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

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Exploiting confidential data from the euro area, we show that sound banks can pass negative rates on to their corporate depositors without experiencing a contraction in funding. These pass-through effects become stronger as policy rates move deeper into negative territory. Banks offering negative rates provide more credit than other banks suggesting that the transmission mechanism of monetary policy is not hampered. The negative interest rate policy (NIRP) provides further 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.

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1. Introduction

A tenet of modern macroeconomics is that monetary policy cannot achieve much with standard interest rate policies once rates have already reached 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). 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. For this reason, the economy is expected to enter a liquidity trap.

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 A ZLB may exist for household deposits, which, being relatively small, may be easily withdrawn and held as cash. However, corporations cannot conduct their operations (that is, pay wages and suppliers or receive payments from customers) without deposits as easily. Consistent with this observation, this paper shows, using confidential data, that sound banks in the euro area started to charge negative rates on corporate depositors 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, in Germany, deposits remunerated below zero account for 15% of total deposits and around 50% of enterprises' deposits, indicating that the effects are economically relevant.

All these effects become more pronounced as the ECB moves further into negative territory, suggesting that the ECB has not yet met an effective lower bound or a reversal rate, at which the negative effect of a lower interest rate on bank profits may lead to a contraction in lending (Brunnermeier and Koby, 2016).

We conjecture that the transmission from policy to deposit rates below the ZLB is not necessarily 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 and 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, in other words sound banks, are more inclined to offer negative rates once the ECB policy rates turn negative. In addition, sound banks do not experience a decrease in deposits 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 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 decreased. Thus, banks offering negative rates experience a positive shock to their net wealth when the policy interest rate is lowered below the ZLB. Banks that pass negative rates onto depositors are able to increase their lending, confirming that the transmission mechanism of monetary policy is not hampered.

Not only is the lending channel of monetary policy still operational for some banks below the ZLB, but a *corporate channel* of monetary policy also emerges. 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 a ZLB arises only if agents lack confidence in the banking system and deposits shrink when the interest rate approaches zero. For sound banks, the transmission mechanism appears to remain intact even when interest rates turn negative. Not only do sound banks pass the negative rates onto corporate depositors, but the transmission mechanism is enhanced by the fact that firms whose deposits are more exposed to negative rates decrease their liquid asset holdings and invest more in fixed assets as well as intangible assets. Thus, in contrast to conventional wisdom, we find that, when banks are sound, the NIRP can provide effective stimulus to an economy by impacting the behaviour of both banks and firms.

To the best of our knowledge, this is the first paper to question the existence of a ZLB. 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.[1] Altavilla, Boucinha, and Peydro (2018) and Lopez, Rose and Spiegel (2018) however find that low and negative rates do not adversely affect bank profitability, suggesting that banks may pass through interest rate cuts also when policy rates move into negative territory. We rely on a comprehensive sample of banks and firms. Controlling for banks' reliance on deposits, we show that the most important determinant of the extent of pass-through is a bank's soundness and highlight positive effects of monetary policy below the ZLB on the amount of credit extended by banks and 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 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

[1] Evidence from Riksbanken reports, however, suggests that monetary policy has been effective even at negative policy rate levels (see Erikson and Vestin, 2019).

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. The DFR is the rate on the deposit facility, which banks may 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 is the relevant rate during this period because of the ample liquidity provided by the central bank, which was far in excess of banks' liquidity needs. The introduction of the ECB's expanded asset purchase program at the beginning of 2015 further increased the volume of excess liquidity in the system. While banks can adjust their individual holdings of excess liquidity by shifting into alternative assets, in the aggregate, the program 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 reason, the interbank interest rate (Eonia) moves towards the DFR.[2] 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 Great Depression in the US, as well as economic stagnation in Japan, following the bubble burst of the late nineties (Bernanke, 1983). However, in the US and Japan most banks were troubled preventing cross-sectional analysis, while the euro area comprises a variety of countries whose banks are exposed

[2] 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.

to different economic conditions following the sovereign crisis in Cyprus, Greece, Ireland, Italy, Portugal, Slovenia, and Spain (hereafter, the "stressed" countries).[3]

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 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 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 large cross-sectional differences in banks' health at the beginning of the NIRP enable us to explore how these cross-sectional differences affect bank reactions to negative rates, controlling for differences in credit demand.

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 the main asset and liability items of over 300 banks resident in the euro area from

[3] 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.

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 Eurosystem and has more extensive coverage than the stress tests of 2014, which covered about 100 banks.

We also obtain firm level information from Bureau Van Dick'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 lenders in Orbis.

Even if we do not observe firms' actual deposits and outstanding credit, main banks provide their customers a wide range of services including deposits and credit (Santikian, 2014). Therefore, we expect firms to both have deposits and receive credit from their lending banks because these activities are typically associated and 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).

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.[4]

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 very 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.[5] 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 the current assets and cash holdings and invest more in tangible and intangible assets if they face negative rates, suggesting that, under the NIRP, there may exist a direct corporate channel in the transmission mechanism of monetary policy. Our firm-level dataset is well suited to explore this mechanism.

[4] The composition and construction of our sample is similar to Giannetti and Ongena (2012) and Kalemli-Ozcan, Laeven, and Moreno (2018).

[5] Syndicated loans extended to firms in the euro area represent less than 10% of the outstanding amount of bank loans. Our sample covers, instead, around 70% of the total bank loan outstanding in the euro area.

Panel B of Table 1 summarizes the main variables of the firm-level dataset.

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 (MFI) and have been growing even during the period of negative interest rates. The importance of deposits for bank funding in Europe makes concerns regarding 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 of the DFR below zero. It reports different percentiles of the interest rate on the deposits of non-financial corporations distinguishing between interest rate adjustment 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 in the months following the ECB's decision to lower the DFR below zero in 2014, 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 lower the interest rates on deposits of non-financial corporations below zero following the additional cuts in the DFR in 2016. 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 interest rates on deposits were still largely positive

until June 2014, when the ECB started to move into negative territory. Back then, banks could adjust the interest rates on deposits 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 effective lower bound (ELB).

