DEUTSCHE BUNDESBANK
EUROSYSTEM

Discussion Paper

Deutsche Bundesbank
No 33/2022

Going below zero – How do banks react?

Henrike Michaelis

Deutsche Bundesbank, Wilhelm-Epstein-Straße 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-0

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax +49 69 9566-3077

Internet http://www.bundesbank.de

ISBN 978–3–95729–907–9
ISSN 2749–2958

Non-technical summary

Research question

What characterises a banks that's opts to apply negative interest rates to corporate deposits? What is the role of household deposits and excess liquidity in this respect? Do banks adjust their fee and commission strategy during the negative interest rate policy (NIRP) period? If they do, what characterises those banks?

Contribution

My contributions to the interest rate pass-through literature are threefold. First, I analyse which bank characteristics are associated with the probability that a bank starts charging negative rates in Germany and whether there are differences between banks dependent on their exposure to NIRP. Previous literature analysed the euro area with a focus on "bank health". However, in most countries with significant portions of negative deposit rates, such as Germany, NPLs and default risk are not of a major concern. Most likely, other bank characteristics are at play. Second, I analyse if German banks changed their behaviour in charging fees after the implementation of NIRP. Third, I assess whether the influence of different bank characteristics has changed throughout the NIRP period.

Results

Banks that are highly exposed to NIRP, i.e. funded by a larger share of household deposits, are more likely to apply negative corporate deposit rates. Foremost banks with a business model that focuses on retail customers are driving this result. Most likely, especially these banks face a relatively higher pressure on their interest margins. To mitigate this pressure, they are more incentivised to charge negative corporate deposit rates. Furthermore, NIRP also implies a direct cost for banks due to their excess liquidity holdings. Thus, banks with relatively higher excess liquidity holdings might be incentivised to apply negative rates to mitigate the cost pressure. However, my results suggest that a relatively higher excess liquidity ratio only leads banks to be a little more incentivised to charge negative rates. This moderate effect fits with the finding that the cost of holding excess liquidity for banks is rather low relative to their burden of a shrinking interest margin in lending and deposit business as well. Thus, banks do not seem to be exposed to a far less favourable situation following an increase in their excess liquidity ratio.

Further, banks adjusted their strategy in deposit business with households during the NIRP period. Compared to before, they generated higher net commission income on their outstanding household deposit holdings.

Nichttechnische Zusammenfassung

Fragestellung

Was charakterisiert eine Bank, die negative Einlagenzinsen von ihren Unternehmenskunden verlangt? Welche Rolle spielen in diesem Zuge Einlagen von privaten Haushalten und die gehaltene Überschussliquidität? Verändern Banken ihre Strategie bzgl. Provisionserträgen während der Negativzinsphase? Falls ja, was charakterisiert solche Banken?

Beitrag

Auf dreierleiweise trägt dieses Papier zur Negativzinsliteratur bei. Erstens, analysiert es welche Bankcharakteristika in Verbindung stehen mit der Wahrscheinlichkeit, dass eine Bank beginnt negative Einlagenzinsen in Deutschland zu verlangen und ob sich diesbezüglich Banken unterscheiden abhängig von ihrer Belastung aus der Negativzinspolitik. Bisherige Literatur analysiert den Euroraum und fokussiert sich auf die finanzielle Solidität von Banken. Jedoch sind Soliditätsprobleme eher unbedeutend in den meisten Ländern, wie z.B. Deutschland, in dem Einlagen zu einem großen Teil negativ verzinst werden. Wahrscheinlich dürften andere Bankcharakteristika hier wichtiger sein. Zweitens analysiert die Studie, ob deutsche Banken ihr Verhalten bzgl. ihrer Provisionserträge während der Negativzinsphase verändert haben. Drittens, wird untersucht, ob sich der Einfluss der Bankcharakteristika auf die genannten Fragestellungen während der Negativzinsphase verändert hat.

Ergebnisse

Banken die der negativen Zinspolitik besonders ausgesetzt sind, sich z.B. stärker über Haushaltseinlagen finanzieren, verlangen eher negative Einlagenzinsen von Unternehmen. Vor allem treiben Banken dieses Ergebnis, deren Geschäftsmodell auf Einzelkunden beruht. Wahrscheinlich sehen sie sich einem höheren Druck auf ihre Zinsmargen ausgesetzt. Um diesen zu vermindern, sind sie stärker angereizt negative Einlagenzinsen zu verlangen. Ferner verursacht die Negativzinspolitik direkte Kosten für Banken aus dem Halten von Überschussliquidität. So haben Banken mit relativ höherer Überschussliquidität einen stärkeren Anreiz negative Zinsen zu verlangen. Die Ergebnisse zeigen jedoch, dass eine relative höhere Überschussliquidität nur einen leicht höheren Anreiz für negativen Zinsen generiert. Dieser moderatere Effekt steht im Einklang damit, dass die Kosten aus dem Halten von Überschussliquidität für Banken eher niedrig sind verglichen mit ihrer Belastung aus schrumpfenden Zinsmargen im Kredit- und Einlagengeschäft. Daher dürften Banken keiner ungünstigeren Lage ausgesetzt sein, wenn sich ihre Überschussliquidität erhöht.

Ferner veränderten Banken ihre Strategie bzgl. ihrer Provisionserträge während der Negativzinsphase. Verglichen mit zuvor, generieren sie höhere Provisionserträge aus ihren Einlagen privater Haushalte.

Going below zero – How do banks react?[1]

Henrike Michaelis

Deutsche
Bundesbank

Abstract

Exploiting confidential data on individual German bank balance-sheets, I analyse what characterises a bank that opts to apply negative interest rates to corporate deposits. The results suggest that banks that are highly exposed to the negative interest rate policy (NIRP), i.e. funded by a larger share of household deposits, are more likely to apply negative corporate deposit rates. Furthermore, I examine whether banks adjusted their fee and commission strategy during the NIRP period and if they do what characterises those banks. My results show that banks adjusted their strategy in deposit business with households during the NIRP period. Compared with before, they generated higher net commission income on their outstanding household deposit holdings.

Keywords: Monetary policy transmissions, negative rates, deposits, excess liquidity, interest rate pass-through, fees and commissions

JEL classification: E52, E43, E44, E58, G20, G21

---

[1] Contact address: Wilhelm-Epstein-Strasse 14, 60431 Frankfurt am Main, Germany. Phone: +49 (0)69 9566 4317. Email: Henrike.Michaelis@bundesbank.de. The author wishes to thank Ulrike Busch, Nicole Binder, Sebastian Bredl, Peter Egger, Nuri Rimon Khayal, Melanie Klein, Björn Kraaz, Steven Ongena, José-Luis Peydró, Joachim Winter, Kerstin Zimmermann and participants at a Bundesbank Research Workshop for their very helpful comments. The views expressed in this paper are those of the author and do not necessarily coincide with the views of the Deutsche Bundesbank or the Eurosystem.

1. Introduction

Negative monetary policy rates are unprecedented and controversial. Nevertheless, several central banks around the world have moved their policy rates below zero to stimulate the economy in the post-crisis period, which featured anaemic growth and low inflation. E.g., the ECB's Governing Council decided in June 2014 to lower the deposit facility rate to –0.10 %. From September 2019 until most recently, the DFR stood at –0.50 %. Next to the ECB, also the central banks of Denmark, Switzerland, Sweden and Japan implemented negative polity rates. The Federal Reserve (Fed) as well as the Bank of England (BoE) lowered their policy rates close to zero but have not implemented negative policy rates.[2] Therefore, many of the major central banks operated already at the zero lower bound or are still close to it. Although the current inflation outlook points towards higher central bank interest rates, it cannot be ruled out that the ability to go below zero or even further negative might be a crucial fall back option in fighting future economic downturns again.

Generally, banks hesitate to remunerate retail depositors negatively and thus contribute to an imperfect pass-through of policy rates to deposit rates (Jobst and Lin, 2016; Eisenschmidt and Smets, 2018; Demiralp et al., 2019). The theoretical argument for this is intuitive. At some point, deposits with negative interest rates become inferior to holding cash and are thus more likely to be withdrawn. Fearing withdrawals, banks are reluctant to charge deposit rates below zero. However, we do observe negative deposit rates. E.g., in the euro area the share of deposits with negative interest rates to total deposits stands at 5 % and at around 20 % for corporate deposits in 2019 (Altavilla et al., 2019). The respective numbers for the German banking system are even higher. On average, 15 % of total deposits remunerate below zero and approximately 50 % of corporate deposits.[3] Within the different deposit categories, the so-called sight deposits account for the highest share of negatively remunerated deposits. Here, more than 20 % of German private household deposits remunerate below zero and around 80 % of corporate deposits since mid-2019.[4] Thus, although the interest rate of a significant portion of bank deposits is in negative territory, the data reveals a possible zero lower bound (ZLB) for private household deposits. It is unclear why the ZLB seems more binding for household deposits than for corporates. One common hypothesis is that households, compared to corporates, are generally in a better position to withdraw a larger share of their deposits. Their deposits are in general smaller and can thus be easily withdrawn. In contrast, corporations cannot operate as easily without bank accounts; they need to pay employees and suppliers and receive payments

[2] In the surge of the coronavirus crisis, officials at the BoE also reassessed the implementation of negative policy rates (Pugsley, 2021; Tenreyro, 2021; O'Brien and Meakin, 2020).

[3] An explicit statement on the exact share of depositors which face negative remunerations is not possible since each bank only reports the average interest rate for each deposit category. Each deposit category may therefore contain positive and negative interest rates. Data source: MFI interest rate statistics (ZISTA), Deutsche Bundesbank.

[4] Data source: MFI interest rate statistics (ZISTA), Deutsche Bundesbank.

from customers. Furthermore, during the first years of the negative interest rate period in Germany, there was a floor for the application of negative rates on deposits. Initially, deposits below 100 000 € were exempted. Thus, many private household deposits and those of smaller companies were typically below this threshold. However, over time, this threshold was slowly softened by banks (Damyanova, 2021; tagesschau, 2021).[5] This might also partially explain why a larger share of retail customer deposits (especially private households) were initially exempted from negative deposit rates but over time also remunerated below zero.

From a monetary policy perspective, the effectiveness of negative interest rate policies also depends on the pass-through of negative policy rates to most banks' funding costs. Among the funding structure of banks, deposits play a crucial role. Especially German banks rely to a large extent on deposits as a funding source. Household and corporate deposits account for 40 % of their funding.[6] Thus, if the pass-through to banks' funding costs and especially to their deposit rates is seriously hampered while interest rates on banks' assets decline, banks' interest margins erode, decreasing their ability to build up equity internally. Inter alia, this could negatively affect loan supply and furthermore, weaken the shock absorbing capacity of the banking system.

It is still largely unclear why some banks pass negative rates to their deposit customers while others do not. Further, it is not clear how banks exactly react to increased profitability pressure caused by negative policy rates and thus influence the real economy (see literature below). One possibility is a reduced pass-through to deposit rates banks offer. Another possibility is to attempt to generate more income from fees and commissions. A third option is that banks rebalance their portfolio towards higher interest rate bearing assets such as financial assets or loans to firms and households. This most likely comes along with an increase in risk taking.

It is crucial for monetary policy to learn how banks react to negative interest rates policies, especially when this situation lasts for a long period. Also the existing theoretical and empirical literature on the role of banks in the transmission mechanism of monetary policy below the ZLB is still rather inconclusive. A country like Germany, which has already experienced negative rates for several years, can thus provide highly interesting insights.

Against this background, this paper aims at tackling two research questions. The first question focuses on what characterises a bank that opts to apply negative interest rates to corporate deposits.[7] The other traces what characterises a bank that increases its fee and commission income during the negative interest rate policy (NIRP) period.[8] These two avenues are empirically analysed independently of each other.

[5] The successive lowering of the threshold started more broadly in the second half of 2021 (Stiftung Warentest, 2022).
[6] The number refers to deposits of private households and non-financial corporations relative to total liabilities (without other liabilities). Data source: MFI balance sheet statistics (BISTA), Deutsche Bundesbank.
[7] The underlying data for this research question runs from September 2014 to September 2019.
[8] This analysis is based on data from January 2012 until September 2019.

The results suggest that especially a larger share of household deposits in relation to total liabilities increases the probability of negative interest rates being applied to corporate deposits by 46 percentage points.[9] Further, banks seem to have adjusted their strategy in deposit business with households during the NIRP period. They generated higher net commission income on their outstanding deposit holdings than during pre-NIRP. This could be because banks raised their fees in deposit business with households. It might also be because banks used their business relationships with households to cross-sell further banking services from which they generated commission profits.

The remainder of this paper is structured as follows: Section 2 describes the contribution to the existing literature. Section 3 outlines institutional background information on the NIRP period in the euro area. Section 4 summarises the data. Section 5 introduces the estimation strategy and section 6 presents the results. Section 7 concludes.

2. Literature on the transmission of monetary policy under negative rates

The literature on the pass-through of negative interest rates policies (NIRP) and bank performance is still rather limited with partly ambiguous results. It often focuses on discussing implications of NIRP on bank performance and thereby summarising developments in important banking characteristics (Bech and Malkhozov, 2015; Jobst and Lin, 2016; Blot and Huber, 2016; Gross, 2016; Brunnermeier and Koby, 2018).

Normally, monetary policy easing leads to lower rates on both deposits and lending rates. This does not necessarily hold in case of NIRP: the cost of funding for banks relying relatively more on deposit funding than wholesale funding may not fall in a similar way. Thus, ceteris paribus, banks with a higher deposit funding ratio would experience a decrease in profitability and net worth. Against this background, Heider et al. (2019) argue that NIRP exposes banks differently depending on their liability structure. Therefore, banks that are relatively more affected might start taking on more risk and reduce lending. Thus, their results suggest possible contractionary effects following NIRP. In a similar vein are the findings by Borio and Gambacorta (2017). They stress that the bank-lending channel is less effective in a low interest rate environment. Eggertsson et al. (2019) even document a collapse in pass-through to deposit and lending rates once the policy rate turns negative, owing to zero-interest-bearing cash becoming relatively more competitive. Others are arguing that the bank-lending channel remains intact under NIRP (Bräuning and Wu, 2017; Basten and Mariathasan, 2018) or might even be strengthened (Altavilla et al., 2021; Demiralp et al., 2019). More specifically, Demiralp et al. (2019) estimate that banks with large excess reserves respond to NIRP by granting more loans. Thus, this confirms studies that point to higher risk taking by banks as a reaction to NIRP. Altavilla et al.

[9] Following a one standard deviation increase in the household deposit share.

(2021) estimate for the euro area that banks charging negative rates provide more credit than other banks suggesting a not hampered transmission as well. They show that sound banks can pass negative rates on to their customers without experiencing a contraction in funding.

A further implication of NIRP is that banks might be trying to compensate the reduced interest rate margin by trying to increase their non-interest income, such as requiring higher fees and commissions. This effect is estimated by Bastan and Mariathasan (2018) for Switzerland and by Bottero et al. (2019) for Italy. Both papers employ a difference-in-differences framework and find that bank profitability is unaffected by NIRP as banks offset lower-interest margins with raising fees. Furthermore, they also show that banks that were more affected by NIRP (have a larger share of retail deposits) increased their fee income more than less affected banks. For the euro area, Altavilla et al. (2019) find that only banks with high excess liquidity appear to increase their fees after the implementation of NIRP. They do not estimate that banks with larger retail deposit shares charge higher fees. Quite the contrary, also with respect to the existing literature, they show that these banks always charge lower fees and do not change their behaviour after the implementation of NIRP. For Germany, Busch et al. (2021) estimate that banks that suffer income losses increase their fees and commissions. However, they employ only very few bank specific determinants (e.g. income and a capital ratio). This limits a more detailed analysis on possible driving bank characteristics and differences among banks. They use data from three quantitative surveys (2015, 2017, 2019).

However, while NIRP may lead banks to adjust their balance sheet and increase risk taking, "tipping points" might exist at which banks cannot handle further reductions in their profits and therefore shift to other strategies. These might entail adverse effects on bank lending. Brunnermeier and Koby (2018) argue that a so-called "reversal-rate" exists. More specifically, below some, possibly negative level of the policy rate further easing could also be contractionary. Its existence relies on faster decreases in net interest income of banks than banks' asset revaluation gains from duration mismatch.

Summing up, there already exists some research addressing the interest rate, balance sheet and risk-taking channel during NIRP. However, an examination which bank characteristics are associated with the probability that a bank starts charging negative rates has only been done by Altavilla et al. (2021) for the euro area. They are exploring possible drivers of bank characteristics on charging negative rates with a focus on "bank health" (proxied by NPLs or bank default risk). However, in most countries with significant portions of negative deposit rates, such as Denmark, Switzerland, Sweden, Japan and Germany, NPLs and default risk are not of a major concern.[10] Most likely, other bank characteristics are responsible for

[10] The NPL ratio in Germany stands on average at 1.6 % during the negative interest rate period (ECB Statistical Data Warehouse, Consolidated Banking data). The respective number for the euro area is 4.3 %.

remunerating deposits negatively.[11] Therefore, the contribution of this paper is to shed more light on how bank characteristics are related to negative deposit rates in Germany and whether there are differences between banks dependent on their exposure to NIRP.

Furthermore, to the best of my knowledge, the literature has not so far explored the question if German banks changed their behaviour in charging fees after the implementation of NIRP. Taking thus a closer look on German banks provides first insights whether they changed their behaviour and whether this is possibly linked to the NIRP-exposure of the respective banks.

Also, there seems (at least to my knowledge) no analysis on both topics (probability to charge negative rates and fee charging) yet that assesses whether the influence of different bank characteristics has changed throughout the NIRP period. Against the background of a low for long environment, it is likely that their influences alter. Finally, a better understanding of the NIRP transmission mechanism in Germany might also help in improving the overall understanding of the euro area wide transmission mechanism.

3. Institutional background of NIRP in the euro area

The ECB introduced negative policy rates in June 2014 by lowering the deposit facility rate (DFR) to –0.10 %. With this decision, the ECB moved into negative territory for the first time. Further decreases followed (September 2014, December 2015, March 2016 and September 2019). Since September 2019 until July 2022, the DFR stood at –0.50 %. Money market rates were the first to follow the DFR below zero. They generally reflect banks' funding cost best. E.g., the 3-month OIS (3M-OIS) turned negative in September 2014. Figure 1 shows that the initial transmission of the DFR cut in September 2014 to the 3M-OIS took longer than usual. But, the preceding rate cuts passed through more quickly and were after all complete.

