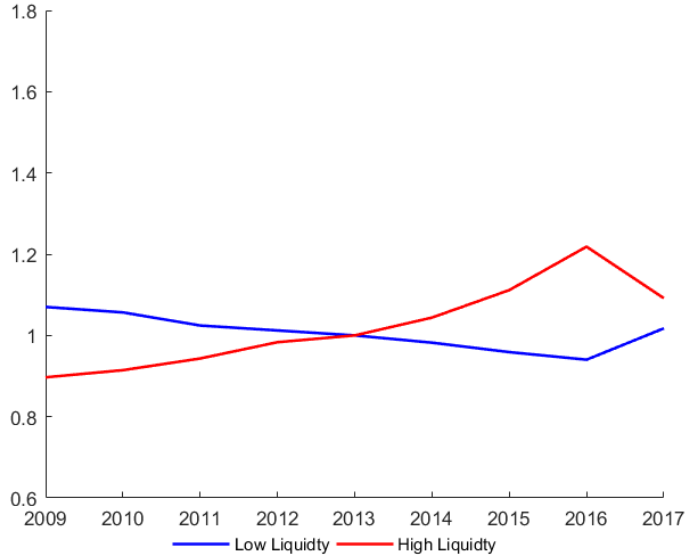


Table 1: Variable names, units, definitions, and summary statistics

Panel A. Bank-level dataset

The unit of observation is the bank-month. Our sample consists of a panel of 202 banks (monetary financial institutions) from August 2007 to September 2018 (134 months).

Variable name	Units	Definition	Obs.	Mean	St.Dev.	Min	p25	p50	p75	Max
Deposit rate	%	Average deposit rate on outstanding amounts of overnight deposits from NFCs or deposits with agreed maturity from NFCs.	22633	0.9	1.1	-0.8	0.1	0.5	1.3	11.3
Probability that deposit rate<0	%	Dummy variable equal to 100 if the average deposit rate is less than zero in a given month.	22633	0.8	9.0	0	0	0	0	100
Post	Cat.	Dummy variable equal to 1 if the year is 2014 or later, 0 otherwise.	22633	0.4	0.5	0	0	0	1	1
Stressed country	Cat.	Dummy variable equal to 1 if a given MFI is located in a stressed country (IT, ES, IE, PT, GR, CY, SI).	22633	0.5	0.5	0	0	0	1	1
NPL ratio	%	Ratio of gross impaired loans over loans at amortized costs. Quarterly frequency, extended over the reference quarter. One month lag.	22633	7.7	10.1	0	2.2	4.4	9.0	55.0
CDS spread	b.p.	Price of a given bank's credit default swap. One month lag.	13296	208.9	308.3	3.7	73.8	118.1	196.6	5272.5
Assets	log(€Mln)	Log of total assets minus remaining assets (check BSI statistics for details). One month lag.	22633	10.4	1.5	2.2	9.5	10.5	11.4	13.8
ROA	%	Return on assets. One month lag.	22633	0.2	1.3	-7.3	0.1	0.4	0.7	2.6
Foreign branch/subs.	Cat.	Dummy variable equal to 1 if a given MFI is a branch or a subsidiary of a group whose head institution is located in a different country than the MFI's.	22633	0.3	0.4	0	0	0	1	1
Deposit ratio	%	Ratio of total deposits to NFC over main liabilities. One month lag.	22633	7.9	7.0	0	3.2	6.8	11.0	100.0
Total deposit ratio	%	Ratio of total deposits to the non-financial private sector over main liabilities. One month lag.	22633	34.2	23.2	0	14.8	35.8	50.6	100.0
Excess liquidity	%	Ratio of excess liquidity (current account + deposit facility - minimum reserve requirements) over main assets. One month lag.	22633	2.8	8.4	-0.1	0	0	1.5	63.6
Deposit rate on new deposits	%	Average bank deposit rate in a given month on new overnight deposits from NFCs or new deposits with agreed maturity from NFCs.	22265	0.6	0.8	-0.5	0	0.2	0.7	11.3
Fees and commissions ratio	%	Ratio of fees and commissions income over total deposits from NFC. Quarterly frequency, extended over the reference quarter.	17554	6.6	12.3	0.0	1.8	3.0	5.2	98.5
Loan volume	€Mln	Outstanding amounts of loans to NFC at all agreed maturities, excluding overdrafts.	22633	12909	18820	0	1823	6347	14723	126338
Lending rate	%	Average lending rate on outstanding amounts of loans to NFC at all agreed maturities, excluding overdrafts.	22417	3.2	1.6	0	2.2	3.1	4.0	13.5
Deposit volume	€Mln	Outstanding amounts of overnight deposits from NFCs or deposits with agreed maturity from NFCs.	22633	4975	9031	0	477	1641	4560	78110
Growth rate in deposit volume	%	Monthly growth rate in deposit volume.	22569	1.1	13.4	-51.0	-3.2	0.2	4.1	80.6
Cum. growth in deposit volume	%	Growth rate in deposit volume since May 2014.	22058	11.2	59.1	-100.0	-20.9	-0.7	25.2	200.0
Cum. growth in loan demand	%	Growth rate in demand for NFC loans since May 2014 as reported in the ECB BLS (1 if increased somewhat or considerably, -1 if decreased somewhat or considerably).	9065	1.8	4.1	-12.0	0.0	1.0	3.0	20.0