The conventional wisdom that interest rates on deposits do not fall below zero appears to 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 Figure 3, there is a gradual increase in the proportion of deposits with negative rates. 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, while the proportion of deposits with negative rates remains below 10 percent (as shown by the proportion of the deposits of the non-financial private sector), there could be important cross-sectional differences in the transmission of monetary policy. It is therefore important to ask which banks are able to lower the interest rates on deposits below zero.

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 much lower level in the stressed countries.

Because sovereign debt problems in stressed countries are intertwined with bank health, this evidence suggests that bank health and soundness may play a significant role in the transmission of monetary policy when policy 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 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 in all specifications time fixed effects.

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 non-performing loans (NPL) and the CDS spread. Only banks that are more solid, as captured by a lower proportion of non-performing loans or lower default risk, are able to offer negative interest rates on the deposits of financial corporations. The effects are not only statistically significant, but also economically large. A one-standard-deviation increase in the proportion of non-performing loans 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 effective lower bound.

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).

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 8, 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 once we consider bank health. The effect of the proportion of non-performing loans 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 non-performing loans 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).

A possible concern with this interpretation of the empirical evidence is that different banks may use different instruments to pass through monetary policy shocks. Less healthy banks and banks in stressed countries could rely on fees as a way to compensate for the higher interest rates

on deposits they offer. Table 3 relates bank characteristics to the ratio of fees and commissions relative to the deposits of non-financial corporations before and after the implementation of the NIRP. 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. Since banks with higher excess liquidity tend to be healthier in our sample, this finding also indicates that healthier banks are able to safeguard their profitability when policy rates turn negative.

Finally, banks with a large proportion of deposits always charge lower fees and do not change their behaviour after the implementation of the NIRP.

Overall, it appears that the transmission mechanism of monetary policy is not impaired, at least for healthy banks. 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 to their corporate depositors. Figure 7 explores how negative rates are associated with the evolution of

loans and deposits. It appears that some banks are able to offer negative rates on their deposits without experiencing withdrawals. Following the start of the NIRP, high-NPL banks, which are less likely to offer negative rates, experience lower deposit growth than other banks.

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.[6]

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; Altavilla, Boucinha, Holton, and Ongena, 2018).

Figure 8 provides strong support 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 of banks that never offer negative rates seems to have grown faster.

[6] Demiralp, Eisenschmidt, and Vlassopoulos (2017) also find that that following the introduction of the NIRP banks purchased more non-domestic bonds and rely less on wholesale funding.

We next explore the evolution of bank assets and liabilities in a multivariate setting. Since ultimately the decision to offer negative rates on depositors depends on bank health, we estimate reduced form regressions and test how bank health affects changes in loan provision over different intervals, following the implementation of the NIRP. We measure bank health using the proportion of non-performing loans and evaluate its effects on repeated cross-sections of changes in individual banks' deposits and lending.

Table 4 shows that high-NPL banks experience lower deposit growth in the months following the implementation of the NIRP. This is the case whether we consider the interval up to September 2015 (column 1) or up to September 2018 (column 2). High excess liquidity banks, which are safer in our sample, appear to experience higher deposit growth in some specifications (column 3) even though NPL maintains its explanatory power.

Interestingly, in column 5, high interest rates on deposits are negatively related to deposits growth confirming our interpretation that demand for deposits is driven by the desire to hold liquidity in safe banks. In this specification, the banks' NPL is no longer significant at conventional levels, although it remains negative, possibly because the interest rate on deposits partially picks its effect. We also note however that the sample is reduced by the inclusion of the control for credit demand growth.

Table 5 explores differences in lending behaviour between banks. We consider both changes in the quantity of credit (Panel A) and in loan interest rates (Panel B) and include country fixed effects throughout to roughly control for differences in the demand for credit. We also condition on a number of relevant differences between banks and their reported changes in demand for credit to isolate the effects of bank health on the supply of credit.

Column 1 of Panel A considers the change in loans between May 2014 and September 2015. Banks with high non-performing loans experience slower credit growth. The effect is similar if we extend the period over which we evaluate the change in lending growth to September 2018 (column 2) and we include an increasing number of controls aiming to capture different bank characteristics and differences in the demand for credit of different banks' clients (columns 3 to 5). In particular, the effects are robust when we control for the growth in demand for credit (column 5). NPL are not only statistically, but also highly economically significant in explaining differences in credit growth following the start of the NIRP: For instance, in column 1, a one-standard-deviation increase in a bank's NPL is associated with a drop in credit growth of over two standard deviations.

We further explore whether differences in the demand for credit or in banks' ability to extend loans for reasons other than the NIRP affect loan growth. To evaluate this possibility, we consider the growth in credit during the two years preceding the NIRP as a placebo; specifically, we consider the change in outstanding loans between May 2014 and September 2012. In column 6, it appears that banks with low non-performing loans did not lend more in the two years preceding the NIRP, suggesting that they do not experience high growth in demand and that rather they increase the supply of credit as a reaction to the policy.

In Panel B, we find limited effects of the NIRP on the cost of credit. We find no evidence that the average interest rate on loans granted by high NPL banks decreases to a lower extent. This may suggest that the transmission of monetary policy by banks offering negative rates on deposits occurs through the quantity rather than the cost of credit. This is consistent with evidence that the pass-through from the money market rates targeted by the central bank to

lending rates was incomplete and resulted in an increasing dispersion in lending rates since the euro crisis (Holton and Rodriguez d'Acri, 2018).

However, it may also depend on loan composition, if banks with more non-performing loans have riskier borrowers as Bottero, Minoiu, Peydro, Polo, Presbitero, and Sette (2019) suggest may have occurred in Italy, where banks were unable to offer negative rates on deposits. Differences in loan composition between banks are more consistent with the result of the placebo test in column 6. High-NPL banks had relatively higher interest rate loans already in June 2012, suggesting that following the NIRP they may continue to lend to high-risk borrowers.