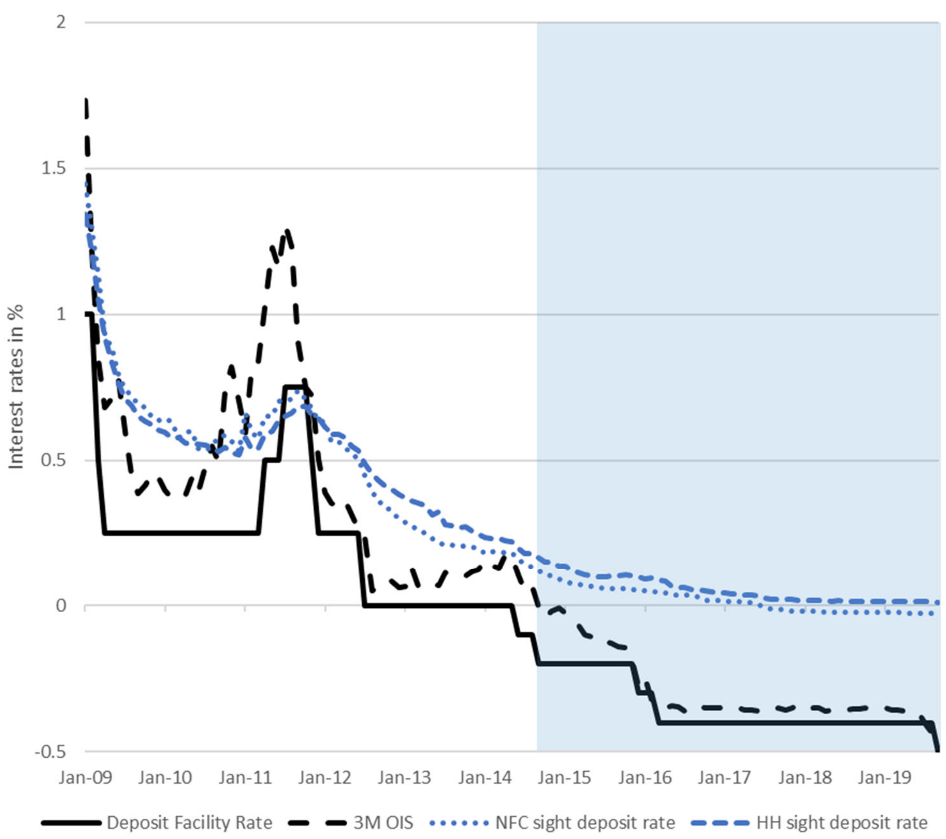
This contrasts with the pass through to interest rates paid by banks for deposits of households (HH) and non-financial corporations (NFC). Figure 1 shows that both interest rates on deposits still declined somewhat throughout the beginning of the NIRP period in Germany and then remained fairly stable around the zero line. Thus, the path of the deposits rates increasingly deviates from the 3M-OIS since the NIRP period.

This illustrates that lowering the policy rate below zero affects a banks' cost of deposit funding and the cost of short-term market funding differently. The monetary policy transmission under these circumstances therefore seems to differ from the transmission under normal circumstances. In the latter case, it passes-through to both lower short-term market rates as well as to lower deposit rates.

[11] Rerunning my benchmark specification of the linear probability model by additionally including the NPL ratio of banks in Germany confirms that it is not correlated with a higher probability that a bank charges negative rates to NFCs. Results can be obtained via request. NPL Data source: quarterly data from FinaRisikoV since January 2014; linearly interpolated to monthly data.

It is still to some extent unclear why banks seem more reluctant to pass-through negative interest rates to depositors and foremost to HH depositors. The main argument is based on the zero nominal return on cash. Depositors could withdraw their deposits and hold it in cash instead (Eisenschmidt and Smets, 2019). This argument would hold more for HH depositors, as it is generally easier for them than for NFCs to convert a larger proportion of their deposits into cash. Furthermore, going below zero might represent more of a "psychological" barrier for HHs and initiates a stronger response. Also, it is possible that banks are afraid of harming their reputation in case they implement negative deposit rates.

Figure 1: The deposit facility rate, the 3-month OIS and the German retail deposit rates



Source: ECB Statistical Datawarehouse, Datastream and ZISTA. The blue area represents the length of the NIRP period which is analysed in this paper (September 2014 to September 2019).

The difference in the transmission of negative policy rates to short-term market rates and deposit rates exposes banks differently depending on their liability structure: the funding costs of banks which are relying relatively more on deposit funding reduce by less compared to banks with relatively little deposit funding. Hence, negative policy rates weigh more on the profits of banks who are more reliant on deposit funding, all other things being equal. This motivates my empirical strategy to classify banks depending on their retail deposit intensity into three business models: low, medium and high retail deposit intensities.[12]

[12] For further details see section 6.

The negative DFR implies, furthermore, that banks face direct expenses for holding excess liquidity.[13] This cost increases with the volume of excess liquidity they hold. Therefore, banks with relatively higher excess liquidity face larger expenses compared to banks with relatively low volumes of excess liquidity, all other things being equal.

In a nutshell, I aim to test whether NIRP leads those banks which are more exposed to it to apply negative deposit rates to NFCs with a higher probability and to attempt to generate more income from fees and commissions.

4. Data

My empirical analysis relies on several proprietary data sources. I obtain German bank level information from the balance sheet statistic (BISTA) from the Deutsche Bundesbank. It reports the main asset and liability items of banks based in Germany. Information on bank-level interest rates is drawn from the MFI interest rate statistic (ZISTA), another proprietary dataset from the Deutsche Bundesbank. It contains information on deposit and lending rates charged by banks for different maturities and different loan sizes (both for loans outstanding and new businesses). Both data sets are collected at a monthly frequency. I use the BISTA data to calculate bank-specific control variables. A detailed description of the variables used in the regressions is shown in Table A1 in the Appendix Section A1. I obtain data on e.g. bank-level return on assets as well as fees and commissions from the MFI profit and loss accounts (GuV). It is an annual statistic from the Deutsche Bundesbank. For enriching the annual GuV-Data with intra-year developments, I refer to the confidential FinaRisikoV[14] from Bafin and Deutsche Bundesbank. It is a quarterly statistic starting in 2014.[15]

I adjust the data with the aim of reducing the influence of outliers in the analysis. Therefore, I winsorize all bank specific variables at the 1st and 99th percentiles. Overall, the final unbalanced sample of the baseline model consists of 267 banks. It provides a comprehensive coverage of the German banking system. Some statistical properties of the rich set of bank characteristics that I obtain from merging the above datasets are shown in Table A2 in the Appendix Section A2. The merged data set runs from January 2003 until September 2019.[16]

[13] Excess liquidity denotes banks' predominantly short-term credit balances on their central bank accounts in excess of their required reserves.

[14] FinaRisikoV denotes "Finanz- und Risikotragfähigkeitsinformationenverordnung". It is based on the German Financial and Internal Capital Adequacy Information Regulation.

[15] Data prior to 2014 is based on the GuV and since 2014 on the FinaRisikoV. The respective data is linearly converted to monthly data.

[16] The analysis stops in September 2019, since the Eurosystem adopted a two-tier system for remunerating excess liquidity in September 2019. Before excess liquidity was remunerated at the negative interest rate of the DFR. From then on, it is remunerated at 0 % up to a certain level (currently six times their minimum reserve).

5. Empirical strategy

My empirical analysis encompasses two mutually independent steps. First, I explore how bank characteristics are associated with the probability that a bank, on average, charges negative rates on its overnight (sight) deposits to NFC after June 2014. The second step focuses on tracing the extent to which the influence of different bank characteristics on the commission margin has changed over time. That is are certain bank characteristics increasingly associated with a higher commission margin?

5.1 Probability to charge negative rates

Why do some banks, but not other, break the zero lower bound? For this, a linear probability model with fixed effects is employed. It analyses which bank characteristics are associated with a higher probability to charge negative interest rates on NFC deposits. The estimation period covers the time period from September 2014 to September 2019.[17] Since September 2014, the three-month OIS remunerates below zero. I specify an estimation equation that is broadly related to Altavilla et al. (2021):

$$Y_{i,t} = \beta_j X_{i,t-3} D^I + \beta_{j+1} X_{i,t-3} D^{II} + \lambda Z_{i,t-3} + T_t + B_i + \varepsilon_{i,t} \quad (1)$$

where $Y_{i,t}$ is the dependent variable which takes a value of one if an individual bank's i average volume-weighted interest rate on NFC sight deposits is negative in month t and equal to zero otherwise. The benchmark model contains three explanatory bank-specific variables which are summarised by $X_{i,t-3}$. These variables are the main point of analysis and comprise: a bank's NFC deposit share ($Dep\_share^{nfc}_{i,t-3}$), HH deposit share ($Dep\_share^{hh}_{i,t-3}$) and the excess liquidity ratio ($EL_{i,t-3}$).[18] Each of these variables are defined as a percentage of the respective bank's total liabilities or assets. D^I and D^{II} are dummy variables. They split the NIRP period to investigate if the influence of the main variables of interest has changed over the course of NIRP. D^I denotes the first half of the NIRP period from September 2014 until December 2016.[19] D^{II} specifies the second half of the NIRP period running from January 2017 to September 2019. Therefore, D^I and D^{II} are equal to one for their respective subperiods and zero otherwise. In addition, the benchmark model contains two bank-specific control variables. These are denoted by $Z_{i,t-3}$ and comprise: liquid assets as a percentage of total assets ($Other\_LR_{i,t-3}$) and the bank's size ($Size_{i,t-3}$). The latter is measured by the logarithm of total assets.

The benchmark model is gradually extended to additionally include the following bank-specific variables: the net interest margin ($NIM_{i,t-3}$), a profitability measure ($RoA_{i,t-3}$) and the capital

[17] Thus, the length of the estimation sample is 61 months.

[18] The deposit base refers to volume (stocks) for sight and time deposits to either NFC or households. Excess liquidity denotes banks' predominantly short-term credit balances on their central bank accounts in excess of their required reserves. Excess liquidity is a subset of banks' total claims on the Eurosystem. Unlike excess liquidity, the latter also include longer-term claims.

[19] The split was timed to have two roughly equal subperiods in length and to coincide with the turn of a year.

ratio ($Tier1\_R_{i,t-3}$). More specifically, the NIM is defined as the net interest income over outstanding loans; RoA refers to net operating income over total assets and the $Tier1\_ratio$ denotes the Tier 1 capital divided by risk weighted assets. The vector $X_{i,t-3}$comprises these variables as well. Thus, these variables are also interacted with the time dummies.

Due to potential endogeneity between the dependent variable and the bank-specific variables, the latter are lagged by three months. T_t refers to time fixed effects that capture all effects which do not vary over the cross sectional dimension such as macroeconomic developments. I also include bank fixed effects (B_i) to control for unobservable time-invariant bank-specific factors that affect the decision to charge negative deposit rates. The standard errors are double clustered at bank and time levels.

5.1.1. Additional interaction term for identifying whether banks highly exposed to NIRP tend to have a higher probability for charging negative rates?

It is plausible to expect that banks which are more exposed to NIRP are more incentivised to turn to charging NFC deposit rates negatively. Especially banks which rely more on traditional retail (foremost HH) deposit funding, are possibly among those banks which are more exposed to NIRP, as these banks might face a relatively higher pressure on their interest margins, all other things being equal. Furthermore, banks with relatively higher excess liquidity holdings might also be more incentivised to turn to charging negative rates, as the holding of excess liquidity implies a direct cost for them. Thus, banks that are most reliant on HH deposit funding and that hold a relatively high level of excess liquidity are likely more inclined to charge negative rates to NFC deposits to mitigate this NIRP pressure. Interacting the HH deposit share ($Dep\_share^{hh}_{i,t-3}$) and the share of a banks' excess liquidity ($EL_{i,t-3}$) allows to trace this relationship. More specifically, it traces whether the effect of the HH deposit share on the probability to charge NFC deposits negatively is different for different levels of excess liquidity. E.g., it is reasonable to expect that this relationship becomes stronger the higher the level of excess liquidity gets. Furthermore, for testing whether the influence of the interaction term changes throughout the NIRP period, it is additionally interacted with the two NIRP dummy variables D^I or D^{II}. The remaining estimation setup is the same as in equation (1). Since this estimation extends the setup from above by the interaction terms, it can also be seen as a robustness check.

$$Y_{i,t} = \beta_j X_{i,t-3} D^I + \beta_{j+1} X_{i,t-3} D^{II} + \gamma_1 EL_{i,t-3} D^I Dep\_share^{hh}_{i,t-3} + \gamma_2 EL_{i,t-3} D^{II} Dep\_share^{hh}_{i,t-3} + \lambda Z_{i,t-3} + T_t + B_i + \varepsilon_{i,t} \quad (2)$$

5.1.2. Introduction of macroeconomic variables to trace their influence on a banks' probability for charging negative rates?

The implementation of macroeconomic variables instead of time fixed effects allows to incorporate further variables of interest, e.g., the share of banks charging negative deposit rates or the term premium. Due to competition it is plausible to expect that a banks' decision on charging negative rates is positively correlated with the overall share of banks in Germany charging negative deposit rates to NFC.[20] Furthermore, the term spread (difference between 10Y German government bond and 2Y OIS) captures the earnings potential of maturity transformation performed by banks. The term spread declined over the sample period. This implies growing pressure from the overall low interest rate environment on banks. A lower term spread is hence assumed to be positively correlated with a higher probability for negative NFC deposit rates. Next to the share of banks charging negative NFC rates ($Neg\_share_{i,t-3}$) and the term spread ($Term\_spread$), real GDP (GDP) and consumer price inflation ($HICP$) are further macroeconomic controls. The latter three are included in the vector $C_{i,t}$. The remaining estimation setup is the same as in equation (1). This reestimation can also be seen as a further robustness check.

$$Y_{i,t} = \beta_j X_{i,t-3} D^I + \beta_{j+1} X_{i,t-3} D^{II} + \lambda Z_{i,t-3} + \delta Neg\_share_{i,t-3} + \vartheta C_{i,t} + B_i + \varepsilon_{i,t} \qquad (3)$$

5.2 Adjustments in fees and commissions

Besides applying deposit rate cuts, banks could also use other instruments, e.g. higher fees and commission, to alleviate the pressure that a declining interest margin exerts on their profitability. In order to analyse whether banks increasingly shifted their income structure towards fees and commissions and which bank characteristics were the potential drivers, I relate the ratio of net fee and commission income relative to a banks' total assets ($Commission\_margin$) to various bank characteristics.[21] The estimation period is January 2012 till September 2019.[22] Thus, it includes both the NIRP period and the preceding (pre-NIRP) period, when the short-term market interest rate was just above zero. This wider observation period allows to investigate if the influence of the variables under consideration in the NIRP period was statistically different from that observed in the pre-NIRP period.

A dynamic panel model with bank and time fixed effects is used. The independent variables are the same as above in equation (1). Thus, the following panel fixed effects model is estimated:

$$Y_{i,t} = \delta Y_{i,t-1} + \beta_j X_{i,t-3} D + \beta_{j+1} X_{i,t-3} D^I + \beta_{j+2} X_{i,t-3} D^{II} + \lambda Z_{i,t-3} + T_t + B_i + \varepsilon_{i,t} \qquad (4)$$

where $Y_{i,t}$ refers to the $Commission\_margin_{i,t}$. D denotes the dummy variables for the pre-NIRP period. It is equal to one for January 2012 until August 2014 and zero otherwise. All the other variables stay the same as in equation (1).

[20] It refers to the share of banks, other than bank *i*, in month *t* with an average negative interest rate on NFC sight deposits.

[21] Net fee and commission income is calculated as fee and commission income net of commission expenses. It notably includes fees from giro transactions, payments, and securities and custody business.

[22] The length of this estimation sample consists of 93 months.

6. Results: negative rates on corporate deposits and higher fees

Bank balance sheet adjustments to NIRP will likely differ depending on a banks' exposure to retail deposit funding, as banks which rely more on this way of funding might face a relatively higher pressure on their interest margins, all other things being equal. I therefore expect banks, with a relatively higher retail deposit funding share to be more responsive to NIRP than those that refinance themselves relatively more via other options such as market funding. To test this argument formally, I classify banks into three business models: low, medium and high retail deposit intensities. These intensities are based on "retail deposits/total liabilities" ratios, using the 33rd and 66th percentiles to split the sample.[23]

6.1. Probability to charge negative rates on corporate deposits

Table 1 explores how bank characteristics are associated with the probability that a bank charges negative rates.[24] The first five columns refer to "all banks". The following columns respectively refer to banks with "low", "medium" and "high retail deposit intensity".

I control for the **deposit share**. In other studies such as Heider, Saidi and Schepens, 2019; Demiralp et al., 2019, the deposit share is found to be an important explanatory variable for the transmission mechanism when rates turn negative. In contrast to these studies, I split the deposit share into two parts: the deposit ratio to NFCs and HH, since I expect that their influence differs. The estimates for "all banks" confirm this:

- A higher **NFC deposit share** is associated, to a statistically significant degree, with a lower probability of a bank charging negative interest rates on NFC deposits during the NIRP I period. During the NIRP II period, a statistically significant relation no longer exists. This difference between the NIRP I and II period is confirmed by a hypothesis test. More specifically, Table 1b displays various differences among coefficients by means of hypothesis tests. The third row refers to the difference of the effect of the NFC deposit ratio during the NIRP I and II period. The one-sided hypothesis tests whether the effect of the NFC deposit share during the NIRP I period is significantly lower than during the NIRP II period.[25] The estimates reveal this, namely: the effect of the NFC deposit share during the NIRP I period is significantly lower.
- Unlike the NFC deposit share, a higher **HH deposit share** is associated, to a statistically significant degree, with a higher probability of a bank charging negative rates on NFC deposits. This correlation becomes even stronger during the NIRP II period. The hypothesis test confirms this finding (Table 1b).

[23] The ratios refer to the mean deposit share of a bank from January 2003 until August 2014. The latter is the month before the market interest rate decreased below zero.
[24] I drop the *i* and *j* indices to simplify the notation in the table.
[25] A one-tailed test for the sole purpose of attaining significance is not appropriate. It has to be considered along with a two-tailed test. If the two-tailed test rejects the null hypothesis, it is appropriate to run a one-tailed test.