Panel B. Firm-level dataset

The unit of observation is the firm-year. The sample consists of an unbalanced panel of 465,860 firms for 11 years from 2007 to 2017, and covers 12 countries, 89 banks, 715 4-digit NACE2 core industries, and 27,598 city locations.

Variable name	Units	Definition	Obs.	Mean	St.Dev.	Min	p25	p50	p75	Max
Negative rates bank	Cat.	Dummy variable equal to 1 if the main bank ever charges a negative average deposit rate to NFCs, 0 otherwise.	3126515	0.1	0.2	0	0	0	0	1
% of negative rates banks	Cat.	Percentage of negative rates banks over the total number of partner banks of a given firm. 9 possible values from 0 to 1.	3126515	0.1	0.2	0	0	0	0	1
Sum of negative rates banks	Cat.	Sum of negative rates banks among partner banks of a given firm. 4 possible values: 0, 1, 2, 3.	3126515	0.1	0.3	0	0	0	0	4
Low rates bank in 2009-2011	Cat.	Dummy variable equal to 1 if the main bank ever charges, between January 2009 and December 2011, an average deposit rate to NFCs equal or below the 5th percentile of the distribution within country-month, 0 otherwise.	3126515	0.3	0.5	0	0	0	1	1
Low rates bank in 2012-2013	Cat.	Dummy variable equal to 1 if the main bank ever charges, between January 2012 and May 2014, an average deposit rate to NFCs equal or below the 5th percentile of the distribution within country-month, 0 otherwise.	3126515	0.2	0.4	0	0	0	0	1
Post	Cat.	Dummy variable equal to 1 if the year is 2014 or later, 0 otherwise.	3126515	0.3	0.5	0	0	0	1	1
Investment	%	Annual growth rate in fixed assets.	3126515	21.5	130.2	-91.2	-14.2	-3.0	9.1	1031.0
Current assets	%	Ratio of current assets over total assets.	3126411	67.5	26.8	3.8	49.1	74.1	90.7	100
Current liabilities	%	Ratio of current liabilities over total liabilities.	3124888	73.0	30.0	0	53.4	84.5	100	100
Interest paid	%	Ratio of interest paid over total liabilities.	2525456	2.4	2.5	0	0.6	1.7	3.4	15.9
Growth in tangible fixed assets	%	Annual growth rate in tangible fixed assets.	3051029	23.5	155.4	-98.1	-18.9	-5.0	6.8	1240.0
Growth in intangible fixed assets	%	Annual growth rate in intangible fixed assets.	1472260	118.4	955.0	-100	-52.3	-13.7	0.0	9242.9
Total assets	%	100*Log of total assets.	3126389	1387.6	172.6	0.0	1275.3	1378.3	1489.0	2436.6
ROA	%	Ratio of net income over total assets.	2981464	2.0	13.1	-52.3	-0.9	1.8	6.7	43.3
ROE	%	Ratio of net income over shareholder equity.	2720263	5.6	48.6	-271.8	0.2	6.4	19.7	146.5
ROCE	%	Ratio of earnings before interests and taxes over capital employed (total assets minus current liabilities).	2407569	7.8	32.8	-162.5	1.1	6.9	17.0	121.3
Profit margin	%	Ratio of net income over sales.	2932444	0.7	14.9	-65.6	-0.6	1.5	5.5	46.6
EBITDA margin	%	Ratio of earnings before interests, tax, depreciation and amortization over sales.	2813052	5.9	15.8	-58.0	1.4	5.0	11.0	61.7
EBIT margin	%	Ratio of earnings before interests and taxes over sales.	2944385	2.0	14.8	-63.5	0.0	2.6	6.8	48.1
Cashflow /Op. Rev.	%	Ratio of cashflow over operating revenue.	2800515	3.9	14.3	-58.4	0.8	3.5	8.4	52.0