Overall, we find no evidence that interest rate cuts below the ZLB translate into cheaper loans. This is consistent with the findings of Eggertsson, Juelsrud, Summers, and Wold (2019). However, this does not mean that the transmission mechanism is impaired. Our results indicate that the transmission of monetary policy below the ZLB occurs through quantities rather than rates.

Below, we consider firm level reactions to evaluate the real effects of the NIRP as well to further explore whether the difference in lending behaviour between banks may be driven by their borrowers' demand shocks.

6. The Real Effects of Negative Rates

Negative rates may affect firms through their assets and liabilities. As we have shown, banks that manage to transfer the negative rates to their depositors increase lending. This implies that for the clients of sound banks, the conventional mechanism of transmission of monetary policy should be at work.

Negative rates can however affect firms also through their asset composition because they increase the cost of holding deposits. Cash-rich firms may therefore find it optimal to decrease the amount of cash held in deposits and invest more without increasing their leverage. 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 that any shocks affect firms in the same cluster similarly.

Table 6 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 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 do not drive our findings and corroborate our interpretation that the increase in the use of financial debt by firms associated with banks offering negative rates is 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 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.

Nevertheless, the NIRP may have real effects. In columns 7 to 9, we start exploring whether there are any real effects related to the fact that firms typically also have deposits with their lending banks. The 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 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, 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. High exposure firms decrease their leverage, presumably in an attempt to decrease their cash holdings. There is also evidence that they rebalance their assets by investing more (column 8).

Column 9 shows that firms, which are associated with negative rates banks and have low cash holdings before the implementation of the NIRP, tend to increase the proportion of current assets. This indicates that these firms have greater 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 proportion of current assets and we only capture the differential reaction of firms with high current assets 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. By concentrating on high-exposure clients and controlling for the proportion of current assets, we are able to isolate the effects on clients of banks offering negative rates on deposits.

Columns 1 to 3 in Panel A of Table 7 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 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 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 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 need to 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.

Table 8 performs tests similar to Panel A of Table 7 considering the proportion of current assets. Unsurprisingly, the increase in investment noted in Table 7 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 9 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 10 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 10 is economically small. This is consistent with our earlier findings that the NIRP is not associated with a reduction in lending rates, even for banks that offer negative rates on their deposits.

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 11 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 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 similarly statistically and economically significant for other measures of profitability 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 their 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 12 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 association with banks that eventually offer negative rates on deposits (after NIRP starts) affected investment after the DFR 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 following the NIRP. We find however positive, but smaller increases in investment following an interest rate cut during the low interest rate period and an even smaller effect during the "normal" interest rate period.

These estimates are consistent with the idea that the opportunity cost of holding liquid assets increases when policy interest rates are further lowered. Increases in the cost of holding deposits in turn stimulate investment through the asset rebalancing channel, which we highlight. The drop in current assets is particularly pronounced for high exposure firms when the opportunity cost of

holding liquid assets becomes particularly pronounced, following the NIRP, but there are some smaller effects also following interest rates cuts during the previous period of low rates, suggesting that banks offering negative rates on deposits may have always had higher pass-through.

As is consistent with earlier evidence that firms' financial structure does not change, we do not find any effect of the NIRP on debt maturity or interest paid. During the low interest rate period, instead, high-exposure firms seem to have increased their short-term borrowing, contributing to their higher investment.

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 only recently central banks in Switzerland, Sweden, Denmark, Japan, and the euro area have moved their policy rates into the negative territory. However, breaking the so-called ZLB is more 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.

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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.

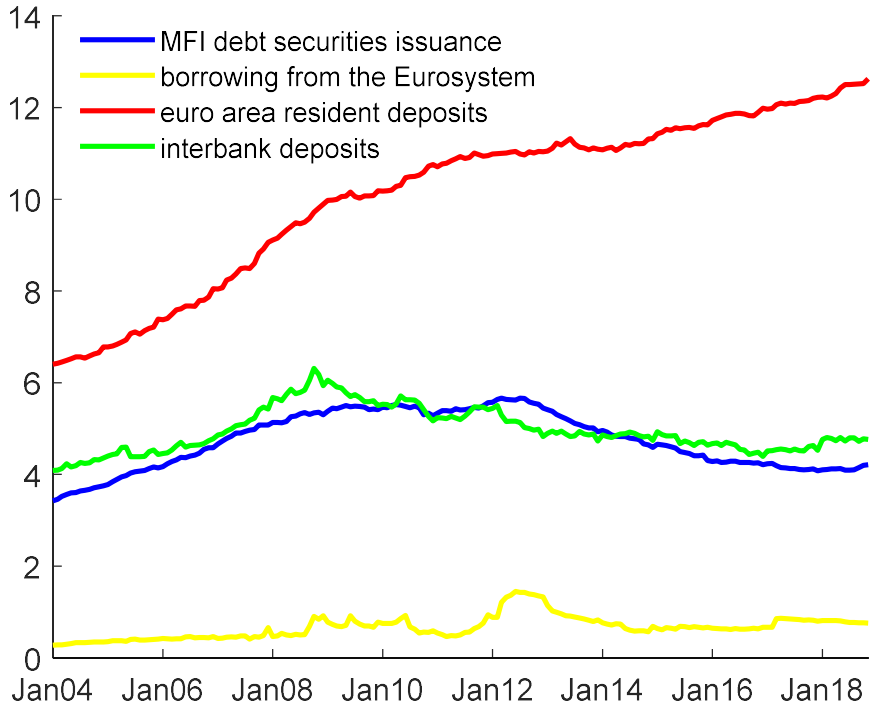
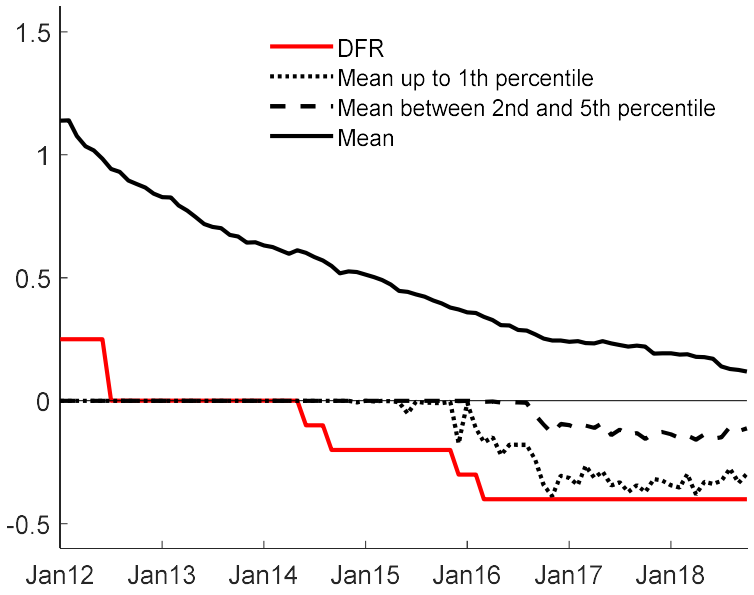