Firstly, the estimation results show that banks for which NFC deposits are a relatively important source of funding are less inclined to apply negative interest rates to these deposits at the beginning of the NIRP period. E.g., an increase in the NFC deposit share by one standard deviation is associated with a 15 percentage points lower probability of negative rates being applied to NFC deposits in the NIRP I period.[26] One explanation for this could be that, at the beginning of the NIRP period, the banks in question were still uncertain how their customers would respond to negative rates. However, the more banks and customers became accustomed to negative deposit rates, the less inhibited the individual bank probably was to risk this step and apply a negative rate to NFC deposits. The insignificant coefficient of the NFC deposit share during the NIRP II period might be a reflection of this. Furthermore, these results might also suggest that the pressure to respond to shrinking interest margins was not yet as intense in the NIRP I period as it would become in the NIRP II period.

Secondly, the estimation results also show that banks for which HH deposits are a relatively important source of funding are more inclined to apply negative interest rates to NFC deposits. Given banks' reluctance to apply negative rates to HH deposits, banks which make greater use of this type of deposits as a source of funding are likely to experience more pressure on their interest margins, all other things being equal. Negative NFC deposit rates are one way in which these banks could attempt to mitigate the pressure on interest margins. Moreover, the significantly larger HH deposit share coefficients in the NIRP II period suggest a growing pressure to respond to shrinking interest margins the longer NIRP lasts as well (Table 1b). In economic terms, the HH deposit share also seems to be highly relevant: an increase by one standard deviation increases the probability for negative rates being applied to NFC deposits by around 46 percentage points in the NIRP II period.[27]

The rear three-fourth of the columns in Table 1 refer to the retail deposit intensities of banks. Across all three retail deposit intensities, the NFC deposit share seems unrelated to a banks' probability of charging negative rates. This stands in contrast to the findings for "all banks" during NIRP I. However, a higher HH deposit share is of relevance across the deposit intensity categories: especially for "medium deposit banks" and "high deposit banks" it is associated with a higher probability to charge negative interest rates on NFC deposits.[28] Therefore, these two deposit categories seem to drive the respective positive coefficients for "all banks". This is as expected, as the business model of "medium" and "high deposit banks" focuses on retail customers. Therefore, these banks might experience a relatively higher pressure on their interest margins. Banks belonging to the "medium deposit" category are above all savings banks. Banks in the "high deposit" category are primarily cooperative banks and secondarily savings banks. In contrast, the HH deposit share of "low deposit banks" is mostly unrelated to their probability

[26] The standard deviation of the NFC deposit share for "all banks" is 7.4 % in the NIRP I period (Table A2).
[27] The standard deviation of the HH deposit share for "all banks" is 27.8 % in the NIRP II period.
[28] An increase by one standard deviation increases the probability for negative NFC deposit by around 25 percentage points in the NIRP II period.

Table 1: Linear Probability Model – Benchmark specification

Variables	(1)	(2)	(3)	(4)	(5)
	All banks				
$Dep\_share^{I}_{nfc,t-3}$	**-2.039*****	**-1.992*****	**-1.793***	**-2.138****	**-2.194****
	(0.660)	(0.664)	(0.987)	(1.026)	(1.018)
$Dep\_share^{II}_{nfc,t-3}$	-0.205	-0.155	0.589	0.163	0.191
	(0.620)	(0.639)	(0.988)	(1.013)	(1.024)
$Dep\_share^{I}_{hh,t-3}$	**1.260*****	**1.167****	**1.499****	**1.275****	**1.220***
	(0.461)	(0.482)	(0.608)	(0.625)	(0.654)
$Dep\_share^{II}_{hh,t-3}$	**1.718*****	**1.627*****	**1.823*****	**1.592****	**1.548****
	(0.439)	(0.460)	(0.582)	(0.601)	(0.627)
EL^{I}_{t-3}	**1.327****	**1.435****	**1.570****	**1.316***	**1.337***
	(0.515)	(0.547)	(0.622)	(0.662)	(0.790)
EL^{II}_{t-3}	0.182	0.199	-0.208	-0.334	-0.229
	(0.429)	(0.420)	(0.431)	(0.447)	(0.433)
$Other\_liq\_ratio_{t-3}$	0.905	0.859	**1.026**	0.837	0.759
	(0.607)	(0.610)	(0.623)	(0.619)	(0.633)
$Size_{t-3}$	0.059	0.046	0.074	-0.018	-0.011
	(0.060)	(0.060)	(0.076)	(0.094)	(0.099)
NIM^{I}_{t-3}		-0.021			-0.038
		(0.017)			(0.034)
NIM^{II}_{t-3}		0.008			0.001
		(0.017)			(0.018)
RoA^{I}_{t-3}			-0.799		1.048
			(1.187)		(1.264)
RoA^{II}_{t-3}			-0.405		0.134
			(1.202)		(0.953)
$Tier1\_R^{I}_{t-3}$				-0.432	-0.615
				(0.457)	(0.452)
$Tier1\_R^{II}_{t-3}$				-0.688	-0.604
				(0.457)	(0.447)
Constant	-1.307	-1.039	-1.680	0.036	0.005
	(1.106)	(1.128)	(1.440)	(1.782)	(1.882)
Observations	12,224	12,204	11,585	11,228	11,205
Number of Banks	224	224	210	203	203

Variables	(1)	(2)	(3)	(4)	(5)
	Low deposit banks				
$Dep\_share^{I}_{nfc,t-3}$	-0.137	-0.267	0.292	-0.450	-0.478
	(0.555)	(0.581)	(1.114)	(1.377)	(1.361)
$Dep\_share^{II}_{nfc,t-3}$	0.323	0.150	1.263	0.294	0.283
	(0.480)	(0.472)	(1.257)	(1.498)	(1.477)
$Dep\_share^{I}_{hh,t-3}$	0.002	0.043	-0.037	-0.311	-0.323
	(0.493)	(0.482)	(0.555)	(0.530)	(0.520)
$Dep\_share^{II}_{hh,t-3}$	**0.813***	**0.812***	0.719	0.381	0.353
	(0.458)	(0.446)	(0.492)	(0.485)	(0.488)
EL^{I}_{t-3}	**0.779****	**0.902****	**0.775***	0.375	0.426
	(0.356)	(0.359)	(0.411)	(0.425)	(0.579)
EL^{II}_{t-3}	**1.114****	**1.130*****	**0.980****	**0.958****	**0.960****
	(0.425)	(0.419)	(0.423)	(0.432)	(0.414)
$Other\_liq\_ratio_{t-3}$	-0.573	-0.521	-0.326	-0.606	-0.575
	(0.772)	(0.772)	(0.830)	(0.844)	(0.825)
$Size_{t-3}$	-0.084	-0.077	-0.071	**-0.210****	**-0.205****
	(0.060)	(0.059)	(0.072)	(0.099)	(0.095)
NIM^{I}_{t-3}		**0.023***			0.019
		(0.012)			(0.026)
NIM^{II}_{t-3}		0.024			**0.026***
		(0.019)			(0.014)
RoA^{I}_{t-3}			-1.380		-0.468
			(0.868)		(1.347)
RoA^{II}_{t-3}			-0.004		0.317
			(0.639)		(0.666)
$Tier1\_R^{I}_{t-3}$				-0.239	-0.337
				(0.405)	(0.449)
$Tier1\_R^{II}_{t-3}$				**-0.923****	**-1.015****
				(0.393)	(0.409)
Constant	1.320	1.179	1.071	3.698**	3.583**
	(1.074)	(1.066)	(1.274)	(1.790)	(1.718)
Observations	3,665	3,645	3,123	2,873	2,853
Number of Banks	74	74	62	57	57

Variables	(1)	(2)	(3)	(4)	(5)
	Medium deposit banks				
$Dep\_share^{I}_{nfc,t-3}$	-1.540	-1.544	-1.565	-1.522	-1.564
	(1.789)	(1.782)	(1.798)	(1.824)	(1.833)
$Dep\_share^{II}_{nfc,t-3}$	0.247	0.252	0.224	0.195	0.171
	(1.613)	(1.592)	(1.620)	(1.614)	(1.613)
$Dep\_share^{I}_{hh,t-3}$	**1.635****	**1.645****	**1.620****	**1.475***	**1.485***
	(0.767)	(0.677)	(0.767)	(0.850)	(0.761)
$Dep\_share^{II}_{hh,t-3}$	**2.096****	**2.112****	**2.053****	**1.818***	**1.790****
	(0.887)	(0.800)	(0.883)	(0.934)	(0.866)
EL^{I}_{t-3}	0.587	0.590	0.419	0.905	0.755
	(1.018)	(1.021)	(0.956)	(0.981)	(0.910)
EL^{II}_{t-3}	-1.136	-1.138	-1.167	-1.227	**-1.272***
	(0.721)	(0.728)	(0.715)	(0.749)	(0.725)
$Other\_liq\_ratio_{t-3}$	-0.934	-0.927	-0.965	-1.037	-1.060
	(1.175)	(1.165)	(1.186)	(1.172)	(1.173)
$Size_{t-3}$	**0.288***	**0.287***	**0.291***	0.286	0.291
	(0.164)	(0.147)	(0.162)	(0.193)	(0.174)
NIM^{I}_{t-3}		0.002			-0.000
		(0.078)			(0.076)
NIM^{II}_{t-3}		0.005			0.008
		(0.112)			(0.112)
RoA^{I}_{t-3}			2.133		2.575
			(2.196)		(2.181)
RoA^{II}_{t-3}			-0.673		-1.543
			(2.585)		(2.052)
$Tier1\_R^{I}_{t-3}$				-0.193	-0.242
				(1.874)	(1.881)
$Tier1\_R^{II}_{t-3}$				0.552	0.582
				(1.674)	(1.671)
Constant	-5.204**	-5.358**	-5.197**	-4.975	-5.191*
	(2.555)	(2.421)	(2.538)	(3.051)	(2.931)
Observations	4,224	4,224	4,224	4,172	4,172
Number of Banks	73	73	73	72	72

Variables	(1)	(2)	(3)	(4)	(5)
	High deposit banks				
$Dep\_share^{I}_{nfc,t-3}$	-2.116	-1.792	-1.091	-1.387	-1.625
	(1.456)	(1.361)	(1.535)	(1.492)	(1.163)
$Dep\_share^{II}_{nfc,t-3}$	-0.363	-0.594	-0.336	-0.128	0.059
	(1.411)	(1.394)	(1.474)	(1.412)	(1.414)
$Dep\_share^{I}_{hh,t-3}$	**1.939****	**1.885****	**2.955*****	**2.570****	**1.845***
	(0.824)	(0.773)	(1.102)	(1.107)	(1.075)
$Dep\_share^{II}_{hh,t-3}$	**1.707*****	**1.401****	**2.081****	**2.014****	1.343
	(0.556)	(0.559)	(0.924)	(0.915)	(0.920)
EL^{I}_{t-3}	**2.903***	**3.950****	**3.134****	**3.630****	**5.320*****
	(1.525)	(1.690)	(1.519)	(1.534)	(1.730)
EL^{II}_{t-3}	-0.888	-0.546	-0.564	-0.481	-0.140
	(1.249)	(1.104)	(1.146)	(1.111)	(0.888)
$Other\_liq\_ratio_{t-3}$	0.789	1.144	1.029	1.108	1.326
	(1.584)	(1.582)	(1.595)	(1.527)	(1.469)
$Size_{t-3}$	-0.148	-0.273	-0.272	-0.334	-0.498
	(0.305)	(0.332)	(0.382)	(0.415)	(0.411)
NIM^{I}_{t-3}		**-0.052***			**-0.184*****
		(0.028)			(0.067)
NIM^{II}_{t-3}		-0.006			-0.106
		(0.029)			(0.072)
RoA^{I}_{t-3}			0.291		2.393
			(2.495)		(1.971)
RoA^{II}_{t-3}			0.274		**-3.417***
			(2.493)		(2.003)
$Tier1\_R^{I}_{t-3}$				**-2.766***	**-3.182*****
				(1.387)	(1.158)
$Tier1\_R^{II}_{t-3}$				**-2.723***	**-2.474***
				(1.557)	(1.350)
Constant	1.393	3.507	2.890	4.354	7.799
	(4.846)	(5.307)	(6.269)	(6.834)	(6.764)
Observations	4,335	4,335	4,238	4,183	4,180
Number of Banks	77	77	75	74	74

Note: robust standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1; Regressions include bank and time fixed effects; Standard errors are clustered at bank and time level.

Table 1b: Hypothesis tests

Variables	(1) 2pv	(1) 1pv	(2) 2pv	(2) 1pv	(3) 2pv	(3) 1pv	(4) 2pv	(4) 1pv	(5) 2pv	(5) 1pv
All banks										
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}=0$	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$Dep\_share^{I}_{hh,t-3} - Dep\_share^{II}_{hh,t-3}=0$	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$EL^{I}_{t-3} - EL^{II}_{t-3}=0$	**0.02**	**0.01**	**0.03**	**0.01**	**0.00**	**0.00**	**0.01**	**0.01**	**0.06**	**0.03**
$NIM^{I}_{t-3} - NIM^{II}_{t-3}=0$			**0.05**	**0.02**					0.17	0.08
$RoA^{I}_{t-3} - RoA^{II}_{t-3}=0$					0.34	0.17			0.90	0.45
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}=0$							0.43	0.22	0.98	0.49

Variables	(1) 2pv	(1) 1pv	(2) 2pv	(2) 1pv	(3) 2pv	(3) 1pv	(4) 2pv	(4) 1pv	(5) 2pv	(5) 1pv
Low deposit banks										
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}=0$	**0.10**	**0.05**	0.12	0.06	**0.08**	**0.04**	0.13	0.07	0.13	0.06
$Dep\_share^{I}_{hh,t-3} - Dep\_share^{II}_{hh,t-3}=0$	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**
$EL^{I}_{t-3} - EL^{II}_{t-3}=0$	0.33	0.17	0.57	0.28	0.84	0.42	0.27	0.13	0.45	0.23
$NIM^{I}_{t-3} - NIM^{II}_{t-3}=0$			0.93	0.47					0.84	0.42
$RoA^{I}_{t-3} - RoA^{II}_{t-3}=0$					**0.06**	**0.03**			0.46	0.23
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}=0$							**0.03**	**0.01**	**0.06**	**0.03**

Variables	(1) 2pv	(1) 1pv	(2) 2pv	(2) 1pv	(3) 2pv	(3) 1pv	(4) 2pv	(4) 1pv	(5) 2pv	(5) 1pv
Medium deposit banks										
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}=0$	**0.01**	**0.01**	**0.02**	**0.01**	**0.01**	**0.01**	**0.02**	**0.01**	**0.02**	**0.01**
$Dep\_share^{I}_{hh,t-3} - Dep\_share^{II}_{hh,t-3}=0$	0.21	0.10	0.21	0.11	0.21	0.11	0.40	0.20	0.42	0.21
$EL^{I}_{t-3} - EL^{II}_{t-3}=0$	0.29	0.15	0.28	0.14	0.29	0.15	0.17	0.09	0.15	0.07
$NIM^{I}_{t-3} - NIM^{II}_{t-3}=0$			0.93	0.47					0.89	0.44
$RoA^{I}_{t-3} - RoA^{II}_{t-3}=0$					0.76	0.38			0.43	0.21
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}=0$							0.38	0.19	0.34	0.17

Variables	(1) 2pv	(1) 1pv	(2) 2pv	(2) 1pv	(3) 2pv	(3) 1pv	(4) 2pv	(4) 1pv	(5) 2pv	(5) 1pv
High deposit banks										
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}=0$	**0.07**	**0.03**	0.15	0.08	0.48	0.24	0.25	0.13	0.12	0.06
$Dep\_share^{I}_{hh,t-3} - Dep\_share^{II}_{hh,t-3}=0$	0.68	0.34	0.31	0.15	0.22	0.11	0.43	0.21	0.51	0.26
$EL^{I}_{t-3} - EL^{II}_{t-3}=0$	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$NIM^{I}_{t-3} - NIM^{II}_{t-3}=0$			**0.00**	**0.00**					**0.01**	**0.01**
$RoA^{I}_{t-3} - RoA^{II}_{t-3}=0$					0.68	0.34			0.26	0.13
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}=0$							0.95	0.47	0.30	0.15

Note: bold numbers highlight significant p-values for p<0.01, p<0.05, or p<0.1; "2pv" denotes two-sided p-value and "1pv" one-sided p-value.

of charging negative rates. Banks belonging to this category are primarily dominated by big- and regional banks and secondarily by mortgage banks. It confirms that for these banks HH deposits play a subordinated role as a funding source.

I also control for the banks' **excess liquidity ratio**. When the policy rate turns negative, I assume for banks with high excess liquidity a negative impact on profits and thus a higher probability of charging negative rates. In my sample, this is true for "all banks" and "high deposit banks" in the NIRP I period and for "low deposit banks" in the NIRP II period. Generally, "low deposit banks" are the ones in Germany, which hold the highest amounts of excess liquidity (see Figure A1 in Appendix). An increase by one standard deviation in their excess liquidity ratio in the NIRP II period is associated with a 7 percentage points higher probability for negative rates being applied to NFC deposits.[29] For "high deposit banks" roughly the same economic relevance is observed.[30] On the overall level for "all banks", the probability increases by 4 percentage points.[31] However, these numbers on the economic relevance seem generally rather moderate. This fits in with the finding that the cost of holding excess liquidity is rather low relative to the burden of a shrinking interest margin in lending and deposit business as well (Bundesbank, 2020).[32] Thus, the presented results suggest only some headwinds from holding higher excess liquidity.

The **NIM** is assumed to be negatively correlated with the probability of charging negative rates, meaning that when retail lending is on average less profitable, banks are more likely to charge negative rates. However, the results reveal no or no clear statistically significant effect. Only for "high deposit banks" the expected negative correlation is observed in the NIRP I period. It thus suggests that only for these banks a relatively lower NIM is associated with a higher probability of negative rates being applied to NFC deposits.

The **RoA** coefficient is insignificant. Thus, it does not seem that mounting pressure on overall profitability would have led to negative interest rates increasingly being applied to NFC deposits.

The **Tier 1 ratio** turns out to be relevant for "high deposit banks" in both NIRP periods and for "low deposit banks" in the NIRP II period. Regarding the "high deposit banks", a lower capital ratio is associated with a higher probability of offering negative NFC deposit rates.[33] This suggests that relatively lower capitalized banks in this business model category are more inclined to charge negative rates vis à vis NFC depositors. In economic terms, this probability

[29] The standard deviation of the excess liquidity ratio for "low deposit banks" is 6.8 % in the NIRP II period.
[30] The standard deviation of the excess liquidity ratio for "high deposit banks" is 1.9 % in the NIRP I period. The respective probability increases also by around 7 percentage points.
[31] The standard deviation of the excess liquidity ratio for "all banks" is 3.1 % in the NIRP I period.
[32] From the beginning of the NIRP period up to end- 2019, the burden that banks in Germany faced from the declining interest margin was around four times higher than the costs of holding excess liquidity (Bundesbank, 2020).
[33] Its statistically significance seems however rather weak, since it is mostly only significant at the 10 % level.