Table 2: Which Banks Offer Negative Rates on Deposits?

This table provides estimates of linear probability models in which the dependent variable takes value equal to 100 if a bank offers negative rates on non-financial corporations' deposits in month *t* and to zero if the bank offers positive rates. We consider a range of bank characteristics. Standard errors are double-clustered at the bank and time levels. All models include a constant and fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: Probability that deposit rate<0 in month t	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Stressed country	-1.057**			-0.752*	-0.802				
	(0.473)			(0.447)	(0.508)				
NPL ratio		-0.051***		-0.034**	-0.037*	-0.040*	-0.007	-0.046*	-0.051**
		(0.019)		(0.016)	(0.022)	(0.023)	(0.021)	(0.024)	(0.024)
CDS spread			-0.001**						
			(0.000)						
NPL ratio*Exc. liquidity							-0.008*		
							(0.004)		
Assets					0.102	0.274*	0.312**	0.480	0.308
					(0.153)	(0.146)	(0.150)	(0.655)	(0.609)
ROA					-0.151**	-0.132*	-0.087	-0.183**	-0.177**
					(0.074)	(0.077)	(0.062)	(0.072)	(0.072)
Foreign branch/subs.					-0.075	-1.104	-1.192		
					(0.547)	(0.805)	(0.826)		
Excess liquidity						0.190**	0.217**	0.173***	0.170***
						(0.091)	(0.102)	(0.065)	(0.065)
Deposit ratio						0.013	0.017	0.054	
						(0.048)	(0.049)	(0.084)	
Total deposit ratio									-0.008
									(0.028)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	-	-	-	-	-	Yes	Yes	-	-
Bank FE	-	-	-	-	-	-	-	Yes	Yes
Observations	22,633	22,633	13,296	22,633	22,633	22,633	22,633	22,633	22,633
R-squared	0.036	0.036	0.043	0.037	0.038	0.079	0.079	0.217	0.216

Table 3: Do Fees Substitute Rates?