Figure 2: Evolution of Deposit Rates

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 show the evolution of different percentiles of the interest rates on corporate deposits. 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

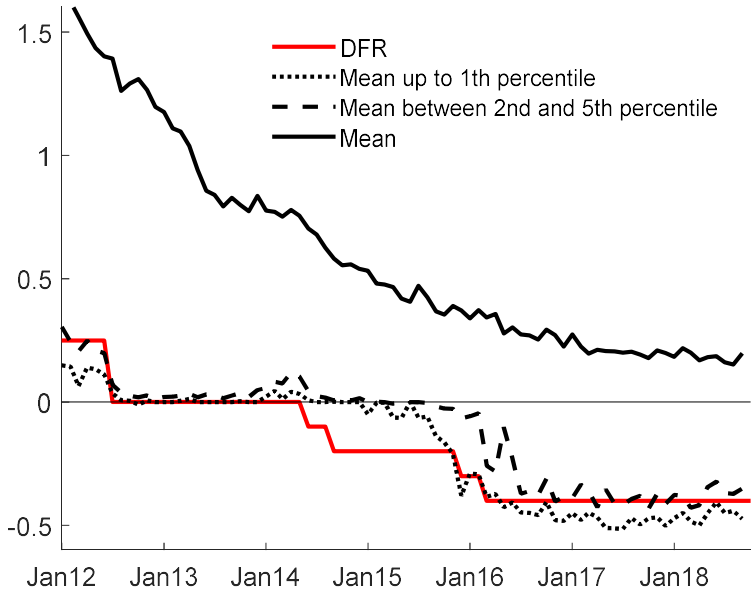
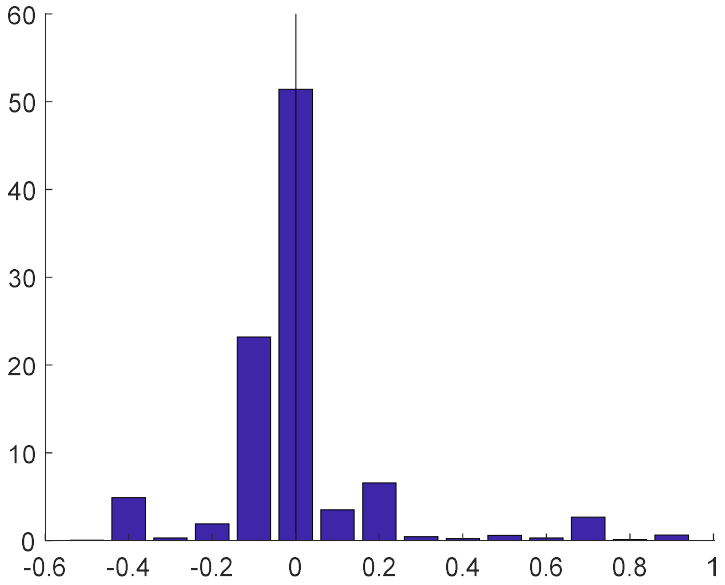


Figure 3: Deposits with Negative Rates

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

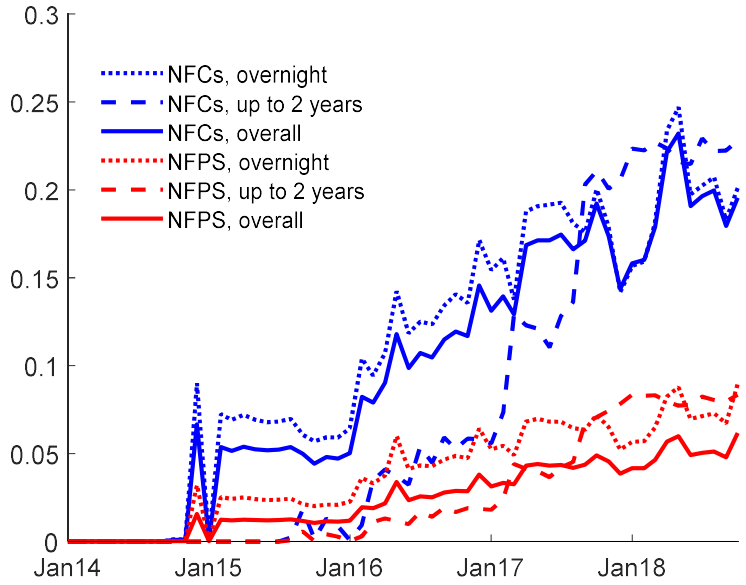


Figure 4: Deposits with negative rates across countries

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.