(following a one standard deviation decrease in the Tier 1 ratio) rises by 18 percentage points.[34] For "low deposit banks" a decline in the Tier 1 ratio by one standard deviation is associated with an increase in the probability of around 10 percentage points during the NIPR II period.[35]

6.1.1. Robustness checks

To ensure that the above results are not subject to reverse causality, I reestimate the models with a six months lag as a first robustness check. The results are very robust and thus confirm the above findings (see Appendix Tables A3). As a second robustness check, I estimate a probit model. However, a probit model is generally more restrictive than a linear probability model. Furthermore, a linear probability model is a lot easier to handle especially when interaction terms are part of the estimation. Generally, a linear probability model provides a good (linear) approximation. Thus, they are usually the preferred model. For completeness however, a probit model is estimated by pooled maximum likelihood (MLE). The probit results resemble the above findings (see Appendix Table A4). Especially for "all banks" the results are very much the same, both in terms of significance and magnitude. Regarding the "medium" and "high deposit banks", the NFC deposit share estimates are negative and significant during NIRP I. Above, they are also negative but insignificant. The HH deposit share turns out to be a little less often significant for "high deposit banks". Regarding the "low deposit banks", their coefficient estimates of excess liquidity also seem a bit less significant as well as a bit smaller in size. Overall however, also the probit results confirm the above presented findings. This also holds for the hypothesis tests on the differences between coefficients.

6.1.2. Do banks highly exposed to the negative rate policy tend to have a higher probability of charging negative NFC deposit rates?

It is plausible to expect that banks which rely more on retail (especially HH) deposit funding, are more exposed to NIRP, as these banks are likely to face a relatively higher pressure on their interest margins, all other things being equal. Thus, they are possibly more incentivised to charge negative NFC deposit rates to mitigate this pressure. Further, NIRP also implies a direct cost for banks due to their excess liquidity holdings. For these reserve holdings in excess of required reserves, banks had to pay the negative DFR to the central bank until September 2019. Since then, the Eurosystem adopted a two-tier system for remunerating excess reserve holdings.[36] This analysis traces the effects until the introduction of the tiering system. Most likely the tiering system changes the here analysed relationship. As mentioned above, there are differences among banks with respect to their excess liquidity exposure. In absence of a tiering system, banks with relatively higher excess liquidity holdings might be more incentivised to charge negative NFC deposit rates to mitigate the pressure arising from negative policy rates.

[34] The standard deviation of the Tier 1 ratio for "high deposit banks" is around 6 % in the NIRP I and II periods.
[35] The standard deviation of the Tier 1 ratio for "low deposit banks" is around 10 % in the NIRP II period.
[36] The tiering system exempts part of these holdings from negative remuneration and thus reduces the entailed interest expenditures for banks (reserve holdings are remunerated at 0 % up to a certain level - currently six times their minimum reserve).

In view of this, it is plausible to expect that banks who both rely more on retail deposit funding and hold more excess liquidity are especially inclined to charge negative rates to NFC deposits. Exploiting the interaction of the cross-sectional variation of retail deposit intensity and the share of banks' excess liquidity allows to trace this relationship.

For testing whether the influence of the interaction term changes throughout NIRP, it is additionally interacted with a dummy variable for the NIRP I and NIRP II period respectively. The remaining estimation setup is the same as above. Since this setup extends equation (1) by the interaction terms, it can also be seen as a third robustness check. Table 2 shows the estimations results. These resemble very much the findings from above and thus underline the robustness of the already presented results.

Regarding the interaction term, the positive and significant sign for "all banks" in NIRP I reflects that banks are exposed to a less favourable situation when they hold more excess liquidity and the HH deposit share is > 0 at the same time. This might incentivise them to search for a cost reduction by being more inclined to charge negative NFC deposit rates. The hypothesis tests reveal that for banks which rely on HH deposit funding there is a significant and positive impact such that higher values of the excess liquidity ratio are associated with a higher probability to charge negative rates to NFC deposits in the NIRP I period. This can be seen in the seventh row in Table 2b. It tests whether the joint excess liquidity effect is significant in the NIRP I period. The one-sided hypothesis tests whether the joint effect is positive. The ninth row shows that the respective effect in the NIRP I period is significantly larger than in the NIRP II period for "all banks".

Regarding the economic significance of the joint excess liquidity effect in the NIRP I period, it corresponds to an increase of 11 percentage points in the probability to charge negative rates to NFC deposits for "all banks".[37] This is the impact of a one standard deviation increase in the excess liquidity ratio for a bank which has an average HH deposit share. Thus, these banks seem to some extent more inclined to charge negative rates to NFC deposits. However, an 11 percentage points higher probability is still pointing to a rather moderate effect.

Positive and significant interaction terms are also estimated for "high deposit banks" and occasionally for "low deposit banks" in the NIRP II period. This suggests that mostly "high deposit banks" are exposed to a less favourable situation when the HH deposit share is > 0 and the excess liquidity ratio increases. The according hypothesis tests on the joint excess liquidity effect reveals for both deposit intensity groups a significant and positive impact during the NIRP II period. However, the economic relevance of this joint effect points to an increase of around 7 percentage points for "low deposit banks" and is close to zero for "high deposit banks. This indicates that for the average "high deposit bank" in terms of the HH deposit share, a

[37] The economic significance is calculated by means of *Excess_liq_ratio*$(\beta_5+\beta_9$ *Deposit_share_hh)*, where D*eposit_share_hh* is the sample average during NIRP I, *Excess_liq_ratio* is the average standard deviation during NIRP I and β_i is the coefficient estimate from equation (1.2) (presented in Table 2).

higher excess liquidity ratio has no impact on the probability to charge negative rates on NFC deposits. Furthermore, a higher HH deposit share does not increase this probability in a substantial way. For example, a bank which has a HH deposit share equal to the 75th percentile, is estimated to have a respective higher probability for negative rates of around 6 percentage points. Overall, this suggests that higher values of excess liquidity at "high deposit banks" are not associated with a considerably higher probability to charge negative NFC deposit rates. However, this is different for higher values of the HH deposit share at a given excess liquidity ratio. The respective economic relevance suggests then an impact on the probability of around 18 percentage points.[38] This indicates that for a bank with average excess liquidity holdings a higher HH deposit funding share exposes them to a less favourable situation given the higher probability of charging negative NFC deposit rates.

Therefore, these results underline that the associated effect of a higher excess liquidity ratio, when the HH deposit share is > 0, is rather moderate. Thus, banks do not seem to be exposed to a far less favourable situation following an increase in their excess liquidity ratio. This underlines the findings from above, that a higher excess liquidity ratio is only associated to have a moderate impact on the probability to charge negative NFC deposits. Furthermore, these results also support those from above in terms of a higher HH deposit share. More specifically, a higher HH deposit share seems to be associated with a relatively stronger effect, in economic terms, on the probability to charge negative NFC deposit rates. E.g., for "all banks" the economic relevance of the joint effect suggests a by 36 percentage points higher probability in the NIRP I period.

[38] The economic significance is calculated by means of D*eposit_share_hh*(β_4+β_9 *Excess_liq_ratio)*, where *deposit_share_hh* is the average standard deviation during NIRP II, *Excess_liq_ratio* is the sample average during NIRP II and β_i is the coefficient estimate from equation (1.2) (presented in Table 2).

Table 2: Linear Probability Model – with additional interaction term on a banks' HH deposit share and excess liquidity

Variables	(1)	(3)	(5)	(6)	(7)	(1)	(3)	(5)	(6)	(7)	(1)	(3)	(5)	(6)	(7)	(1)	(3)	(5)	(6)	(7)
	All banks					Low deposit banks					Medium deposit banks					High deposit banks				
$Dep\_share^{I}_{nfc,t-3}$	**-1.966*****	**-1.904*****	**-1.758***	**-2.080***	**-2.120****	-0.126	-0.245	0.153	-0.593	-0.604	-1.704	-1.688	-1.707	-1.702	-1.695	**-2.741***	**-2.445***	-1.639	-1.985	-1.828
	(0.653)	(0.646)	(0.998)	(1.044)	(1.014)	(0.542)	(0.561)	(1.125)	(1.378)	(1.369)	(1.759)	(1.763)	(1.768)	(1.778)	(1.793)	(1.407)	(1.322)	(1.497)	(1.425)	(1.172)
$Dep\_share^{II}_{nfc,t-3}$	-0.152	-0.080	0.609	0.152	0.230	0.280	0.129	1.119	0.150	0.145	0.096	0.088	0.092	0.031	0.023	-0.933	-1.139	-1.246	-1.004	-0.394
	(0.607)	(0.619)	(0.997)	(1.027)	(1.027)	(0.478)	(0.462)	(1.264)	(1.516)	(1.493)	(1.594)	(1.577)	(1.599)	(1.591)	(1.578)	(1.418)	(1.387)	(1.465)	(1.417)	(1.414)
$Dep\_share^{I}_{hh,t-3}$	**1.220****	**1.112****	**1.455****	**1.229***	**1.131***	-0.146	-0.077	-0.260	-0.522	-0.511	**1.652****	**1.627****	**1.638****	**1.482***	**1.453***	**1.740****	**1.652****	**2.600****	**2.280****	1.636
	(0.464)	(0.483)	(0.612)	(0.626)	(0.657)	(0.476)	(0.481)	(0.517)	(0.504)	(0.496)	(0.775)	(0.681)	(0.772)	(0.858)	(0.753)	(0.788)	(0.755)	(1.064)	(1.081)	(1.087)
$Dep\_share^{II}_{hh,t-3}$	**1.741*****	**1.654*****	**1.816*****	**1.560****	**1.526****	0.490	0.548	0.342	0.011	0.035	**2.018****	**1.976****	**1.989****	**1.735***	**1.671***	**1.132****	0.841	1.007	1.148	0.824
	(0.454)	(0.474)	(0.599)	(0.612)	(0.640)	(0.479)	(0.471)	(0.490)	(0.489)	(0.483)	(0.965)	(0.865)	(0.956)	(1.008)	(0.908)	(0.557)	(0.538)	(0.926)	(0.920)	(0.976)
EL^{I}_{t-3}	0.357	0.334	0.571	0.188	-0.189	0.571	0.687	0.340	-0.029	0.005	**6.923****	**7.025****	**6.410***	**6.881****	**6.241***	1.449	0.931	2.861	1.491	2.102
	(0.462)	(0.487)	(0.569)	(0.618)	(0.731)	(0.491)	(0.548)	(0.633)	(0.622)	(0.669)	(3.093)	(3.035)	(3.524)	(3.159)	(3.411)	(4.995)	(4.679)	(4.585)	(4.903)	(4.335)
EL^{II}_{t-3}	0.248	0.336	-0.329	-0.565	-0.254	0.583	0.673	0.391	0.347	0.416	-1.661	-1.769	-1.660	-1.858	-1.924	**-8.651****	**-8.722****	**-9.328****	**-9.006****	**-6.243****
	(0.477)	(0.490)	(0.465)	(0.490)	(0.524)	(0.394)	(0.410)	(0.417)	(0.453)	(0.435)	(2.131)	(2.068)	(2.153)	(2.068)	(2.045)	(3.724)	(3.277)	(3.721)	(3.661)	(2.720)
$Other\_liq\_ratio_{t-3}$	0.768	0.699	0.936	0.752	0.606	-0.687	-0.621	-0.417	-0.725	-0.687	-0.993	-1.008	-1.009	-1.108	-1.131	0.882	1.247	1.186	1.275	1.427
	(0.630)	(0.633)	(0.627)	(0.635)	(0.656)	(0.770)	(0.778)	(0.822)	(0.832)	(0.818)	(1.215)	(1.201)	(1.223)	(1.217)	(1.209)	(1.557)	(1.557)	(1.555)	(1.513)	(1.471)
$Size_{t-3}$	0.062	0.046	0.083	-0.007	-0.007	-0.058	-0.056	-0.029	-0.166	-0.167	**0.282***	**0.289****	**0.285***	0.275	**0.288***	-0.141	-0.235	-0.348	-0.347	-0.473
	(0.063)	(0.063)	(0.077)	(0.096)	(0.101)	(0.056)	(0.057)	(0.069)	(0.101)	(0.100)	(0.149)	(0.139)	(0.146)	(0.175)	(0.164)	(0.322)	(0.328)	(0.385)	(0.412)	(0.407)
$\boldsymbol{EL\_Dep\_share^{I}_{hh,t-3}}$	**4.577***	**5.336****	3.782	**4.517***	**6.105***	-0.019	0.229	3.001	2.785	2.970	-14.453	**-15.349***	-14.113	-14.267	-13.010	1.673	3.948	-0.275	2.449	3.801
	(2.331)	(2.608)	(2.450)	(2.327)	(3.248)	(4.914)	(5.013)	(6.089)	(6.138)	(6.546)	(8.700)	(8.475)	(9.464)	(8.751)	(9.141)	(7.156)	(7.212)	(6.613)	(7.501)	(7.356)
$\boldsymbol{EL\_Dep\_share^{II}_{hh,t-3}}$	-0.190	-0.461	0.446	0.963	0.296	3.678	3.131	**4.128***	**4.207***	3.698	1.262	1.475	1.192	1.518	1.532	**11.738****	**12.431*****	**13.236****	**12.988****	**9.287****
	(1.492)	(1.464)	(1.477)	(1.505)	(1.525)	(2.322)	(2.512)	(2.207)	(2.318)	(2.428)	(4.670)	(4.515)	(4.770)	(4.534)	(4.490)	(5.014)	(4.661)	(5.159)	(5.181)	(4.199)
NIM^{I}_{t-3}		-0.024			-0.048		**0.022***			0.015		0.007			0.005		**-0.050***			**-0.174****
		(0.017)			(0.031)		(0.013)			(0.028)		(0.079)			(0.078)		(0.026)			(0.067)
NIM^{II}_{t-3}		0.010			0.003		0.021			0.018		0.000			0.004		-0.016			-0.113
		(0.018)			(0.017)		(0.022)			(0.016)		(0.111)			(0.113)		(0.028)			(0.076)
RoA^{I}_{t-3}			-0.995		0.760			-1.245		-0.330			1.377		1.781			1.311		2.488
			(1.103)		(1.187)			(0.867)		(1.338)			(2.479)		(2.444)			(2.440)		(1.968)
RoA^{II}_{t-3}			-0.280		0.263			-0.308		-0.019			-0.812		-1.534			-1.525		**-3.546***
			(1.184)		(0.925)			(0.532)		(0.593)			(2.560)		(2.077)			(2.090)		(1.973)
$Tier1\_R^{I}_{t-3}$				-0.431	-0.631				-0.338	-0.370				-0.185	-0.222				**-2.495***	**-2.889****
				(0.460)	(0.472)				(0.408)	(0.439)				(1.823)	(1.849)				(1.363)	(1.176)
$Tier1\_R^{II}_{t-3}$				-0.748	-0.670				**-0.946****	**-1.005****				0.472	0.483				-2.357	**-2.317***
				(0.466)	(0.455)				(0.392)	(0.415)				(1.667)	(1.679)				(1.529)	(1.352)
Constant	-1.343	-1.025	-1.814	-0.113	-0.016	1.147	0.857	0.663	3.251*	3.227*	-4.816**	-4.917**	-4.854**	-4.589*	-4.768*	1.588	3.227	4.524	4.965	7.591
Observations	12,176	12,176	11,559	11,202	11,177	3,697	3,675	3,155	2,905	2,883	4,166	4,166	4,166	4,114	4,114	4,335	4,335	4,238	4,183	4,180
Number of Banks	222	222	210	203	203	73	73	63	58	58	72	72	72	71	71	77	77	75	74	74

Note: robust standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1; Regressions include bank and time fixed effects; Standard errors are clustered at bank and time level.

Table 2b: Hypothesis tests

Variables	(1)		(2)		(3)		(4)		(5)		(1)		(2)		(3)		(4)		(5)		(1)		(2)		(3)		(4)		(5)		(1)		(2)		(3)		(4)		(5)	
	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3} = 0$	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.10**	**0.05**	0.13	0.07	**0.07**	**0.04**	0.14	0.07	0.14	0.07	**0.01**	**0.01**	**0.02**	**0.01**	**0.01**	**0.01**	**0.02**	**0.01**	**0.02**	**0.01**	**0.09**	**0.04**	0.12	0.06	0.70	0.35	0.38	0.19	0.20	0.10
$Dep\_share^{I}_{hh,t-3} - Dep\_share^{II}_{hh,t-3} = 0$	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	**0.03**	**0.02**	**0.06**	**0.03**	**0.05**	**0.03**	0.34	0.17	0.36	0.18	0.35	0.17	0.52	0.26	0.55	0.28	0.35	0.17	**0.10**	**0.05**	**0.04**	**0.02**	0.14	0.07	0.26	0.13
$EL^{I}_{t-3} - EL^{II}_{t-3} = 0$	0.70	0.35	0.92	0.46	**0.07**	**0.03**	0.14	0.07	0.86	0.43	0.86	0.43	0.93	0.46	0.94	0.47	0.44	0.22	0.42	0.21	**0.04**	**0.02**	**0.03**	**0.01**	**0.05**	**0.02**	**0.04**	**0.02**	**0.03**	**0.02**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.04**	**0.02**
$NIM^{I}_{t-3} - NIM^{II}_{t-3} = 0$			**0.02**	**0.01**					**0.05**	**0.03**			0.99	0.49					0.92	0.46			0.98	0.49					0.98	0.49			**0.00**	**0.00**					**0.09**	**0.05**
$RoA^{I}_{t-3} - RoA^{II}_{t-3} = 0$					0.20	0.10			0.73	0.36					0.29	0.15			0.76	0.38					0.78	0.39			0.49	0.25					0.73	0.37			**0.21**	**0.11**
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3} = 0$							0.34	0.17	0.91	0.45							**0.06**	**0.03**	**0.07**	**0.03**							0.41	0.21	0.38	0.19							0.82	0.41	0.42	0.21
$EL\_Dep\_share^{I}_{hh,t-3} + EL^{I}_{t-3} = 0$	**0.02**	**0.01**	**0.02**	**0.01**	**0.05**	**0.02**	**0.07**	**0.04**	**0.04**	**0.02**	0.66	0.33	0.62	0.31	0.33	0.16	0.35	0.17	0.37	0.19	0.14	0.07	0.13	0.06	0.14	0.07	0.19	0.09	0.19	0.09	0.25	0.13	0.13	0.06	0.30	0.15	0.22	0.11	**0.10**	**0.05**
$EL\_Dep\_share^{II}_{hh,t-3} + EL^{II}_{t-3} = 0$	0.99	0.50	0.88	0.44	0.96	0.48	0.78	0.39	1.00	0.50	**0.09**	**0.04**	**0.15**	**0.07**	**0.05**	**0.02**	**0.06**	**0.03**	**0.10**	**0.05**	0.77	0.38	0.81	0.41	0.76	0.38	0.77	0.39	0.79	0.39	**0.07**	**0.04**	**0.04**	**0.02**	**0.03**	**0.01**	**0.03**	**0.02**	**0.08**	**0.04**
$EL\_Dep\_share^{I}_{hh,t-3} + EL^{I}_{t-3} = 0 = EL\_Dep\_share^{II}_{hh,t-3} + EL^{II}_{t-3}$	**0.02**	**0.01**	**0.01**	**0.01**	**0.04**	**0.02**	**0.08**	**0.04**	**0.04**	**0.02**	0.59	0.29	0.71	0.36	0.88	0.44	0.90	0.45	0.82	0.41	0.22	0.11	0.19	0.10	0.23	0.12	0.27	0.14	0.27	0.13	0.97	0.48	0.70	0.35	0.56	0.28	0.94	0.47	0.39	0.20

Note: bold numbers highlight significant p-values for p<0.01, p<0.05, or p<0.1; "2pv" denotes two-sided p-value and "1pv" one-sided p-value.