We relate the ratio of fees and commissions relative to the deposits of non-financial corporations or total deposits as indicated on top of each column to a range of bank characteristics before and after the start of the NIRP. Standard errors are double-clustered at the bank and time levels. All models include a constant and fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Fees and commissions income	over total NFC deposits	over total NFC deposits	over total NFC deposits	over total NFC deposits	over total NFC deposits	over total NFC deposits	over total NFC deposits	over total NFC deposits	over total NFC deposits	over total NFPS deposits
Stressed country	-0.132			0.524	0.804					
	(2.012)			(2.169)	(2.529)					
Stressed country*Post	-1.484									
	(1.456)									
NPL ratio		-0.127		-0.141	-0.120	-0.171	-0.019	-0.022	-0.002	0.180
		(0.101)		(0.130)	(0.114)	(0.150)	(0.043)	(0.043)	(0.051)	(0.190)
NPL ratio*Post		-0.030		-0.032	-0.038	0.023	0.054	0.058	0.062	-0.109
		(0.083)		(0.081)	(0.078)	(0.094)	(0.050)	(0.050)	(0.059)	(0.126)
CDS spread			-0.003							
			(0.002)							
CDS spread*Post			0.000							
			(0.002)							
Assets					0.172	-1.188	-6.744*	-7.146**	-4.942	-2.417
					(0.434)	(0.747)	(3.455)	(3.547)	(3.024)	(1.711)
ROA					0.152	0.576	-0.113	-0.088	-0.130	0.425
					(0.588)	(0.588)	(0.096)	(0.089)	(0.100)	(0.461)
Foreign branch/subs.					1.428	3.441				
					(2.430)	(2.247)				
Excess liquidity						0.425***	0.137**	0.067	0.107	0.044
						(0.152)	(0.068)	(0.067)	(0.087)	(0.059)
Excess liquidity*Post								0.069*	0.078	0.075
								(0.039)	(0.061)	(0.056)
Deposit ratio						-0.511**	-0.356***	-0.508***		
						(0.223)	(0.096)	(0.166)		
Deposit ratio*Post								0.199		
								(0.154)		
Total deposit ratio									-0.009	-0.084**
									(0.083)	(0.041)
Total deposit ratio*Post									-0.033	0.035
									(0.065)	(0.037)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	-	-	-	-	-	Yes	-	-	-	-
Bank FE	-	-	-	-	-	-	Yes	Yes	Yes	Yes
Observations	17,554	17,554	10,937	17,554	17,554	17,554	17,554	17,554	17,554	17,816
R-squared	0.007	0.015	0.013	0.016	0.018	0.149	0.774	0.777	0.769	0.785

Table 4: Deposit Growth and Bank Health

We relate changes in banks' deposits over the intervals indicated on top of each column to a dummy capturing whether a bank offers negative rates on deposits and bank NPL in May 2014, right before the start of the NIRP and other bank characteristics. Standard errors are corrected for heteroskedasticity. All models include a constant and fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Dependent Variable: Growth in deposits since May 2014	until Jun-15	until Sep-18	until Sep-18	until Sep-18	Placebo: Change between May-14/ Jun-12
Negative rates bank*100	0.158	0.462**	0.383*	0.328*	-0.194
	(0.218)	(0.211)	(0.199)	(0.196)	(0.153)
Assets in May 2014	-1.388	-12.583**	-11.673**	-26.990***	3.099
	(2.693)	(5.249)	(5.008)	(8.245)	(3.168)
ROA in May 2014	1.027**	0.719	-1.050	-0.984	-1.330**
	(0.414)	(0.627)	(0.884)	(0.856)	(0.647)
Foreign branch/subs.	-11.424	-27.490*	-26.825*	-27.634*	0.382
	(8.403)	(14.643)	(14.137)	(15.526)	(7.735)
NPL ratio in May 2014			-2.212***	-2.043**	
			(0.782)	(0.823)	
Deposit ratio in May 2014			-0.450	-1.436	
			(1.186)	(1.178)	
Excess liquidity in May 2014			0.800	0.590	
			(1.123)	(1.195)	
Deposit rate in May 2014				1.543	
				(22.292)	
Lending rate in May 2014				-10.329	
				(11.735)	
Deposit volume in May 2014				0.001	
				(0.001)	
Loan volume in May 2014				0.001	
				(0.001)	
Country FE	Yes	Yes	Yes	Yes	Yes
Observations	125	125	125	125	125
R-squared	0.213	0.306	0.347	0.384	0.182