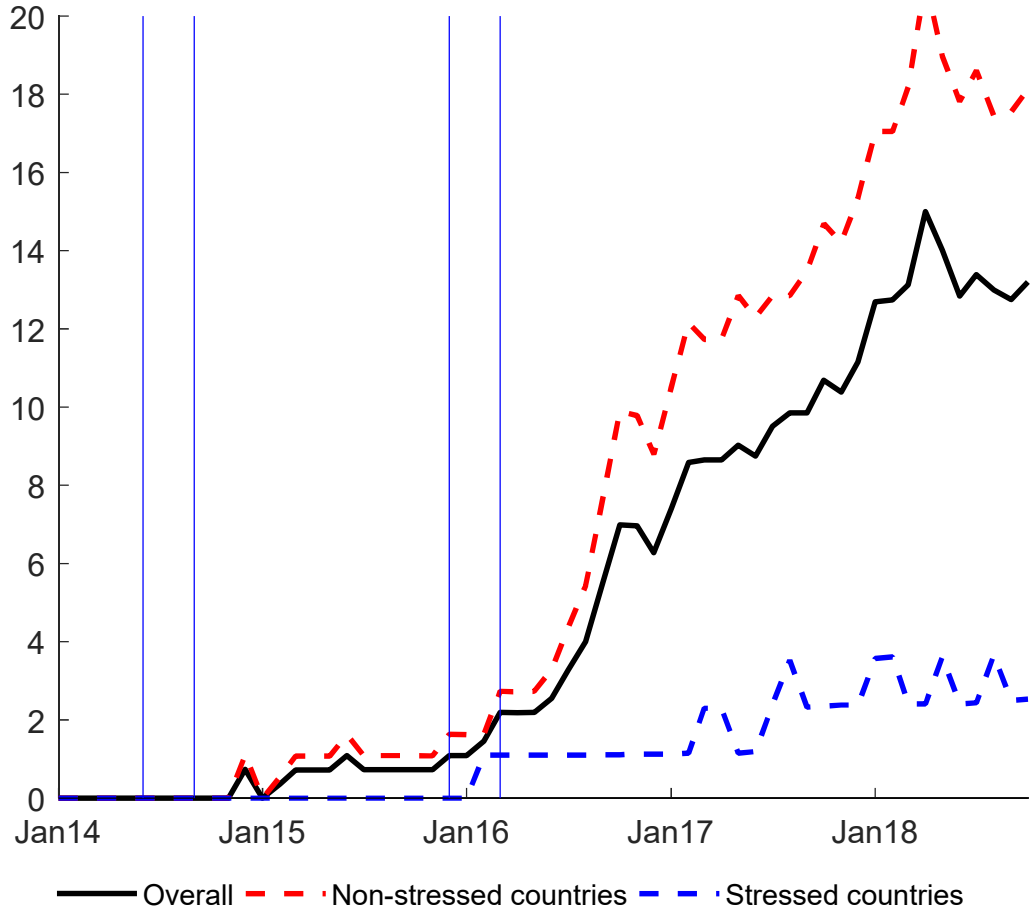
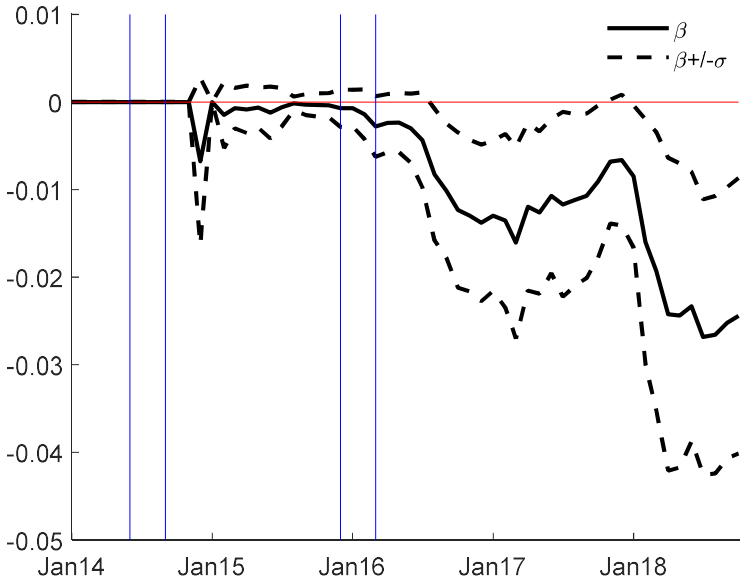


Figure 5: Estimated cross-sectional differences in the probability of negative rates

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

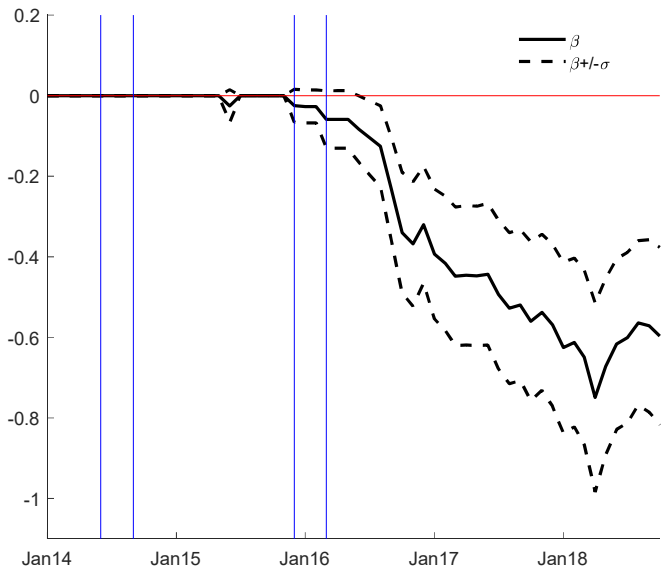


Figure 6: Pass-Through at Positive and Negative Rates

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.