6.1.3. What is the influence of other banks with negative deposits and the term spread squeeze on a banks' probability of charging negative deposit rates?

For evaluating how the share of banks charging negative deposit rates or the squeeze in term premium influence the probability of charging NFC deposits negatively, I reestimate the above models and implement macroeconomic variables instead of time fixed effects. Apart from the share of banks charging negative NFC rates and the term spread, I add GDP and HICP as further macroeconomic controls. This reestimation can also be seen as a fourth robustness check to the results presented above. It confirms the previous findings. Therefore, the results seem very robust to this alternative specification as well.

A higher **share of banks with negative deposits** is statistically associated with a higher probability to charge negative rates on NFC deposits for "all banks" (Table 3). This holds for the NIRP I and II period. However, in the NIRP I period, the coefficients are statistically larger compared to the NIRP II period.[39] This suggests that banks are more inclined, especially in the NIRP I period, to charge negative NFC rates the more their peers also pursue this strategy. Also in economic terms, the share of banks with negative deposits is relevant: an increase of the share of banks with negative deposits by one standard deviation increases the probability for negative rates being applied to NFC deposits by around 10 percentage points in the NIRP I period and 5 percentage points in the NIRP II period.[40] Mostly "medium deposit banks" and to a lesser extent "high deposit banks" seem to drive the results for "all banks". However, the share of banks with negative deposits seems to be, above all, of relevance in the NIRP I and II period for "medium deposit banks" and in the NIRP II period for "high deposit banks". This might mirror that "high deposit banks" increasingly started to offer negative rates during the NIRP II period, more specifically since spring 2017 (Figure A3). This was about half a year later than "medium deposit banks". For "low deposit banks", the share of banks with negative NFC deposits seems to be in most of the cases of relevance in the NIRP I period. This might reflect that these banks increasingly started to charge negative NFC deposit rates during this period (Figure A3).

The **term spread** is assumed to be negatively correlated with the probability of charging negative rates. This holds for "all banks" in the NIRP II period.[41] However, in economic terms, it is hardly of relevance: a one standard deviation decrease in the term spread suggests an increase in the probability for negative rates being applied to NFC deposits by 0.01 percentage points in the NIRP II period.[42] Thus, the growing pressure from NIRP, captured by the squeeze in term spreads, has not lead banks to increasingly charge negative rates yet.

---

[39] The hypotheses tests confirm this difference as well (Table 3b, row 9).

[40] The standard deviation of the share of banks with negative deposits for "all banks" is 6 % in the NIRP I period and 10 % in the NIRP II period.

[41] The hypothesis test also reveals that the effect in the NIPR II period is statistically lower compared to NIRP I.

[42] The standard deviation of the term spread in the NIRP II period is 0.21 %.

Table 3: Linear Probability Model – with bank fixed effects

Variables	All banks					Low deposit banks					Medium deposit banks					High deposit banks				
	(1)	(2)	(4)	(5)	(6)	(1)	(2)	(4)	(5)	(6)	(1)	(2)	(4)	(5)	(6)	(1)	(2)	(4)	(5)	(6)
$Dep\_share^{I}_{nfc,t-3}$	-1.900***	-1.853***	-1.681*	-2.031*	-2.048*	-0.107	-0.244	0.416	-0.375	-0.402	-1.322	-1.351	-1.295	-1.329	-1.074	-2.035	-1.830	-1.584	-1.523	-1.347
	(0.663)	(0.670)	(1.002)	(1.041)	(1.029)	(0.545)	(0.571)	(1.055)	(1.368)	(1.348)	(1.739)	(1.722)	(1.752)	(1.733)	(1.732)	(1.380)	(1.332)	(1.399)	(1.350)	(1.193)
$Dep\_share^{II}_{nfc,t-3}$	-0.235	-0.213	0.587	0.102	0.088	0.329	0.149	1.351	0.419	0.415	0.215	0.218	0.212	0.148	0.126	-0.417	-0.552	-0.241	-0.014	-0.098
	(0.616)	(0.632)	(1.000)	(1.012)	(1.003)	(0.475)	(0.473)	(1.218)	(1.474)	(1.443)	(1.582)	(1.558)	(1.580)	(1.590)	(1.612)	(1.387)	(1.354)	(1.430)	(1.363)	(1.275)
$Dep\_share^{I}_{hh,t-3}$	1.293***	1.227**	1.497**	1.272**	1.183*	0.080	0.130	-0.018	-0.278	-0.311	1.771**	1.683**	1.479*	1.584*	1.554**	2.012***	1.849***	2.700***	2.470**	1.919*
	(0.466)	(0.482)	(0.612)	(0.629)	(0.643)	(0.491)	(0.477)	(0.543)	(0.526)	(0.511)	(0.797)	(0.667)	(0.775)	(0.874)	(0.752)	(0.607)	(0.607)	(0.913)	(0.942)	(0.967)
$Dep\_share^{II}_{hh,t-3}$	1.697***	1.622***	1.776***	1.546**	1.448**	0.838*	0.851*	0.735	0.423	0.366	2.071**	2.012***	1.706**	1.785*	1.584*	1.691***	1.412**	2.252**	2.063**	1.291
	(0.448)	(0.462)	(0.589)	(0.605)	(0.617)	(0.453)	(0.438)	(0.482)	(0.478)	(0.484)	(0.864)	(0.736)	(0.837)	(0.929)	(0.840)	(0.571)	(0.573)	(0.882)	(0.906)	(0.931)
EL^{I}_{t-3}	1.385***	1.485***	1.650***	1.334**	1.336*	0.808**	0.926**	0.798*	0.391	0.387	0.552	0.496	0.302	0.832	1.074	2.967*	3.979**	3.518**	3.635**	5.500***
	(0.486)	(0.496)	(0.583)	(0.648)	(0.710)	(0.351)	(0.354)	(0.403)	(0.417)	(0.550)	(1.038)	(1.056)	(0.998)	(0.974)	(0.803)	(1.540)	(1.683)	(1.592)	(1.534)	(1.719)
EL^{II}_{t-3}	0.129	0.135	-0.254	-0.314	-0.295	1.116**	1.133***	0.972**	0.956**	0.966**	-1.124	-1.129	-1.117	-1.121	-1.299	-0.843	-0.531	-0.649	-0.502	0.019
	-0.401	-0.399	-0.414	-0.414	-0.408	(0.423)	(0.419)	(0.419)	(0.429)	(0.411)	(0.708)	(0.707)	(0.657)	(0.705)	(0.672)	(1.242)	(1.112)	(1.126)	(1.129)	(0.844)
$Other\_liq\_ratio_{t-3}$	0.895	0.883	1.074*	0.872	0.857	-0.563	-0.505	-0.321	-0.599	-0.597	-0.933	-0.973	-0.991	-1.002	-0.995	0.788	1.123	0.886	1.080	1.269
	-0.631	-0.636	-0.637	-0.641	-0.655	(0.767)	(0.766)	(0.823)	(0.838)	(0.833)	(1.161)	(1.148)	(1.189)	(1.160)	(1.199)	(1.587)	(1.580)	(1.602)	(1.522)	(1.489)
$Size_{t-3}$	0.07	0.061	0.095	-0.009	-0.005	-0.082	-0.075	-0.071	-0.205**	-0.202**	0.295*	0.301**	0.312*	0.291	0.322*	-0.127	-0.258	-0.279	-0.307	-0.496
	-0.062	-0.062	-0.078	-0.094	-0.098	(0.059)	(0.058)	(0.072)	(0.096)	(0.092)	(0.157)	(0.142)	(0.160)	(0.183)	(0.178)	(0.305)	(0.325)	(0.362)	(0.399)	(0.400)
NIM^{I}_{t-3}		-0.017			-0.027		0.025**			0.015		-0.002			-0.012		-0.065*			-0.190***
		(0.018)			(0.031)		(0.012)			(0.023)		(0.070)			(0.055)		(0.029)			(0.068)
NIM^{II}_{t-3}		0.004			-0.005		0.023			0.027*		-0.015			0.038		-0.009			-0.125
		(0.017)			(0.019)		(0.018)			(0.014)		(0.077)			(0.076)		(0.029)			(0.075)
$Neg\_share^{I}_{t-3}$	1.660***	1.814***	1.629***	1.439***	1.610***	0.698**	0.670**	0.736**	0.464	0.582	1.685***	1.612***	1.343***	1.733***	1.504***	0.517	0.413	0.366	0.449	0.480
	(0.260)	(0.290)	(0.264)	(0.280)	(0.333)	(0.293)	(0.313)	(0.315)	(0.358)	(0.393)	(0.433)	(0.436)	(0.366)	(0.417)	(0.387)	(0.388)	(0.352)	(0.378)	(0.367)	(0.357)
$Neg\_share^{I}_{t-3}$	0.422***	0.412***	0.480***	0.562***	0.539***	-0.186	-0.164	-0.232	-0.210	-0.213	0.625***	0.618***	0.695***	0.598***	0.694***	1.018***	1.058***	1.127***	1.160***	1.078***
	(0.127)	(0.134)	(0.127)	(0.131)	(0.138)	(0.149)	(0.147)	(0.156)	(0.166)	(0.160)	(0.198)	(0.203)	(0.185)	(0.206)	(0.213)	(0.198)	(0.189)	(0.193)	(0.202)	(0.193)
GDP_{t}	0.733	0.334	0.788	1.633**	1.128	2.397**	2.603**	3.110***	4.452***	4.485***	1.936	2.029	1.936	1.929	2.035	2.075**	2.197***	2.095**	2.797***	1.688
	(0.670)	(0.718)	(0.693)	(0.775)	(0.933)	(0.995)	(1.038)	(1.077)	(1.309)	(1.400)	(1.138)	(1.215)	(1.077)	(1.180)	(1.214)	(0.789)	(0.738)	(0.885)	(0.903)	(1.000)
$HICP_{t}$	-0.001	-0.005	0.002	0.007	0.002	0.000	0.002	0.003	0.010	0.008	0.018	0.019	0.012	0.015	0.018	0.026***	0.029***	0.034***	0.028***	0.026***
	(0.010)	(0.011)	(0.010)	(0.009)	(0.010)	(0.010)	(0.011)	(0.012)	(0.014)	(0.014)	(0.011)	(0.011)	(0.008)	(0.011)	(0.011)	(0.008)	(0.007)	(0.008)	(0.007)	(0.008)
$Term\_spread^{I}_{t}$	0.034	0.042	0.031	0.015	0.026	-0.049*	-0.055**	-0.063**	-0.084**	-0.082**	-0.001	-0.005	-0.034	-0.001	-0.028	0.031	0.027	0.011	0.03	0.052***
	(0.028)	(0.031)	(0.027)	(0.024)	(0.026)	(0.026)	(0.027)	(0.029)	(0.033)	(0.034)	(0.029)	(0.028)	(0.028)	(0.028)	(0.029)	(0.018)	(0.017)	(0.014)	(0.018)	(0.014)
$Term\_spread^{II}_{t}$	-0.073**	-0.088***	-0.069**	-0.058*	-0.060*	-0.049	-0.051	-0.063*	-0.027	-0.043	-0.004	0.004	0.023	-0.001	0.013	0.011	0.009	0.006	0.012	0.008
	(0.029)	(0.032)	(0.031)	(0.031)	(0.035)	(0.030)	(0.033)	(0.036)	(0.042)	(0.044)	(0.052)	(0.058)	(0.048)	(0.051)	(0.055)	(0.046)	(0.045)	(0.048)	(0.048)	(0.047)
RoA^{I}_{t-3}			-0.345		0.639			-0.959		-0.659			2.279		3.211			-2.826		-0.028
			(0.904)		(0.888)			(0.680)		(0.688)			(1.841)		(2.252)			(2.958)		(2.374)
RoA^{II}_{t-3}			-0.298		-0.654			-0.250		-0.327			-1.988		-2.303			4.092		-1.115
			(0.597)		(0.669)			(0.248)		(0.325)			(2.538)		(2.097)			(3.307)		(3.337)
$Tier1\_R^{I}_{t-3}$				-0.257	-0.280				-0.286	-0.366				0.235	-0.665				-2.804**	-2.926***
				(0.438)	(0.431)				(0.387)	(0.424)				(1.860)	(1.717)				(1.265)	(1.066)
$Tier1\_R^{II}_{t-3}$				-0.728	-0.702				-0.890**	-0.993**				0.817	0.771				-2.734*	-2.355*
				(0.446)	(0.435)				(0.378)	(0.393)				(1.591)	(1.521)				(1.475)	(1.326)
Constant	-6.492	-3.640	-7.401	-11.169**	-7.753	-14.437**	-15.983**	19.339***	25.806***	26.089***	-18.554**	-19.531**	22.659***	-18.019**	-20.094**	-13.100**	-11.691**	-11.363**	15.017***	-5.202
	(4.464)	(4.784)	(4.595)	(4.860)	(5.959)	(6.410)	(6.635)	(6.926)	(8.026)	(8.637)	(7.897)	(8.072)	(7.338)	(8.256)	(8.013)	(5.118)	(4.964)	(5.146)	(5.120)	(5.770)
Observations	12,176	12,176	11,559	11,202	11,177	3,697	3,675	3,155	2,905	2,883	4,166	4,166	4,166	4,114	4,114	4,335	4,335	4,238	4,183	4,180
Number of Banks	222	222	210	203	203	73	73	63	58	58	72	72	72	71	71	77	77	75	74	74

Note: robust standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1; Regressions include bank fixed effects; Standard errors are clustered at bank and time level.

Table 3b: Hypothesis tests

Variables	(1)		(2)		(3)		(4)		(5)	
	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}$= 0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$Dep\_share^{I}_{hh,t-3} - Dep\_share^{II}_{hh,t-3}$= 0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**
$EL^{I}_{t-3} - EL^{II}_{t-3}$=0	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.02**	**0.01**
$NIM^{I}_{t-3} - NIM^{II}_{t-3}$= 0			**0.10**	**0.05**					0.33	0.16
$RoA^{I}_{t-3} - RoA^{II}_{t-3}$ =0					0.97	0.49			0.35	0.17
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}$=0							**0.08**	**0.04**	0.11	0.05
$Neg\_share^{I}_{t-3} - Neg\_share^{II}_{t-3}$= 0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**
$Term\_sread^{I}_{t} - Term\_spread^{II}_{t}$= 0	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	0.11	0.06	**0.05**	**0.03**

Variables	(1)		(2)		(3)		(4)		(5)	
	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}$= 0	0.21	0.11	0.25	0.13	0.22	0.11	0.29	0.15	0.27	0.13
$Dep\_share^{I}_{hh,t-3} - Dep\_share^{II}_{hh,t-3}$= 0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.01**
$EL^{I}_{t-3} - EL^{II}_{t-3}$=0	0.21	0.11	0.47	0.24	0.59	0.30	**0.08**	**0.04**	0.21	0.11
$NIM^{I}_{t-3} - NIM^{II}_{t-3}$= 0			0.86	0.43					0.66	0.33
$RoA^{I}_{t-3} - RoA^{II}_{t-3}$ =0					0.25	0.13			0.59	0.29
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}$=0							**0.01**	**0.01**	**0.03**	**0.02**
$Neg\_share^{I}_{t-3} - Neg\_share^{II}_{t-3}$= 0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.02**	**0.03**	**0.02**
$Term\_sread^{I}_{t} - Term\_spread^{II}_{t}$= 0	0.99	0.50	0.93	0.47	0.99	0.50	0.35	0.17	0.55	0.27

Variables	(1)		(2)		(3)		(4)		(5)	
	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}$= 0	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.03**	**0.01**
$Dep\_share^{I}_{hh,t-3} - Dep\_share^{II}_{hh,t-3}$= 0	0.22	0.11	0.30	0.15	0.28	0.14	0.61	0.31	0.68	0.34
$EL^{I}_{t-3} - EL^{II}_{t-3}$=0	0.23	0.12	0.26	0.13	0.23	0.11	0.14	0.07	**0.03**	**0.01**
$NIM^{I}_{t-3} - NIM^{II}_{t-3}$= 0			0.83	0.41					0.47	0.23
$RoA^{I}_{t-3} - RoA^{II}_{t-3}$ =0					**0.01**	**0.01**			**0.00**	**0.00**
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}$=0							0.61	0.31	0.19	0.09
$Neg\_share^{I}_{t-3} - Neg\_share^{II}_{t-3}$= 0	**0.06**	**0.03**	**0.07**	**0.04**	0.16	0.08	**0.04**	**0.02**	**0.09**	**0.04**
$Term\_sread^{I}_{t} - Term\_spread^{II}_{t}$= 0	0.96	0.48	0.90	0.45	0.29	0.15	0.99	0.50	0.49	0.25

Variables	(1)		(2)		(3)		(4)		(5)	
	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}$= 0	**0.01**	**0.00**	**0.02**	**0.01**	**0.02**	**0.01**	**0.01**	**0.00**	**0.03**	**0.01**
$Dep\_share^{I}_{hh,t-3} - Dep\_share^{II}_{hh,t-3}$= 0	**0.05**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.01**	**0.00**	**0.00**
$EL^{I}_{t-3} - EL^{II}_{t-3}$=0	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$NIM^{I}_{t-3} - NIM^{II}_{t-3}$= 0			**0.00**	**0.00**					**0.03**	**0.01**
$RoA^{I}_{t-3} - RoA^{II}_{t-3}$ =0					0.17	0.09			0.82	0.41
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}$=0							0.92	0.46	0.36	0.18
$Neg\_share^{I}_{t-3} - Neg\_share^{II}_{t-3}$= 0	0.32	0.16	0.15	0.07	**0.10**	**0.05**	0.13	0.06	0.19	0.09
$Term\_sread^{I}_{t} - Term\_spread^{II}_{t}$= 0	0.73	0.37	0.72	0.36	0.93	0.46	0.73	0.36	0.36	0.18

Note: bold numbers highlight significant p-values for p<0.01, p<0.05, or p<0.1; "2pv" denotes two-sided p-value and "1pv" one-sided p-value.