Table 5: Real Effects of the Bank Lending Channel

The unit of observation is the firm year and we relate firm level outcomes indicated on top of each column to firms' exposure to the NIRP. The dummy *Post* takes value equal to one after the ECB lowered the DFR below zero in 2014. *Exposure* is a firm's proportion of current assets multiplied by a dummy that takes value equal to one if a firm has a bank that offers negative rates on deposits after the NIRP starts. Standard errors are clustered at bank level. All models include fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable:	Debt/Assets	Debt/Assets	Debt/Assets	Investment	Investment	Investment	Debt/Assets	Investment	Current assets
Negative bank*Post	0.728***	0.681***	0.543***	1.045	1.395	0.089	3.150***	-11.135**	0.953**
	(0.176)	(0.151)	(0.128)	(0.774)	(0.889)	(0.799)	(1.135)	(4.575)	(0.434)
Exposure*Post							-0.034**	0.177***	-0.014***
							(0.015)	(0.058)	(0.005)
Exposure							0.043***	0.867***	-0.134***
							(0.010)	(0.109)	(0.011)
Current assets (lag)							-0.104***	3.434***	0.528***
							(0.006)	(0.055)	(0.008)
Current assets (lag)*Post							0.017***	0.062***	-0.022***
							(0.004)	(0.018)	(0.001)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Time FE	Yes	-	-	Yes	-	-	Yes	Yes	Yes
Country-Industry-Time FE	-	Yes	Yes	-	Yes	Yes	-	-	-
City-Time FE	-	-	Yes	-	-	Yes	-	-	-
Observations	3,126,407	3,126,406	3,035,455	3,126,515	3,126,515	3,035,564	3,126,407	3,126,515	3,126,401
R-squared	0.797	0.804	0.810	0.177	0.189	0.217	0.798	0.245	0.906

Table 6: Exposure to Negative Rates and Firms' Investment

Panel A. Average Effects.

The unit of observation is the firm year and we relate firm level outcomes indicated on top of each column to firms' exposure to the NIRP. The dummy *Post* takes value equal to one after the ECB lowered the DFR below zero in 2014. In columns 1 to 3, *Exposure* is a firm's proportion of current assets multiplied by a dummy that takes value equal to one if a firm has a bank that offers negative rates on deposits after the NIRP starts. In column 4, *Exposure* is defined using the proportion of a firm's banks offering negative rates on deposits instead of the dummy variable. In column 5, we consider firms reporting only one bank. Standard errors are clustered at the bank level. All models include fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: Investment	(1)	(2)	(3)	(4)	(5)
Exposure*Post	0.178***	0.348***	0.575***	0.229***	0.335***
	(0.057)	(0.102)	(0.109)	(0.045)	(0.126)
Exposure	0.872***	0.862***	1.013**	1.017***	0.825***
	(0.110)	(0.106)	(0.487)	(0.171)	(0.179)
Current assets (lag)	3.434***	3.461***	3.643***	3.458***	3.616***
	(0.055)	(0.056)	(0.047)	(0.056)	(0.064)
Current assets (lag)*Post	0.064***	0.055***	0.007	0.060***	0.085***
	(0.018)	(0.020)	(0.026)	(0.021)	(0.024)
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	-	-	-	-
Bank-Industry-Time FE	-	Yes	-	Yes	Yes
Bank- Industry-City-Time FE	-	-	Yes	-	-
Observations	3,126,515	3,126,515	1,262,118	3,126,515	1,798,592
R-squared	0.245	0.282	0.439	0.282	0.307