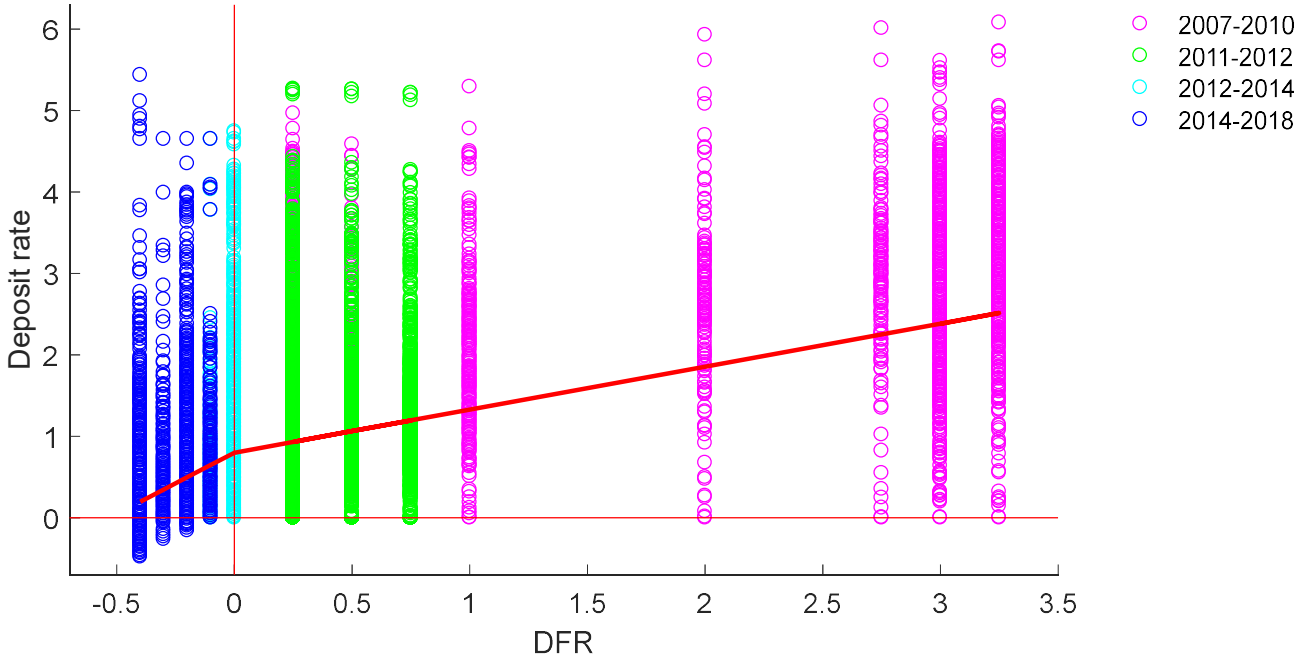
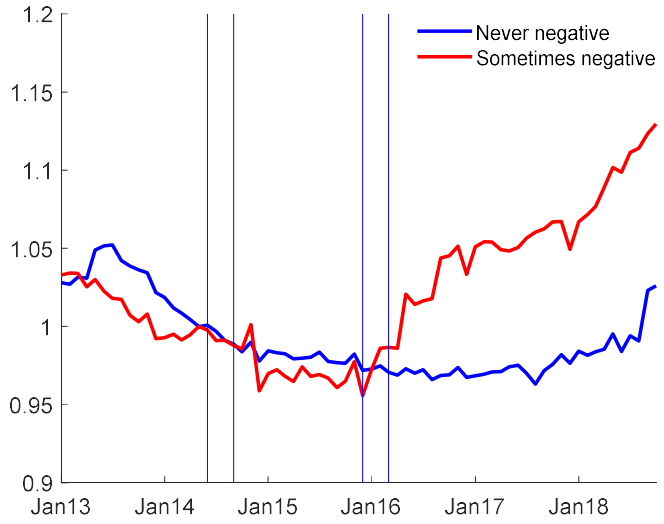


Figure 7: Lending and deposit volumes for banks with and without negative rates

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

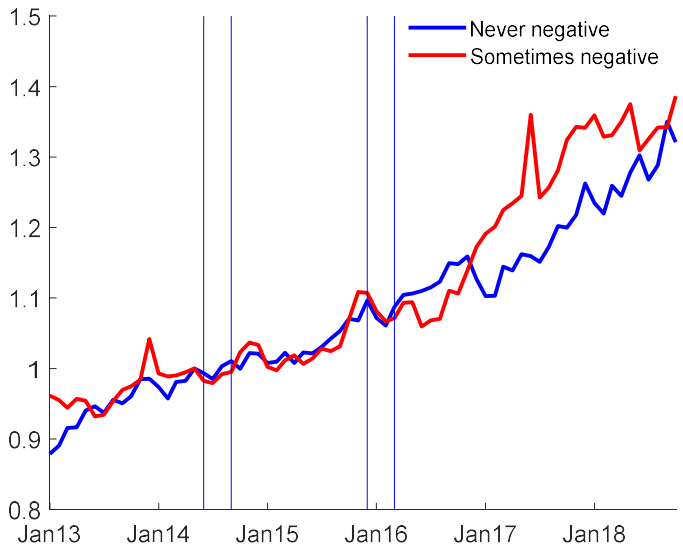


Figure 8: Evolution of the Demand for Credit of Different Banks

This figure reports 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 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 5 of Panel A of Table 5.