6.2. Do banks use fees and commissions as a substitute?

Besides deposit rate cuts, there are other instruments, such as higher fees and commissions, which banks can use to alleviate the pressure that a declining interest margin exerts on their profitability. This section examines the extent to which the influence of different bank characteristics on the commission margin has changed over time. The commission margin is computed as net commission income over total assets. The estimation period runs from January 2012 until September 2019. Thus, it includes the two NIRP periods and the period immediately preceding NIRP (pre-NIRP). The latter refers to the period when the short-term market interest rate was only just above zero. This wider observation period allows to investigate whether the influence of the variables under consideration in the NIRP period is statistically different from that observed in the pre-NIRP period.

The results do not show a clear empirical correlation between the **NFC deposit share** and a bank's commission margin, neither for "all banks" nor for the different deposit intensity categories (Table 4a). But, the hypothesis tests suggest that the NIRP periods are statistically different from the pre-NIRP period.[43] This seems to hold for the NIRP I and II period for "all banks" as well as "high deposit banks". For these banks the influence in the NIRP periods are associated with a higher commission margin than in the pre-NIRP period. For the "medium deposit banks" only the NIRP I coefficients are significantly larger than those in pre-NIRP.

By contrast, a larger **HH deposit share** is always associated with a higher commission margin in the pre-NIRP period as well as during the NIRP periods for "all banks". Furthermore, this influence increased significantly in the NIRP II period compared to the pre-NIRP period.[44] While a 1-percentage point increase in the HH deposit share in the pre-NIRP period was associated with a rise of around 0.37 percentage points in the commission margin, its effect was even stronger during the NIRP periods. E.g. in the NIRP II period, the commission margin increases by 0.45 percentage points.[45] Thus, compared with the pre-NIRP period, banks were able to increase their net commission income per euro of HH deposits by 0.08 cent in the NIRP II period.[46] This may not sound like much, but it is equivalent to 16 % of the commission margin and therefore also of economic significance.[47] These effects for "all banks" seem to be driven by "medium" and "high deposit banks". E.g., "medium deposit banks" seemed to increase their

[43] A hypothesis test based on one-tailed and two-tailed tests reveals that especially the NIRP I and II coefficients are significantly larger than the pre-NIRP coefficients (Table 4b).

[44] A hypothesis test based on one-tailed and two-tailed tests shows that the NIRP II coefficients are significantly larger than the pre-NIRP coefficients (Table 4b).

[45] An increase of one standard deviation in HH deposits widens the commission margin at maximum by 0.14 percentage points during the NIRP I and NIRP II period. This seems quite of economic significance, since the mean commission margin stands at almost 0.5 % in the NIRP I and NIRP II period. The standard deviation for HH deposits is 28 %.

[46] The number is the difference between the average coefficients (in percentage points): 0.45-0.37 = 0.08. Both the deposit share and the commission margin are calculated as a share of total assets. Thus, the figures can be interpreted "per euro of HH deposits".

[47] The mean commission margin is close to 0.5 % in both NIRP periods.

net commission income per euro of HH deposits by 0.20 cent in the NIRP II period compared to the pre-NIRP period.[48] A hypothesis test confirms for these banks significantly higher NIRP II coefficients compared to the pre-NIRP period as well (Table 4b).[49] This indicates that "medium deposit banks" adjusted their business strategy in deposit business with HH during the NIRP periods. Thus, they seem to generate higher net commission income on their outstanding deposit holdings than in the pre-NIRP period.

The **excess liquidity ratio** is always statistically relevant for a higher commission margin in the NIRP I period for "medium deposit banks". Also their coefficients in the NIRP I period are in almost every specification significantly larger compared to the pre-NIRP period (Table 4b). Thus, e.g. "medium deposit banks" increase their net commission income per euro of excess liquidity by 0.82 cent during the NIRP I period.[50] This suggests that these banks with a higher excess liquidity ratio adjust their behaviour during the NIRP period as well. Also "high deposit banks" reveal statistically significant coefficients. However, the hypothesis test reveals for them no statistical difference between the periods. Regarding the economic relevance, evaluated based on an increase of one standard deviation in the excess liquidity ratio, the commission margin increases by 0.01 and 0.02 percentage points for "medium" and "high deposit banks" during the NIRP I period.[51] Compared to the overall mean of the provision margin of around 0.5 %, this seems to be a rather small influence.[52]

A lower **NIM** seems to be associated with a higher commission margin during the NIRP II period for "all banks".[53] However, a change in the NIM is not of economic relevance. More specifically, a decrease of one standard deviation in the NIM increases the commission margin at maximum by 0.0003 percentage points during the NIRP II period.[54] Thus, a change in the NIM hardly affects the commissions applied to bank customers. Regarding the different deposit intensity categories, no clear pictures emerges.

RoA are generally unrelated to the commission margin for "all banks". This suggests that a higher pressure on banks' profits does not lead them to charge higher commissions. This basically also holds for the other deposit intensity categories, except for "high deposit banks". Here, lower RoA are associated to a statistically significant degree with a higher commission margin during the NIRP II period.[55] Compared to the pre-NIRP period, they seem to increase

[48] The number is the difference between the average coefficients (in percentage points): 0.70-0.5 = 0.20.

[49] For "high deposit banks" the hypothesis tests reveal no statistical difference for the NIRP periods compared to the pre-NIRP period.

[50] The numbers are the difference between the average coefficients: 0.97-0.15 = 0.82.

[51] The respective standard deviation is 1.23 % and 1.86 % for "medium" and "high deposit banks" in the NIRP I period.

[52] An increase of 0.01 or 0.02 percentage points equates to 2 % till 4 % of the mean provision margin of 0.5 %.

[53] The according hypothesis test on the difference between NIRP II and pre-NIRP supports this as well. Also, the NIRP I coefficients are statistically larger compared to the pre-NIRP period.

[54] The standard deviation of the NIM for "all banks" is 1.63 % in the NIRP II period.

[55] Also the hypothesis test reveals a significant difference compared to the pre-NIRP period.

their net commission income per euro less of returns by 4.2 cent during the NIRP II period.[56] However, the economic relevance suggests a much smaller effect on the commission margin following a one standard deviation decrease in the RoA. It increases the commission margin for “high deposit banks” by 0.02 percentage points during the NIRP II period.[57]

Finally, a higher-capitalized bank is associated with a lower commission margin during the NIRP I period for “all banks” and “low deposit banks”. During the pre-NIRP and NIRP II period, the effect is unrelated with the commission margin.[58] The influence of a higher **Tier 1 ratio** also seems of small or moderate economic relevance for the commission margin, since a by one higher standard deviation decreases the commission margin by 0.02 percentage points for “all banks” and by 0.05 percentage points for “low deposit banks” during the NIRP I period.[59]

[56] The number is the difference between the average coefficients (in percentage points): -3.7-0.55 = 4.25.
[57] The respective standard deviation is 0.68 % in the NIRP II period.
[58] For “low deposit banks”, the hypothesis test shows a statistical difference between the pre-NIRP and NIRP I or NIRP II period.
[59] The standard deviation is 7 % for “all banks” and 10 % for “low deposit banks” in the NIRP I period.

Table 4: Commission margin

Variables	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	All banks					Low deposit banks				
$Commission\_margin_{t-3}$	0.4032***	0.3885***	0.4022***	0.3391***	0.3241***	0.4675***	0.4501***	0.4722***	0.3484***	0.3473***
	(0.0849)	(0.0859)	(0.0806)	(0.0801)	(0.0741)	(0.1160)	(0.1182)	(0.1046)	(0.1166)	(0.0904)
$Dep\_share_{nfc,t-3}$	-0.0017	-0.0019	-0.0016	0.0012	0.0014	-0.0024	-0.0023	0.0013	0.0087*	0.0085**
	(0.0033)	(0.0031)	(0.0034)	(0.0022)	(0.0019)	(0.0074)	(0.0069)	(0.0070)	(0.0044)	(0.0041)
$Dep\_share^{I}_{nfc,t-3}$	0.0029	0.0026	0.0033	0.0049**	0.0039*	0.0067	0.0054	0.0103*	0.0129***	0.0103**
	(0.0032)	(0.0029)	(0.0031)	(0.0022)	(0.0020)	(0.0059)	(0.0052)	(0.0061)	(0.0048)	(0.0039)
$Dep\_share^{II}_{nfc,t-3}$	0.0017	0.0012	0.0019	0.0037**	0.0026*	0.0038	0.0024	0.0062	0.0103**	0.0083**
	(0.0029)	(0.0027)	(0.0026)	(0.0017)	(0.0014)	(0.0062)	(0.0058)	(0.0059)	(0.0045)	(0.0039)
$Dep\_share_{hh,t-3}$	0.0034**	0.0033**	0.0036**	0.0039***	0.0046***	0.0019	0.0021	0.0018	0.0017	0.0024
	(0.0016)	(0.0015)	(0.0017)	(0.0015)	(0.0014)	(0.0023)	(0.0021)	(0.0021)	(0.0022)	(0.0017)
$Dep\_share^{I}_{hh,t-3}$	0.0036**	0.0035**	0.0038**	0.0043***	0.0049***	0.0015	0.0022	0.0012	0.0012	0.0023
	(0.0017)	(0.0016)	(0.0017)	(0.0014)	(0.0013)	(0.0021)	(0.0020)	(0.0020)	(0.0019)	(0.0016)
$Dep\_share^{II}_{hh,t-3}$	0.0041**	0.0040***	0.0043***	0.0048***	0.0053***	0.0021	0.0027	0.0020	0.0019	0.0028*
	(0.0016)	(0.0015)	(0.0016)	(0.0014)	(0.0013)	(0.0019)	(0.0019)	(0.0017)	(0.0017)	(0.0015)
EL_{t-3}	0.0040	0.0041	0.0041	0.0020	0.0017	0.0041	0.0052*	0.0040	-0.0010	0.0003
	(0.0031)	(0.0025)	(0.0031)	(0.0028)	(0.0018)	(0.0032)	(0.0027)	(0.0030)	(0.0022)	(0.0016)
EL^{I}_{t-3}	0.0052	0.0048	0.0055	0.0052	0.0049	0.0041	0.0027	0.0049	0.0037	0.0024
	(0.0039)	(0.0040)	(0.0040)	(0.0035)	(0.0036)	(0.0044)	(0.0050)	(0.0046)	(0.0034)	(0.0037)
EL^{II}_{t-3}	0.0017	0.0017	0.0021	0.0025	0.0026	0.0012	0.0011	0.0021	0.0022	0.0022
	(0.0016)	(0.0016)	(0.0018)	(0.0018)	(0.0018)	(0.0019)	(0.0019)	(0.0021)	(0.0020)	(0.0017)
$Other\_liq\_ratio_{t-3}$	0.0021	0.0023	0.0027*	0.0030**	0.0034**	0.0045	0.0049*	0.0060**	0.0055**	0.0060**
	(0.0017)	(0.0017)	(0.0016)	(0.0014)	(0.0014)	(0.0028)	(0.0027)	(0.0027)	(0.0025)	(0.0023)
$Size_{t-3}$	-0.0002	-0.0002	0.0000	-0.0000	-0.0001	0.0001	0.0001	0.0003	0.0000	-0.0001
	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0002)
NIM_{t-3}		0.0001			0.0002***		0.0002			0.0003**
		(0.0000)			(0.0001)		(0.0001)			(0.0002)
NIM^{I}_{t-3}		-0.0001			-0.0001		-0.0002			-0.0002
		(0.0001)			(0.0001)		(0.0002)			(0.0001)
NIM^{II}_{t-3}		-0.0002***			-0.0002**		-0.0001			-0.0001
		(0.0001)			(0.0001)		(0.0001)			(0.0001)
RoA_{t-3}			0.0094*		0.0032			0.0109		0.0046
			(0.0054)		(0.0049)			(0.0069)		(0.0064)
RoA^{I}_{t-3}			0.0108		0.0178*			0.0187		0.0329**
			(0.0086)		(0.0106)			(0.0116)		(0.0161)
RoA^{II}_{t-3}			0.0118		0.0349			0.0317		0.0732*
			(0.0260)		(0.0289)			(0.0402)		(0.0433)
$Tier1\_R_{t-3}$				0.0002	0.0011				0.0035	0.0027
				(0.0028)	(0.0026)				(0.0030)	(0.0023)
$Tier1\_R^{I}_{t-3}$				-0.0031***	-0.0038***				-0.0043**	-0.0061***
				(0.0011)	(0.0012)				(0.0016)	(0.0018)
$Tier1\_R^{II}_{t-3}$				-0.0020	-0.0023				-0.0038*	-0.0039*
				(0.0016)	(0.0016)				(0.0022)	(0.0020)
Constant	0.0035	0.0050	0.0004	0.0010	0.0028	-0.0010	-0.0013	-0.0046	0.0008	0.0025
	(0.0073)	(0.0073)	(0.0058)	(0.0059)	(0.0053)	(0.0074)	(0.0069)	(0.0050)	(0.0052)	(0.0045)
Observations	18,111	18,089	18,109	17,509	17,486	5,144	5,122	5,144	4,763	4,741
Number of Banks	214	214	214	209	209	66	66	66	64	64

Variables	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	Medium deposit banks					High deposit banks				
$Commission\_margin_{t-3}$	0.2953***	0.2810***	0.2916***	0.2867***	0.2702***	0.2686***	0.2489**	0.2544***	0.2465**	0.2093**
	(0.0686)	(0.0670)	(0.0667)	(0.0693)	(0.0669)	(0.0977)	(0.0950)	(0.0957)	(0.0989)	(0.0937)
$Dep\_share_{nfc,t-3}$	-0.0012	-0.0012	-0.0025	-0.0017	-0.0029	-0.0030	-0.0013	-0.0034	-0.0042	-0.0030
	(0.0015)	(0.0015)	(0.0019)	(0.0015)	(0.0018)	(0.0028)	(0.0022)	(0.0026)	(0.0026)	(0.0022)
$Dep\_share^{I}_{nfc,t-3}$	0.0041*	0.0033	0.0038	0.0035	0.0025	0.0042	0.0041	0.0037	0.0029	0.0026
	(0.0023)	(0.0022)	(0.0023)	(0.0022)	(0.0022)	(0.0026)	(0.0026)	(0.0023)	(0.0023)	(0.0024)
$Dep\_share^{II}_{nfc,t-3}$	0.0010	0.0009	0.0006	-0.0002	-0.0005	0.0038*	0.0027	0.0032*	0.0021	0.0015
	(0.0022)	(0.0021)	(0.0023)	(0.0021)	(0.0021)	(0.0020)	(0.0021)	(0.0018)	(0.0018)	(0.0021)
$Dep\_share_{hh,t-3}$	0.0048**	0.0047**	0.0049**	0.0052***	0.0054***	0.0032*	0.0042**	0.0025	0.0022	0.0042***
	(0.0018)	(0.0018)	(0.0019)	(0.0019)	(0.0018)	(0.0018)	(0.0016)	(0.0016)	(0.0015)	(0.0014)
$Dep\_share^{I}_{hh,t-3}$	0.0057***	0.0055***	0.0060***	0.0060***	0.0063***	0.0060***	0.0060***	0.0052***	0.0048**	0.0057***
	(0.0021)	(0.0020)	(0.0021)	(0.0022)	(0.0020)	(0.0021)	(0.0019)	(0.0018)	(0.0019)	(0.0017)
$Dep\_share^{II}_{hh,t-3}$	0.0068***	0.0069***	0.0070***	0.0070***	0.0075***	0.0057***	0.0050***	0.0044***	0.0044***	0.0051***
	(0.0020)	(0.0018)	(0.0020)	(0.0021)	(0.0018)	(0.0017)	(0.0017)	(0.0015)	(0.0016)	(0.0015)
EL_{t-3}	0.0011	0.0023	0.0000	0.0025	0.0008	0.0117*	0.0084**	0.0100*	0.0148***	0.0145***
	(0.0065)	(0.0066)	(0.0056)	(0.0065)	(0.0058)	(0.0064)	(0.0036)	(0.0053)	(0.0054)	(0.0044)
EL^{I}_{t-3}	0.0094**	0.0102**	0.0091**	0.0097**	0.0103**	0.0125*	0.0101*	0.0113*	0.0142*	0.0099*
	(0.0038)	(0.0042)	(0.0035)	(0.0043)	(0.0046)	(0.0075)	(0.0060)	(0.0065)	(0.0084)	(0.0059)
EL^{II}_{t-3}	0.0020	0.0024	0.0023	0.0023	0.0027	0.0047	0.0044*	0.0043	0.0057*	0.0031
	(0.0019)	(0.0020)	(0.0019)	(0.0017)	(0.0019)	(0.0030)	(0.0026)	(0.0027)	(0.0029)	(0.0025)
$Other\_liq\_ratio_{t-3}$	-0.0017	-0.0017	-0.0016	-0.0014	-0.0013	0.0025	0.0023	0.0027	0.0032	0.0037*
	(0.0013)	(0.0014)	(0.0011)	(0.0014)	(0.0012)	(0.0020)	(0.0021)	(0.0020)	(0.0020)	(0.0020)
$Size_{t-3}$	-0.0019***	-0.0019***	-0.0018***	-0.0015***	-0.0015***	-0.0020***	-0.0022***	-0.0018***	-0.0018***	-0.0018***
	(0.0005)	(0.0005)	(0.0005)	(0.0004)	(0.0005)	(0.0006)	(0.0006)	(0.0005)	(0.0006)	(0.0005)
NIM_{t-3}		0.0000			0.0001		0.0001			0.0002***
		(0.0001)			(0.0001)		(0.0001)			(0.0001)
NIM^{I}_{t-3}		-0.0002*			-0.0002		0.0000			0.0004***
		(0.0001)			(0.0001)		(0.0001)			(0.0001)
NIM^{II}_{t-3}		-0.0001			0.0000		-0.0002			0.0003**
		(0.0002)			(0.0002)		(0.0001)			(0.0002)
RoA_{t-3}			0.0085*		0.0077			0.0109**		0.0002
			(0.0050)		(0.0051)			(0.0053)		(0.0054)
RoA^{I}_{t-3}			0.0051		0.0065			-0.0048		-0.0082
			(0.0078)		(0.0085)			(0.0141)		(0.0147)
RoA^{II}_{t-3}			0.0049		-0.0005			-0.0415***		-0.0334***
			(0.0076)		(0.0070)			(0.0138)		(0.0116)
$Tier1\_R_{t-3}$				0.0034	0.0044				-0.0045**	-0.0065***
				(0.0028)	(0.0029)				(0.0022)	(0.0019)
$Tier1\_R^{I}_{t-3}$				0.0041	0.0042*				-0.0025	-0.0032
				(0.0025)	(0.0024)				(0.0021)	(0.0020)
$Tier1\_R^{II}_{t-3}$				0.0025	0.0031				-0.0006	-0.0021
				(0.0018)	(0.0019)				(0.0022)	(0.0020)
Constant	0.0306***	0.0315***	0.0291***	0.0243***	0.0235***	0.0299***	0.0331***	0.0288***	0.0294***	0.0276***
	(0.0085)	(0.0091)	(0.0088)	(0.0072)	(0.0076)	(0.0092)	(0.0100)	(0.0090)	(0.0099)	(0.0083)
Observations	6,438	6,438	6,437	6,355	6,355	6,529	6,529	6,528	6,391	6,390
Number of Banks	72	72	72	71	71	76	76	76	74	74

Note: robust standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1; Regressions include bank and time fixed effects; Standard errors are clustered at bank and time level.