Panel B. Small vs. Large Firms

The unit of observation is the firm year and we relate firm level outcomes indicated on top of each column to firms' exposure to the NIRP. In column 1 (2), small (large) firms are defined as firms with total assets below (above) the median. The dummy *Post* takes value equal to one after the ECB lowered the DFR below zero in 2014. *Exposure* is a firm's proportion of current assets multiplied by a dummy that takes value equal to one if a firm has a bank that offers negative rates on deposits after the NIRP starts All models include fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: Investment	(1) Small firms	(2) Large firms
Exposure*Post	0.508*	0.117***
	(0.288)	(0.031)
Exposure	1.925***	0.255**
	(0.289)	(0.101)
Current assets (lag)	3.390***	3.449***
	(0.056)	(0.071)
Current assets (lag)*Post	0.097***	0.037*
	(0.018)	(0.020)
Firm FE	Yes	Yes
Bank-Time FE	Yes	Yes
Observations	1,544,764	1,546,028
R-squared	0.248	0.293

Panel C. High Cash-Holdings Firms

The unit of observation is the firm year and we relate firm level outcomes indicated on top of each column to firms' exposure to the NIRP. The sample includes only firms with current assts in the top decile. The dummy *Post* takes value equal to one after the ECB lowered the DFR below zero in 2014. *Exposure* is a firm's proportion of current assets multiplied by a dummy that takes value equal to one if a firm has a bank that offers negative rates on deposits after the NIRP starts All models include fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Sample firms: Upper tercile of current assets					
Dependent Variable:	(1)	(2)	(3)	(4)	(5)
Investment					
Exposure*Post	1.988***	2.358***	1.670***	0.231**	2.645***
	(0.452)	(0.432)	(0.363)	(0.110)	(0.651)
Exposure	-0.229*	-0.351**	-0.030	0.242	-0.343
	(0.119)	(0.152)	(0.278)	(0.198)	(0.206)
Additional Controls:					
Current assets (lag)	Yes	Yes	Yes	Yes	Yes
Current assets (lag)*Post	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	-	-	-	-
Bank-Industry-Time FE	-	Yes	-	Yes	Yes
Bank- Industry-City-Time FE	-	-	Yes	-	-
Observations	1,026,469	993,419	331,747	993,419	596,949
R-squared	0.235	0.296	0.456	0.296	0.324

Table 7: Exposure to Negative Rates and Firms' Current Assets

The unit of observation is the firm year and we relate firm level outcomes indicated on top of each column to a firms' exposure to the NIRP. The dummy *Post* takes value equal to one after the ECB lowered the DFR below zero in 2014. In columns 1 to 3, *Exposure* is a firm's proportion of current assets multiplied by a dummy that takes value equal to one if a firm has a bank that offers negative rates on deposits after the NIRP starts. In column 4, *Exposure* is defined using the proportion of a firm's banks offering negative rates on deposits instead of the dummy variable. In column 5, we consider firms reporting only one bank. Standard errors are clustered at the bank level. All models include fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: Current assets	(1)	(2)	(3)	(4)	(5)
Exposure*Post	-0.014***	-0.034***	-0.045***	-0.020***	-0.031***
	(0.005)	(0.007)	(0.014)	(0.002)	(0.010)
Exposure	-0.135***	-0.138***	-0.185***	-0.157***	-0.132***
	(0.011)	(0.011)	(0.016)	(0.019)	(0.021)
Current assets (lag)	0.528***	0.523***	0.505***	0.524***	0.503***
	(0.008)	(0.008)	(0.010)	(0.008)	(0.010)
Current assets (lag)*Post	-0.022***	-0.021***	-0.020***	-0.022***	-0.025***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	-	-	-	-
Bank- Industry -Time FE	-	Yes	-	Yes	Yes
Bank- Industry -City-Time FE	-	-	Yes	-	-
Observations	3,126,401	3,126,396	1,262,045	3,126,396	1,798,485
R-squared	0.907	0.912	0.931	0.912	0.911

Table 8: Exposure to Negative Rates and Firms' Investment into Tangible and Intangible Assets