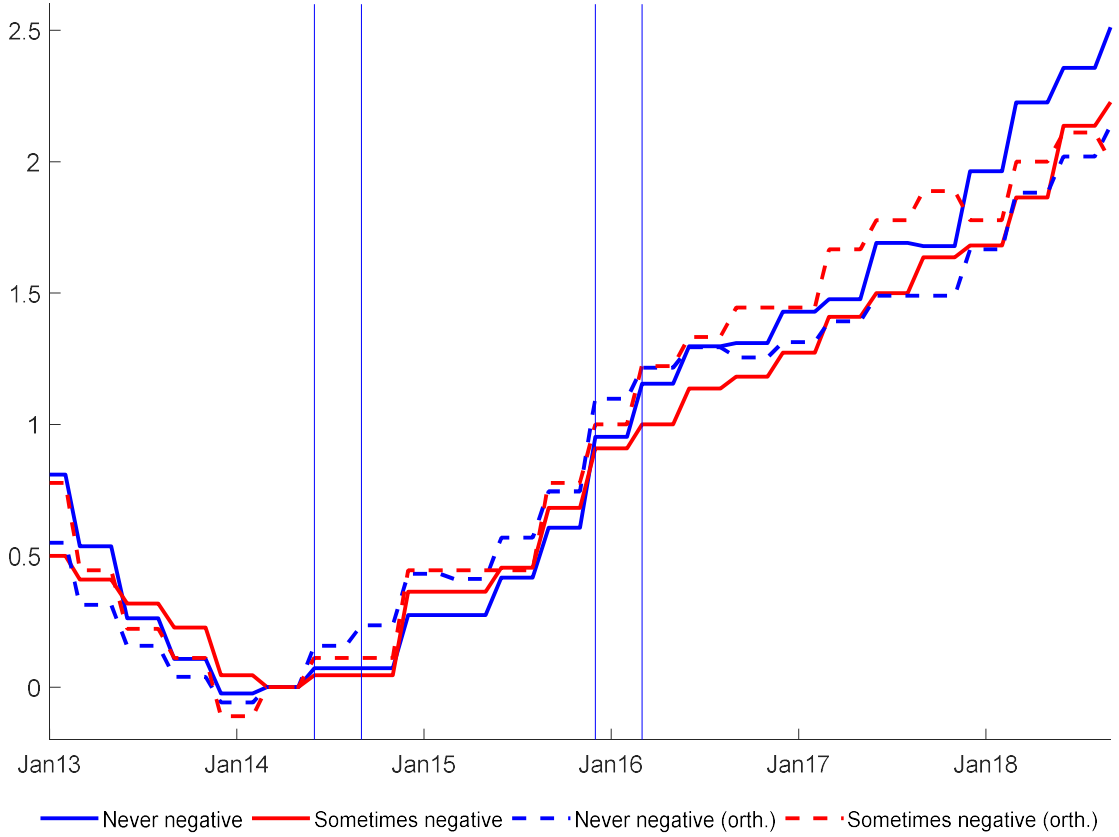


Table 1: Variable names, units, definitions, and summary statistics

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
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
Change in deposit rate	%	Monthly change in deposit rate.	22569	0.0	0.2	-11.3	0.0	0.0	0.0	6.5
Change in lending rate	%	Monthly change in lending rate.	22396	0.0	0.3	-9.3	0.0	0.0	0.0	8.7
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
Growth rates in lending volume	%	Monthly growth rate in lending volume.	22419	0.2	5.0	-35.5	-0.9	0.0	1.1	32.2
Cum. change in deposit rate	%	Change in deposit rate since May 2014.	20688	0.2	0.9	-3.5	-0.3	0.0	0.5	5.1
Cum. change in lending rate	%	Change in lending rate since May 2014.	20616	-0.1	1.2	-7.0	-0.7	-0.1	0.5	10.5
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 volume	%	Growth rate in lending volume since May 2014.	21931	8.2	47.8	-100.0	-10.5	0.9	15.6	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 one of the main banks 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 rate banks over the total number of main 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
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	1388.6	173.6	0.0	1275.3	1378.3	1489.0	2437.6
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 revenues.	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)
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*
		(0.019)		(0.016)	(0.022)	(0.023)	(0.021)	(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
					(0.153)	(0.146)	(0.150)	(0.655)
ROA					-0.151**	-0.132*	-0.087	-0.183**
					(0.074)	(0.077)	(0.062)	(0.072)
Foreign branch/subs.					-0.075	-1.104	-1.192	
					(0.547)	(0.805)	(0.826)	
Deposit ratio						0.013	0.017	0.054
						(0.048)	(0.049)	(0.084)
Excess liquidity						0.190**	0.217**	0.173***
						(0.091)	(0.102)	(0.065)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	-	-	-	-	-	Yes	Yes	-
Bank FE	-	-	-	-	-	-	-	Yes
Observations	22,633	22,633	13,296	22,633	22,633	22,633	22,633	22,633
R-squared	0.036	0.036	0.043	0.037	0.038	0.079	0.082	0.217

Table 3: Do Fees Substitute Rates?

We relate the ratio of fees and commissions relative to the deposits of non-financial corporations 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: Fees and commissions over total NFC deposits	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
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
		(0.101)		(0.130)	(0.114)	(0.150)	(0.043)	(0.043)
NPL ratio*Post		-0.030		-0.032	-0.038	0.023	0.054	0.058
		(0.083)		(0.081)	(0.078)	(0.094)	(0.050)	(0.050)
CDS spread			-0.003					
			(0.002)					
CDS spread*Post			0.000					
			(0.002)					
Assets					0.172	-1.188	-6.744*	-7.146**
					(0.434)	(0.747)	(3.455)	(3.547)
ROA					0.152	0.576	-0.113	-0.088
					(0.588)	(0.588)	(0.096)	(0.089)
Foreign branch/subs.					1.428	3.441		
					(2.430)	(2.247)		
Deposit ratio						-0.511**	-0.356***	-0.508***
						(0.223)	(0.096)	(0.166)
Excess liquidity						0.425***	0.137**	0.067
						(0.152)	(0.068)	(0.067)
Deposit ratio*Post								0.199
								(0.154)
Excess liquidity*Post								0.069*
								(0.039)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	-	-	-	-	-	Yes	-	-
Bank FE	-	-	-	-	-	-	Yes	Yes
Observations	17,554	17,554	10,937	17,554	17,554	17,554	17,554	17,554
R-squared	0.007	0.015	0.013	0.016	0.018	0.149	0.774	0.777

Table 4: Deposit Growth and Bank Health

We relate changes in banks' deposits over the intervals indicated on top of each column to 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.

Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)
Growth in deposits since May 2014	until Jun-15	until Sep-18	until Sep-18	until Sep-18	until Sep-18	Placebo: Change between May-14/ Jun-12
NPL ratio in May 2014	-1.080*	-2.441***	-2.278***	-2.019**	-2.846	0.594
	(0.610)	(0.814)	(0.831)	(0.819)	(2.044)	(0.535)
Assets in May 2014	-0.832	-11.088**	-9.941*	-27.142***	2.476	2.549
	(2.598)	(5.098)	(5.109)	(8.338)	(17.938)	(3.154)
ROA in May 2014	0.147	-1.245	-1.027	-0.933	-5.875	-0.872
	(0.543)	(0.906)	(0.931)	(0.897)	(4.478)	(0.675)
Foreign branch/subs.	-11.950	-29.060**	-29.561**	-31.674**	-5.392	1.064
	(8.256)	(14.036)	(14.092)	(15.360)	(17.229)	(7.600)
Deposit ratio in May 2014			-0.145	-1.402	-1.256	
			(1.276)	(1.238)	(1.529)	
Excess liquidity in May 2014			1.717*	1.402	-8.901	
			(1.027)	(1.079)	(16.948)	
Deposit rate in May 2014				-1.086	-51.862*	
				(22.625)	(30.290)	
Lending rate in May 2014				-12.988	-2.712	
				(11.419)	(20.220)	
Deposit volume in May 2014				0.001	-0.001	
				(0.001)	(0.001)	
Loan volume in May 2014				0.001	0.001	
				(0.001)	(0.001)	
BLS demand growth since May 2014					-1.373	
					(0.987)	
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	125	125	125	125	54	125
R-squared	0.223	0.314	0.327	0.371	0.549	0.173

Table 5: Bank Health and Credit Provision

We relate changes in bank lending (Panel A) and in the average interest rate on bank loans (Panel B) over the intervals indicated on top of each column to 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.

Panel A. Bank Lending

Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)
Growth in lending since May 2014	until Jun-15	until Sep-18	until Sep-18	until Sep-18	until Sep-18	Placebo: Change between May-14/ Jun-12
NPL ratio in May 2014	-1.298***	-1.533**	-1.706***	-1.715***	-2.359**	-0.190
	(0.310)	(0.674)	(0.632)	(0.607)	(1.130)	(0.672)
Assets in May 2014	-1.516	-6.110	-7.450**	-11.590*	1.253	-1.810
	(1.254)	(3.807)	(3.681)	(6.936)	(12.278)	(3.207)
ROA in May 2014	-0.751**	-1.599***	-1.796***	-1.776***	2.759	-2.034***
	(0.309)	(0.607)	(0.563)	(0.532)	(3.261)	(0.700)
Foreign branch/subs.	6.908	21.959	23.100	20.481	30.476**	-2.888
	(5.682)	(14.605)	(15.480)	(14.275)	(14.572)	(6.386)
Deposit ratio in May 2014			-0.064	-0.581	-1.148	
			(0.982)	(1.028)	(1.153)	
Excess liquidity in May 2014			-1.818**	-1.724**	-11.043	
			(0.728)	(0.734)	(11.796)	
Deposit rate in May 2014				-9.981	-16.176	
				(10.515)	(20.061)	
Lending rate in May 2014				-0.487	-2.553	
				(7.452)	(14.730)	
Deposit volume in May 2014				0.000	0.000	
				(0.000)	(0.001)	
Loan volume in May 2014				0.000	-0.001	
				(0.001)	(0.001)	
BLS demand growth since May 2014					1.195	
					(1.395)	
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	125	125	125	125	54	125
R-squared	0.347	0.338	0.361	0.372	0.659	0.275

Panel B. Loan Rates

Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)
Change in loan rates since May 2014	until Jun-15	until Sep-18	until Sep-18	until Sep-18	until Sep-18	Placebo: Change between May-14/ Jun-12
NPL ratio in May 2014	0.007	-0.007	-0.008	0.018	0.013	0.015*
	(0.014)	(0.021)	(0.019)	(0.012)	(0.010)	(0.008)
Assets in May 2014	0.040	0.051	0.026	-0.063	-0.093	0.075
	(0.049)	(0.051)	(0.046)	(0.058)	(0.107)	(0.063)
ROA in May 2014	0.023**	0.006	0.009	0.017	0.046	-0.004
	(0.009)	(0.013)	(0.013)	(0.010)	(0.032)	(0.009)
Foreign branch/subs.	-0.071	-0.039	0.050	-0.185	-0.224*	0.031
	(0.129)	(0.160)	(0.154)	(0.134)	(0.120)	(0.163)
Deposit ratio in May 2014			-0.030***	-0.011	-0.008	
			(0.011)	(0.009)	(0.011)	
Excess liquidity in May 2014			-0.010	-0.009	0.004	
			(0.020)	(0.013)	(0.104)	
Deposit rate in May 2014				0.059	-0.176	
				(0.100)	(0.213)	
Lending rate in May 2014				-0.687***	-0.550***	
				(0.099)	(0.136)	
Deposit volume in May 2014				0.000	0.000	
				(0.000)	(0.000)	
Loan volume in May 2014				0.000	-0.000	
				(0.000)	(0.000)	
BLS demand growth since May 2014					0.008	
					(0.010)	
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	125	125	125	125	54	125
R-squared	0.796	0.434	0.474	0.757	0.896	0.180

Table 6: 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.

Dependent Variable:	Debt/Assets	Debt/Assets	Debt/Assets	Investment	Investment	Investment	Debt/Assets	Investment	Current assets
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
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 7: 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

Table 8: 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 9: 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 10: 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 11: 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 12: 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. 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*Post Decrease	0.202***	-0.001	0.005	-0.002
	(0.030)	(0.002)	(0.010)	(0.002)
Exposure*Post Low	0.322***	-0.016***	0.031**	-0.002
	(0.027)	(0.002)	(0.015)	(0.002)
Exposure*Post Negative	0.407***	-0.025***	0.016	-0.001
	(0.071)	(0.008)	(0.018)	(0.003)
Exposure	0.666***	-0.126***	-0.099***	-0.002
	(0.103)	(0.009)	(0.033)	(0.003)
Current assets (lag)	3.456***	0.553***	0.182***	-0.011***
	(0.047)	(0.007)	(0.013)	(0.000)
Current assets (lag)*Post Decrease	-0.023	-0.032***	-0.019***	0.005***
	(0.025)	(0.001)	(0.004)	(0.000)
Current assets (lag)*Post Low	-0.039*	-0.037***	-0.048***	0.008***
	(0.021)	(0.002)	(0.008)	(0.000)
Current assets (lag)*Post Negative	0.040	-0.049***	-0.072***	0.009***
	(0.031)	(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	0.245	0.907	0.735	0.615