Table 4b: Hypothesis tests

Variables	(1)		(2)		(3)		(4)		(5)	
	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv
$Dep\_share_{nfc,t-3} - Dep\_share^{I}_{nfc,t-3} = 0$	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.02**	0.17	0.08
$Dep\_share_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3} = 0$	**0.02**	**0.01**	**0.02**	**0.01**	**0.02**	**0.01**	**0.10**	**0.05**	0.44	0.22
$Dep\_share_{hh,t-3} - Dep\_share^{I}_{hh,t-3} = 0$	0.42	0.21	0.41	0.20	0.37	0.18	0.28	0.14	0.49	0.25
$Dep\_share_{hh,t-3} - Dep\_share^{II}_{hh,t-3} = 0$	**0.05**	**0.02**	**0.04**	**0.02**	**0.04**	**0.02**	**0.03**	**0.02**	**0.10**	**0.05**
$EL_{t-3} - EL^{I}_{t-3} = 0$	0.76	0.38	0.86	0.43	0.73	0.36	0.36	0.18	0.28	0.14
$EL_{t-3} - EL^{II}_{t-3} = 0$	0.52	0.26	0.41	0.20	0.57	0.29	0.88	0.44	0.68	0.34
$NIM_{t-3} - NIM^{I}_{t-3} = 0$			**0.00**	**0.00**					**0.00**	**0.00**
$NIM_{t-3} - NIM^{II}_{t-3} = 0$			**0.00**	**0.00**					**0.00**	**0.00**
$RoA_{t-3} - RoA^{I}_{t-3} = 0$					0.90	0.45			0.19	0.09
$RoA_{t-3} - RoA^{II}_{t-3} = 0$					0.93	0.46			0.25	0.13
$Tier1\_R_{t-3} - Tier1\_R^{I}_{t-3} = 0$							0.21	0.10	**0.05**	**0.03**
$Tier1\_R_{t-3} - Tier1\_R^{II}_{t-3} = 0$							0.33	0.16	**0.09**	**0.04**

Variables	(1)		(2)		(3)		(4)		(5)	
	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv
$Dep\_share_{nfc,t-3} - Dep\_share^{I}_{nfc,t-3} = 0$	**0.02**	**0.01**	**0.03**	**0.02**	**0.01**	**0.01**	0.21	0.10	0.50	0.25
$Dep\_share_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3} = 0$	**0.09**	**0.04**	0.14	0.07	0.11	0.05	0.64	0.32	0.93	0.46
$Dep\_share_{hh,t-3} - Dep\_share^{I}_{hh,t-3} = 0$	0.55	0.28	0.85	0.43	0.37	0.18	0.49	0.24	0.85	0.42
$Dep\_share_{hh,t-3} - Dep\_share^{II}_{hh,t-3} = 0$	0.77	0.38	0.48	0.24	0.79	0.40	0.80	0.40	0.68	0.34
$EL_{t-3} - EL^{I}_{t-3} = 0$	1.00	0.50	0.59	0.30	0.85	0.42	0.18	0.09	0.47	0.23
$EL_{t-3} - EL^{II}_{t-3} = 0$	0.40	0.20	0.16	0.08	0.58	0.29	0.26	0.13	0.29	0.14
$NIM_{t-3} - NIM^{I}_{t-3} = 0$			**0.04**	**0.02**					**0.01**	**0.00**
$NIM_{t-3} - NIM^{II}_{t-3} = 0$			**0.09**	**0.04**					**0.02**	**0.01**
$RoA_{t-3} - RoA^{I}_{t-3} = 0$					0.56	0.28			0.08	0.04
$RoA_{t-3} - RoA^{II}_{t-3} = 0$					0.61	0.31			**0.10**	**0.05**
$Tier1\_R_{t-3} - Tier1\_R^{I}_{t-3} = 0$							**0.03**	**0.02**	**0.00**	**0.00**
$Tier1\_R_{t-3} - Tier1\_R^{II}_{t-3} = 0$							**0.03**	**0.02**	**0.01**	**0.01**

Variables	(1)		(2)		(3)		(4)		(5)	
	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv
$Dep\_share_{nfc,t-3} - Dep\_share^{I}_{nfc,t-3} = 0$	**0.01**	**0.00**	**0.02**	**0.01**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.00**
$Dep\_share_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3} = 0$	0.23	0.11	0.24	0.12	0.11	0.05	0.38	0.19	0.20	0.10
$Dep\_share_{hh,t-3} - Dep\_share^{I}_{hh,t-3} = 0$	0.41	0.20	0.48	0.24	0.32	0.16	0.49	0.24	0.41	0.21
$Dep\_share_{hh,t-3} - Dep\_share^{II}_{hh,t-3} = 0$	**0.03**	**0.01**	**0.02**	**0.01**	**0.02**	**0.01**	**0.05**	**0.03**	**0.03**	**0.02**
$EL_{t-3} - EL^{I}_{t-3} = 0$	**0.10**	**0.05**	**0.09**	**0.04**	**0.04**	**0.02**	0.20	0.10	**0.03**	**0.01**
$EL_{t-3} - EL^{II}_{t-3} = 0$	0.99	0.49	1.00	0.50	0.68	0.34	0.97	0.49	0.73	0.36
$NIM_{t-3} - NIM^{I}_{t-3} = 0$			**0.00**	**0.00**					**0.01**	**0.00**
$NIM_{t-3} - NIM^{II}_{t-3} = 0$			0.27	0.14					0.75	0.38
$RoA_{t-3} - RoA^{I}_{t-3} = 0$					0.69	0.35			0.88	0.44
$RoA_{t-3} - RoA^{II}_{t-3} = 0$					0.65	0.33			0.34	0.17
$Tier1\_R_{t-3} - Tier1\_R^{I}_{t-3} = 0$							0.80	0.40	0.91	0.46
$Tier1\_R_{t-3} - Tier1\_R^{II}_{t-3} = 0$							0.65	0.33	0.54	0.27

Variables	(1)		(2)		(3)		(4)		(5)	
	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv
$Dep\_share_{nfc,t-3} - Dep\_share^{I}_{nfc,t-3} = 0$	**0.04**	**0.02**	**0.04**	**0.02**	**0.03**	**0.02**	**0.05**	**0.02**	**0.03**	**0.01**
$Dep\_share_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3} = 0$	**0.03**	**0.02**	0.15	0.07	**0.03**	**0.01**	**0.04**	**0.02**	0.12	0.06
$Dep\_share_{hh,t-3} - Dep\_share^{I}_{hh,t-3} = 0$	0.15	0.07	0.29	0.15	0.14	0.07	0.18	0.09	0.26	0.13
$Dep\_share_{hh,t-3} - Dep\_share^{II}_{hh,t-3} = 0$	0.13	0.07	0.66	0.33	0.23	0.11	0.20	0.10	0.58	0.29
$EL_{t-3} - EL^{I}_{t-3} = 0$	0.87	0.44	0.77	0.39	0.80	0.40	0.90	0.45	0.35	0.17
$EL_{t-3} - EL^{II}_{t-3} = 0$	0.35	0.18	0.37	0.18	0.35	0.17	0.18	0.09	**0.02**	**0.01**
$NIM_{t-3} - NIM^{I}_{t-3} = 0$			0.29	0.14					**0.04**	**0.02**
$NIM_{t-3} - NIM^{II}_{t-3} = 0$			**0.02**	**0.01**					0.41	0.21
$RoA_{t-3} - RoA^{I}_{t-3} = 0$					0.31	0.15			0.57	0.29
$RoA_{t-3} - RoA^{II}_{t-3} = 0$					**0.00**	**0.00**			**0.01**	**0.01**
$Tier1\_R_{t-3} - Tier1\_R^{I}_{t-3} = 0$							**0.08**	**0.04**	**0.00**	**0.00**
$Tier1\_R_{t-3} - Tier1\_R^{II}_{t-3} = 0$							**0.01**	**0.01**	**0.00**	**0.00**

Note: bold numbers highlight significant p-values for p<0.01, p<0.05, or p<0.1; "2pv" denotes two-sided p-value and "1pv" one-sided p-value.

7. Conclusion

The existing theoretical and empirical literature on the role of banks in the transmission mechanism of monetary policy below the ZLB is inconclusive. Using confidential bank-level data for Germany, this paper provides new empirical evidence. First, it analysis what characterises a bank that opts to apply negative interest rates to corporate deposits. Second, it explores the characteristics of a bank which increases its fee and commission income.

I find evidence that banks that are highly exposed to the NIRP period, i.e. funded by a larger share of household deposits, are considerably more likely to charge negative interest rates from their corporate depositors. Foremost banks with a business model that focuses on retail customers are driving this result. Most likely, especially these banks face a relatively higher pressure on their interest margins, all other things being equal. To mitigate this pressure, they are more incentivised to charge negative corporate deposit rates. Furthermore, the NIRP period also implies a direct cost for banks due to their excess liquidity holdings. Thus, banks with relatively higher excess liquidity holdings might be incentivised to apply negative rates to mitigate the cost pressure. However, a relatively higher excess liquidity ratio only suggests some headwinds since it is associated with a rather moderately higher probability for negative corporate deposit rates. This fits with the finding that the cost of holding excess liquidity is rather low relative to the burden of a shrinking interest margin in lending and deposit business as well (Bundesbank, 2020).[60] Thus, banks do not seem to be exposed to a far less favourable situation following an increase in their excess liquidity ratio.

The result on the deposit share contrasts with the related study by Altavilla et al. (2021) for the euro area. They estimate that banks with a higher deposit share have a lower probability to charge negative corporate deposit rates. However, they do not split the deposit share along corporates and households.

Furthermore, German banks seem to indeed operate differently under NIRP. They adjusted their business strategy in deposit business with households during the NIRP period. Compared to the pre-NIRP period, they generated higher net commission income on their outstanding household deposit holdings. This could be because banks raised their fees in deposit business with households. It might also be because banks used their business relationships with households to cross-sell further banking services from which they generated commission profits. A relatively higher excess liquidity ratio is only statistically associated with a higher net commission income for "medium deposit banks". However, the economic relevance suggests that this effect is rather small. Therefore, it does not indicate that a higher excess liquidity ratio would have led to higher fees and commissions increasingly being applied to bank customers.

[60] From the beginning of the NIRP period up to end- 2019, the burden that banks in Germany faced from the declining interest margin were around four times higher than the costs of holding excess liquidity (Bundesbank, 2020).

These results on bank fees and commissions are in line with other studies e.g. by Bastan and Mariathasan (2018) for Switzerland and by Bottero et al. (2019) for Italy. However, the results by Altavilla et al. (2019) are different. They find for euro area banks with high excess liquidity an increase in their applied fees after the implementation of NIRP. For banks with a large retail deposit share they always find lower fees and no change in their behaviour after the implementation of NIRP.

On the whole, my results are coherent with those in the literature on the impact of NIRP in that way that banks which are more exposed to NIRP seem more incentivised to turn to mitigating the pressure on their profitability. Especially banks which rely more on traditional retail (foremost household) deposit funding, are possibly among those banks in Germany which are more exposed to NIRP. These banks might face a relatively higher pressure on their interest margins. Thus, it is hardly surprising that these banks seem more inclined to charge corporate deposits negatively as well as to charge higher fees and commissions.

8. References

Altavilla, C., L. Burlon, M. Giannetti, S. Holton (2021), Is there a zero lower bound? The effects of negative policy rates on banks and firms, *Journal of Financial Economics*, July 2021.

Altavilla, C., L. Burlon, M. Giannetti, S. Holton (2019), Is there a zero lower bound? The effects of negative policy rates on banks and firms, ECB working Paper, No. 2289, September 2019.

Altavilla, C., M. Boucinha and J. Peydro (2018), Monetary policy and bank profitability in a low interest rate environment, *Economic Policy*, 33, p. 531-586.

Basten, C., and M. Mariathasan (2018), How Banks Respond to Negative Interest Rates: Evidence from the Swiss Exemption Threshold, CESifo Working Paper Series, No 6901, April 2018.

Bech, M. and A. Malkhozov (2015), How have Central Banks Implemented Negative Policy Rates? BIS Quarterly Review, p. 31-44, Bank for International Settlements, Basel.

Blot, C. and P. Huber (2016), Negative Interest Rates: Incentive or Hindrance for the Banking System? in: Directorate-General for Internal Policies, EC, "How do Low and Negative Interest Rates Affect Banks' Activity and Profitability in the Euro-Area?, November 2016.

Borio, C. and L. Gambacorta (2017), Monetary policy and bank lending in a low interest rate environment: diminishing effectiveness?, *Journal of Macroeconomics*, 54, p. 217-231, December 2017.

Bottero M.B., C. Minoiu, J.L. Peydró, A. Polo, A.F. Presbitero and E. Sette (2019), Negative monetary policy rates and portfolio rebalancing: evidence from credit register data, IMF Working Paper, No 19/44, February 2019.

Bundesbank (2020), Developments in the German banking system during the negative interest rate policy period, Monthly Report, October 2020.

Brunnermeier, M.K. and Y. Koby (2018), The Reversal Interest Rate, NBER Working Paper, No. 25406, December 2018.

Bräuning, F. and B. Wu (2017), ECB Monetary Policy Transmission During Normal and Negative Interest Rate Periods, March 2017, available at SSRN: https://ssrn.com/abstract=2940553.

Busch, R., H. C. N. Littke, C. Memmel and S. Niederauer (2021), German Banks‘ behavior in the low interest rate environment, Deutsche Bundesbank Working Paper, No. 23/2021, July 2021.

Claessens, S., N. Coleman and M. Donnelly (2018), Low-For-Long' interest rates and banks' interest margins and profitability: Cross-country evidence, *Journal of Financial Intermediation*, 35, p. 1-16.

Damyanova, V. (2021), Commerzbank to book millions in provisions after court ruling on fees, S&P Global, June 17h 2021. Link: https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/commerzbank-to-book-millions-in-provisions-after-court-ruling-on-fees-8211-cfo-65049762

Demiralp, S., J. Eisenschmidt and T. Vlassopoulos (2019), Negative Interest Rates, Excess Liquidity and retail deposits: Banks‘ Reaction to Unconventional Monetary Policy in the Euro Area, ECB Working Paper Series, No. 1183, May 2019.

Eggertsson, G., R. Juelsrud, L. Summers and E. Wold (2019), Negative nominal interest rates and the bank lending channel, NBER Working Paper, No. 25416, January 2019.

Eisenschmidt, J. and F. Smets (2019), Negative interest rates: Lessons from the Euro Area, Central Banking, Analysis, and Economic Policies, No. 26, Book Series, in: Álvaro Aguirre & Markus

Brunnermeier & Diego Saravia (ed.), Monetary Policy and Financial Stability: Transmission Mechanisms and Policy Implications, 1 (26), p. 13-42, Central Bank of Chile.

Gross, D. (2016), Low Rates = Low Banks' Profits?, in: Directorate-General for Internal Policies, EC, "How do Low and Negative Interest Rates Affect Banks' Activity and Profitability in the Euro-Area?, November 2016.

Heider, F., F. Saidi and G. Schepens (2019), Life below Zero: Bank Lending under Negative Policy Rates, *The Review of Financial Studies*, 32(10), p. 3728–3761, October 2019.

Jobst, A. and H. Lin (2016), Negative Interest Rate Policy (NIRP): Implications for Monetary Transmission and Bank Profitability in the Euro Area, IMF Working Paper, No. 16/172, August 2016.