The unit of observation is the firm year and we relate firm level outcomes indicated on top of each column to firms' exposure to the NIRP. The dummy *Post* takes value equal to one after the ECB lowered the DFR below zero in 2014. *Exposure* is a firm's proportion of current assets multiplied by a dummy that takes value equal to one if a firm has a bank that offers negative rates on deposits after the NIRP starts. Standard errors are clustered at the bank level. All models include fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
Dependent Variable:	Growth in tangible fixed assets	Growth in intangible fixed assets	Total assets
Exposure*Post	0.073**	0.459*	0.005
	(0.037)	(0.242)	(0.021)
Exposure	0.762***	1.018***	-0.247***
	(0.170)	(0.365)	(0.049)
Current assets (lag)	2.679***	4.183***	0.044*
	(0.110)	(0.226)	(0.026)
Current assets (lag)*Post	0.065***	0.446***	0.049***
	(0.013)	(0.095)	(0.015)
Firm FE	Yes	Yes	Yes
Bank-Time FE	Yes	Yes	Yes
Observations	3,046,660	1,436,770	3,126,376
R-squared	0.204	0.212	0.966

Table 9: Exposure to Negative Rates, Debt Maturity and Financial Expenses

The unit of observation is the firm year and we relate firm level outcomes indicated on top of each column to a firm's exposure to the NIRP. The dummy *Post* takes value equal to one after the ECB lowered the DFR below zero in 2014. In columns 1 to 3, *Exposure* is a firm's proportion of current assets multiplied by a dummy that takes value equal to one if a firm has a bank that offers negative rates on deposits after the NIRP starts. In column 4, *Exposure* is defined using the proportion of a firm's banks offering negative rates on deposits instead of the dummy variable. In column 5, we consider firms reporting only one bank. Standard errors are clustered at the bank level. All models include fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Debt Maturity

Dependent Variable: Current liabilities	(1)	(2)	(3)	(4)	(5)
Exposure*Post	0.004	0.010	-0.005	-0.002	0.009
	(0.010)	(0.014)	(0.023)	(0.007)	(0.018)
Exposure	-0.087***	-0.089***	-0.074***	-0.085***	-0.058**
	(0.028)	(0.028)	(0.018)	(0.026)	(0.024)
Current assets (lag)	0.159***	0.159***	0.141***	0.159***	0.141***
	(0.010)	(0.009)	(0.007)	(0.009)	(0.006)
Current assets (lag)*Post	-0.046***	-0.054***	-0.047***	-0.053***	-0.054***
	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	-	-	-	-
Bank- Industry -Time FE	-	Yes	-	Yes	Yes
Bank- Industry -City-Time FE	-	-	Yes	-	-
Observations	3,124,773	3,124,729	1,261,013	3,124,729	1,797,255
R-squared	0.735	0.749	0.809	0.749	0.760

Panel B. Cost of Debt

Dependent Variable: Interest paid	(1)	(2)	(3)	(4)	(5)
Exposure*Post	0.001	0.001***	-0.000	0.003***	0.002***
	(0.001)	(0.000)	(0.002)	(0.001)	(0.000)
Exposure	-0.004*	-0.004*	-0.004	-0.005**	-0.005**
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Current assets (lag)	-0.007***	-0.007***	-0.006***	-0.007***	-0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Current assets (lag)*Post	0.004***	0.004***	0.004***	0.004***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	-	-	-	-
Bank- Industry -Time FE	-	Yes	-	Yes	Yes
Bank- Industry -City-Time FE	-	-	Yes	-	-
Observations	2,514,058	2,504,287	963,971	2,504,287	1,336,206
Adjusted R-squared	0.614	0.635	0.723	0.635	0.639

Table 10: Exposure to the NIRP and Firm Performance

The unit of observation is the firm year and we relate different measures of firm profitability indicated on top of each column to a firm's exposure to the NIRP. The dummy *Post* takes value equal to one after the ECB lowered the DFR below zero in 2014. *Exposure* is a firm's proportion of current assets multiplied by a dummy that takes value equal to one if a firm has a bank that offers negative rates on deposits after the NIRP starts. All models include fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable:	ROA	ROE	ROCE	Profit margin	EBITDA margin	EBIT margin	Cashflow /Op. Rev.
Exposure*Post	0.012	0.018***	0.022***	0.026**	0.015**	0.019**	0.019*
	(0.009)	(0.006)	(0.008)	(0.011)	(0.006)	(0.009)	(0.010)
Exposure	0.031***	0.103**	0.067***	-0.000	0.015**	0.003	0.007
	(0.010)	(0.042)	(0.011)	(0.006)	(0.006)	(0.005)	(0.008)
Current assets (lag)	0.030***	0.073***	0.055***	0.036***	-0.040***	0.020***	-0.030***
	(0.002)	(0.007)	(0.006)	(0.003)	(0.003)	(0.002)	(0.004)
Current assets (lag)*Post	-0.018***	-0.071***	-0.062***	-0.032***	-0.015***	-0.019***	-0.019***
	(0.001)	(0.005)	(0.005)	(0.003)	(0.001)	(0.002)	(0.001)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,979,079	2,707,987	2,390,501	2,927,748	2,809,372	2,940,959	2,795,506
R-squared	0.472	0.385	0.428	0.483	0.559	0.484	0.525

Table 11: Effects of Rate Cuts Above and Below the ZLB

The unit of observation is the firm year and we relate firm level outcomes indicated on top of each column to a firm's exposure to the NIRP. The dummy *Post Decrease* indicates the period from 2009 to 2011, *Post Low* indicates the period from 2012 to 2013, and *Post Negative* indicates the period from 2014 onwards. *Exposure* is a firm's proportion of current assets multiplied by a dummy that takes value equal to one if a firm has a bank that offers negative rates on deposits after the NIRP starts in the 2014-2017 period. For the earlier periods, we consider firms associated with banks offering rates in the bottom quintile. All models include fixed effects as indicated on the table, but the coefficients are not reported. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
Dependent Variable:	Investment	Current assets	Current liabilities	Interest paid
Exposure Low(2009-2011) * Post(2009-2011)	0.027	0.001	-0.010**	0.001***
	(0.031)	(0.003)	(0.004)	(0.000)
Exposure Low(2012-2013) * Post(2012-2013)	0.021	0.000	0.004	-0.001
	(0.084)	(0.003)	(0.006)	(0.001)
Exposure Negative(2014-2017) * Post(2014-2017)	0.191***	-0.018***	-0.003	0.001
	(0.050)	(0.006)	(0.008)	(0.001)
Exposure Low(2009-2011)	0.772***	-0.071*	-0.040**	-0.004**
	(0.247)	(0.036)	(0.017)	(0.001)
Exposure Low(2012-2013)	-0.541**	0.061	0.016	0.003*
	(0.257)	(0.043)	(0.019)	(0.002)
Exposure Negative(2014-2017)	0.662**	-0.113***	-0.073*	-0.003**
	(0.292)	(0.028)	(0.039)	(0.001)
Current assets (lag)	3.325***	0.562***	0.190***	-0.011***
	(0.030)	(0.005)	(0.012)	(0.000)
Current assets (lag)*Post Decrease	-0.023	-0.033***	-0.016***	0.005***
	(0.023)	(0.001)	(0.004)	(0.000)
Current assets (lag)*Post Low	-0.030	-0.037***	-0.048***	0.008***
	(0.025)	(0.002)	(0.007)	(0.000)
Current assets (lag)*Post Negative	0.046	-0.049***	-0.071***	0.009***
	(0.032)	(0.002)	(0.009)	(0.000)
Firm FE	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	Yes	Yes	Yes
Observations	3,126,515	3,126,401	3,124,773	2,514,058
R-squared	0.246	0.907	0.735	0.615