Stiftung Warentest (2022), Keine Angst vor Negativzinsen, Stiftung Warentest, May 11th 2022. Link: https://www.test.de/Minuszinsen-Keine-Angst-vor-Negativzinsen-5506996-0/

tagesschau (2021), Fast 350 Banken erheben Negativzinsen, tagesschau, June 30th 2021. Link: https://www.tagesschau.de/wirtschaft/finanzen/banken-negativzinsen-gebuehren-101.html

Pugsley J. (2021), BoE official revives negative rate speculation, TheBanker, January 18th 2021. Link: https://www.thebanker.com/World/Western-Europe/UK/BoE-official-revives-negative-rate-speculation

Tenreyro S. (2021), Let's talk about negative rates, Speech held at the UWE Bristol webinar, January 11th 2021, Bank of England. Link: https://www.bankofengland.co.uk/speech/2021/january/silvana-tenreyro-lets-talk-about-negative-interest-rates

O'Brien F. and L. Meakin (2020), BoE Officials Signal Openness to Negative Rates as Stimulus Tool, Bloomberg, December 4th 2020. Link: https://www.bloomberg.com/news/articles/2020-12-04/boe-saunders-sees-modest-scope-for-more-interest-rate-cuts

A.1 Variable definition

Variable	*Source*	*Description*
Dep_neg_{nfc}	MFI interest rate statistic (ZISTA)	Interest rate on sight deposits by NFCs as a dummy variable: =1 if interest rate <0, 0 otherwise
Dep_share_{nfc}	MFI interest rate (ZISTA) and balance sheet statistic (BISTA)	Deposit share by NFCs: deposit volume (stocks) by NFCs for sight deposits and fixed-term deposits over total liabilities
Dep_share_{hh}	MFI interest rate (ZISTA) and balance sheet statistic (BISTA)	Deposit share by HH: deposit volume (stocks) by HHs for sight deposits and fixed-term deposits over total liabilities
EL	Balance sheet statistic (BISTA)	Excess liquidity ratio: bank's excess liquid-dity over its total assets
$Other\_liq\_ratio$	Balance sheet statistic (BISTA)	Cash + foreign and domestic bonds + Eurosystem deposits – excess liquidity – minimum reserves over total assets
$Size$	Balance sheet statistic (BISTA)	Logarithm of the bank's total assets
NIM	MFI interest rate (ZISTA) and balance sheet statistic (BISTA)	Net interest income over outstanding loans
RoA	MFI profit and loss accounts (GuV) and Financial and Internal Capital Adequacy Information Regulation (FinaRisikoV)	Net operating income without value adjustments over total assets; until December 2013 annual data from GuV, afterwards quarterly data from FinaRisikoV; linearly interpolated to monthly data
$Tier1\_R$	Supervisory data from Deutsche Bundesbank	Share of core capital to total risk weighted assets, quarterly data from 2008; linearly interpolated to monthly data
$Commission\_margin$	MFI profit and loss accounts (GuV) and Financial and Internal Capital Adequacy Information Regulation (FinaRisikoV)	Net fee and commission income over total assets; until December 2013 annual data from GuV, afterwards quarterly data from FinaRisikoV; linearly interpolated to monthly data
Neg_share	MFI interest rate (ZISTA)	Share of banks, other than bank i, with on average negative interest rate on NFC sight deposits.
GDP	ECB	Gross domestic product: in constant prices, calendar and seasonally adjusted; quarterly data quadratic interpolated to monthly data, logarithmised
$HICP$	ECB	Harmonised index of consumer prices: calendar and seasonally adjusted, yearly growth rate (%)
$Term\_spread$	Datastream	Difference between 10Y German govern-ment bond and EONIA Swap rate 2Y (%)

A.2 Summary statistics

Table A2: Descriptive statistics

All Banks

	$Dep\_share^{I}_{nfc}$	$Dep\_share^{II}_{nfc}$	$Dep\_share^{I}_{hh}$	$Dep\_share^{II}_{hh}$	EL^{I}	EL^{II}	NIM^{I}	NIM^{II}	$Tier1\_R^{I}$	$Tier1\_R^{II}$	RoA^{I}	RoA^{II}	Com_margin^{I}	Com_margin^{II}	$Term\_spread^{I}$	$Term\_spread^{II}$
Mean	8.77	9.00	46.07	48.04	1.10	3.37	2.70	2.37	15.92	17.38	0.49	0.49	0.48	0.49	0.60	0.54
SD	7.46	7.66	28.17	27.83	3.09	5.00	2.05	1.63	7.01	7.09	0.89	0.83	0.50	0.48	0.20	0.21

Low Deposit banks

	$Dep\_share^{I}_{nfc}$	$Dep\_share^{II}_{nfc}$	$Dep\_share^{I}_{hh}$	$Dep\_share^{II}_{hh}$	EL^{I}	EL^{II}	NIM^{I}	NIM^{II}	$Tier1\_R^{I}$	$Tier1\_R^{II}$	RoA^{I}	RoA^{II}	Com_margin^{I}	Com_margin^{II}	$Term\_spread^{I}$	$Term\_spread^{II}$
Mean	6.63	7.44	11.75	14.08	2.10	5.87	2.89	2.50	18.19	20.19	0.16	0.30	0.33	0.36	0.29	0.27
SD	7.85	8.94	17.60	20.16	4.78	6.77	1.82	1.52	9.98	10.35	1.19	1.30	0.60	0.59	0.33	0.31

Medium Deposit banks

	$Dep\_share^{I}_{nfc}$	$Dep\_share^{II}_{nfc}$	$Dep\_share^{I}_{hh}$	$Dep\_share^{II}_{hh}$	EL^{I}	EL^{II}	NIM^{I}	NIM^{II}	$Tier1\_R^{I}$	$Tier1\_R^{II}$	RoA^{I}	RoA^{II}	Com_margin^{I}	Com_margin^{II}	$Term\_spread^{I}$	$Term\_spread^{II}$
Mean	11.23	11.00	54.11	55.57	0.47	2.56	3.09	2.57	13.88	15.30	0.66	0.59	0.63	0.64	0.27	0.28
SD	5.76	5.56	10.47	11.40	1.23	3.38	0.81	0.67	3.00	3.08	0.66	0.51	0.41	0.39	0.33	0.31

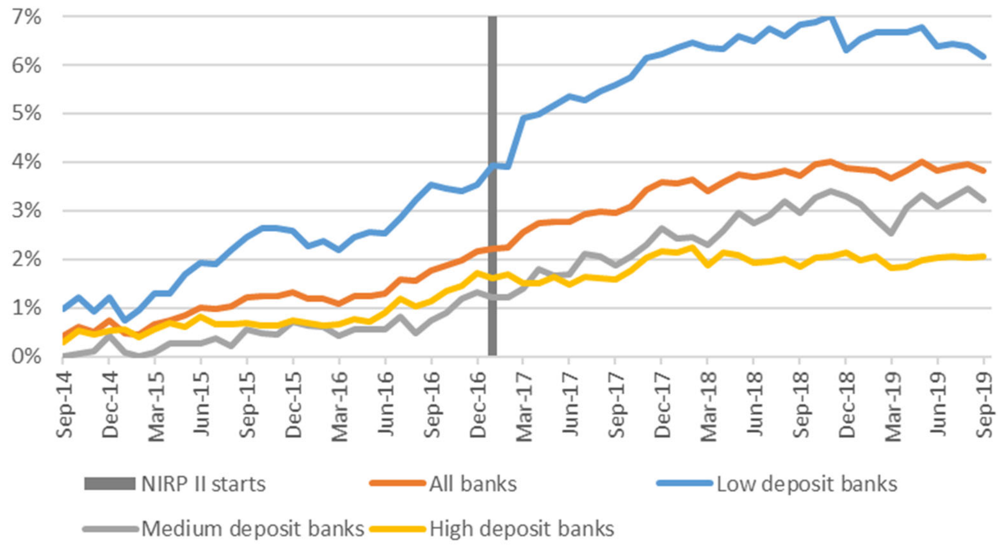
High Deposit banks

	$Dep\_share^{I}_{nfc}$	$Dep\_share^{II}_{nfc}$	$Dep\_share^{I}_{hh}$	$Dep\_share^{II}_{hh}$	EL^{I}	EL^{II}	NIM^{I}	NIM^{II}	$Tier1\_R^{I}$	$Tier1\_R^{II}$	RoA^{I}	RoA^{II}	Com_margin^{I}	Com_margin^{II}	$Term\_spread^{I}$	$Term\_spread^{II}$
Mean	8.25	8.08	69.62	69.63	0.78	1.89	2.17	2.05	16.08	17.41	0.62	0.55	0.45	0.46	0.28	0.28
SD	7.50	7.25	13.01	13.84	1.86	3.20	2.81	2.18	6.33	6.28	0.68	0.54	0.44	0.43	0.33	0.31

Descriptive statistics (in percent, estimation period: September 2014 until September 2019). I denotes the first half of the NIRP period from September 2014 until December 2016. II specifies the second half of the NIRP period running from January 2017 to September 2019.

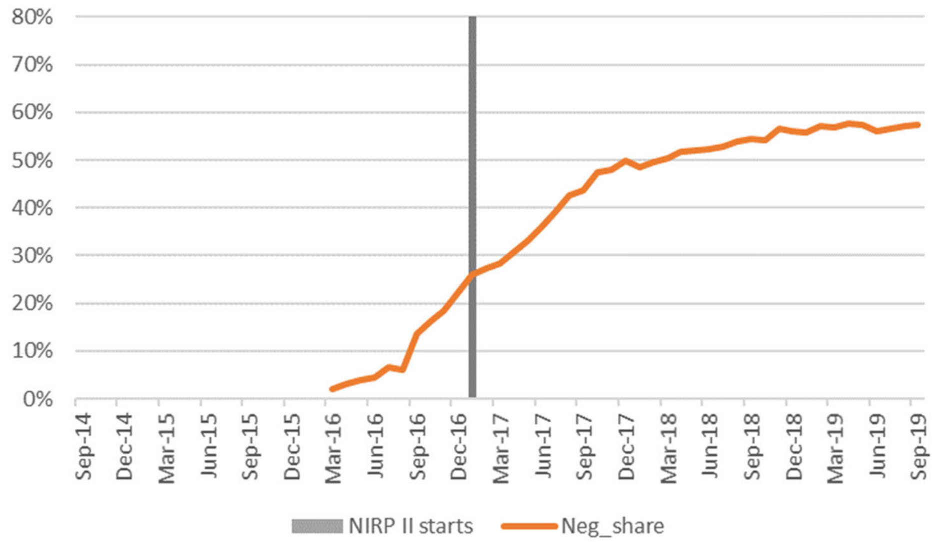
A.3 Figures – NIRP

Figure A1: Excess reserve ratios



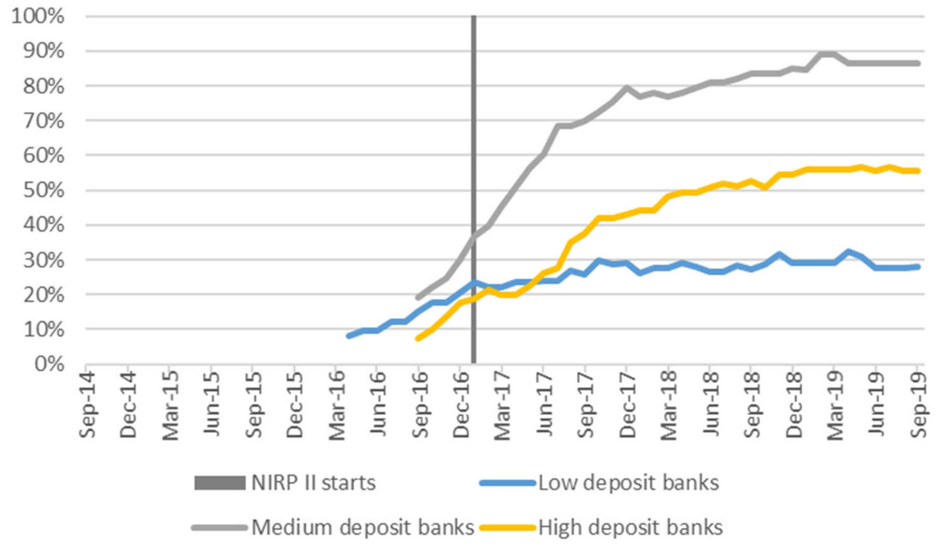
Source: BISTA, average excess reserve holdings relative to total assets

Figure A2: Share of all banks with negative NFC deposit rate



Source: ZISTA. Values before March 2016 cannot be shown due to data confidentiality reasons.

Figure A3: Share of banks with negative NFC deposit rate within each retail deposit intensity category



Source: ZISTA. Values before September or April 2016 cannot be shown due to data confidentiality reasons.

Table A3: Robustness Linear Probability Model

Variables	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	All banks					Low deposit banks					Medium deposit banks					High deposit banks				
$Dep\_share^{I}_{nfc,t-6}$	**-1.498****	**-1.445****	-0.992	-1.310	**-1.346***	0.271	0.143	1.193	0.667	0.631	-0.795	-0.780	-0.813	-0.862	-0.873	-1.401	-1.132	-0.450	-0.750	-0.727
	(0.670)	(0.675)	(1.010)	(1.060)	(0.946)	(0.628)	(0.638)	(1.331)	(1.743)	(1.712)	(1.612)	(1.616)	(1.622)	(1.650)	(1.668)	(1.466)	(1.395)	(1.537)	(1.510)	(1.148)
$Dep\_share^{II}_{nfc,t-6}$	0.329	0.389	1.445	1.054	1.104	0.705	0.531	2.145	1.434	1.415	0.910	0.928	0.900	0.834	0.828	0.578	0.389	0.629	0.789	1.173
	(0.641)	(0.661)	(1.011)	(1.052)	(1.056)	(0.529)	(0.506)	(1.282)	(1.599)	(1.561)	(1.501)	(1.489)	(1.507)	(1.512)	(1.515)	(1.490)	(1.469)	(1.520)	(1.458)	(1.426)
$Dep\_share^{I}_{hh,t-6}$	**1.222****	**1.132****	**1.431****	**1.277***	**1.212***	0.109	0.167	0.057	-0.155	-0.148	**1.680****	**1.686****	**1.666****	**1.499***	**1.504***	**1.960****	**1.873****	**2.989****	**2.600****	**1.789**
	(0.494)	(0.515)	(0.661)	(0.678)	(0.706)	(0.534)	(0.519)	(0.607)	(0.580)	(0.564)	(0.813)	(0.725)	(0.820)	(0.884)	(0.795)	(0.818)	(0.776)	(1.125)	(1.126)	(1.113)
$Dep\_share^{II}_{hh,t-6}$	**1.692*****	**1.605*****	**1.775*****	**1.617****	**1.566****	**0.848***	**0.871***	0.760	0.510	0.501	**2.133****	**2.143****	**2.116****	**1.874***	**1.870****	**1.749*****	**1.460****	**2.187****	**2.103****	1.416
	(0.473)	(0.492)	(0.634)	(0.651)	(0.676)	(0.497)	(0.482)	(0.549)	(0.536)	(0.530)	(0.923)	(0.832)	(0.924)	(0.972)	(0.899)	(0.554)	(0.579)	(0.972)	(0.966)	(1.003)
EL^{I}_{t-6}	**0.887***	**0.959***	**1.058***	0.850	0.838	0.543	**0.637***	0.467	0.110	0.155	0.252	0.245	0.165	0.448	0.356	**2.828**	**3.803****	**3.008***	**3.605***	**5.132*****
	(0.517)	(0.543)	(0.620)	(0.670)	(0.773)	(0.327)	(0.335)	(0.389)	(0.416)	(0.535)	(0.844)	(0.855)	(0.848)	(0.871)	(0.876)	(1.774)	(1.890)	(1.750)	(1.811)	(1.909)
EL^{II}_{t-6}	-0.090	-0.077	-0.504	-0.576	-0.497	**0.924****	**0.917****	**0.763****	**0.737***	**0.728***	**-1.548****	**-1.578****	**-1.547****	**-1.628****	**-1.648****	-1.085	-0.718	-0.782	-0.649	-0.179
	(0.388)	(0.380)	(0.398)	(0.406)	(0.402)	(0.383)	(0.383)	(0.376)	(0.382)	(0.368)	(0.747)	(0.763)	(0.744)	(0.755)	(0.772)	(1.278)	(1.157)	(1.182)	(1.139)	(0.932)
$Other\_liq\_ratio_{t-6}$	0.981	0.931	1.083	0.854	0.777	-0.584	-0.523	-0.362	-0.726	-0.671	-1.056	-1.046	-1.085	-1.186	-1.201	0.839	1.149	1.062	1.155	1.309
	(0.644)	(0.648)	(0.657)	(0.670)	(0.690)	(0.743)	(0.737)	(0.823)	(0.853)	(0.832)	(1.228)	(1.219)	(1.235)	(1.228)	(1.226)	(1.637)	(1.635)	(1.655)	(1.568)	(1.501)
$Size_{t-6}$	0.043	0.031	0.059	-0.021	-0.018	-0.101	-0.093	-0.094	**-0.220***	**-0.215***	**0.265**	**0.269***	0.257	0.251	0.256	-0.126	-0.207	-0.214	-0.276	-0.426
	(0.066)	(0.066)	(0.086)	(0.103)	(0.107)	(0.066)	(0.064)	(0.084)	(0.112)	(0.109)	(0.164)	(0.149)	(0.164)	(0.186)	(0.169)	(0.316)	(0.346)	(0.401)	(0.438)	(0.433)
NIM^{I}_{t-6}		-0.020			-0.032		**0.025****			0.020		0.012			0.008		-0.046			**-0.204*****
		(0.017)			(0.035)		(0.011)			(0.025)		(0.077)			(0.074)		(0.029)			(0.070)
NIM^{II}_{t-6}		0.005			0.001		0.022			**0.024***		0.014			0.010		-0.016			**-0.145***
		(0.016)			(0.019)		(0.016)			(0.014)		(0.112)			(0.111)		(0.029)			(0.074)
RoA^{I}_{t-6}			-0.384		1.324			-0.733		-0.049			0.960		1.189			1.040		2.671
			(1.207)		(1.216)			(1.014)		(1.377)			(2.029)		(2.027)			(2.169)		(1.705)
RoA^{II}_{t-6}			0.215		1.045			0.524		1.116			0.738		0.236			0.898		-1.872
			(1.367)		(1.198)			(0.719)		(0.852)			(2.511)		(2.204)			(3.032)		(2.269)
$Tier1\_R^{I}_{t-6}$				-0.390	-0.547				-0.216	-0.326				-0.168	-0.202				**-2.734***	**-2.959****
				(0.498)	(0.481)				(0.445)	(0.482)				(1.825)	(1.825)				(1.513)	(1.291)
$Tier1\_R^{II}_{t-6}$				-0.528	-0.463				-0.718	**-0.814***				0.614	0.602				-2.699	**-2.495***
				(0.514)	(0.504)				(0.456)	(0.475)				(1.594)	(1.591)				(1.651)	(1.439)
Constant	-1.053	-0.802	-1.465	0.017	0.039	1.804	1.605	1.668	4.012*	3.882*	-4.638*	-4.747*	-4.513*	-4.317	-4.407	0.953	2.394	1.752	3.348	6.606
	(1.208)	(1.225)	(1.620)	(1.941)	(2.023)	(1.177)	(1.157)	(1.499)	(2.069)	(1.996)	(2.548)	(2.394)	(2.558)	(2.883)	(2.735)	(5.035)	(5.522)	(6.601)	(7.234)	(7.145)
Observations	11,587	11,570	10,945	10,613	10,593	3,492	3,475	2,980	2,748	2,731	3,950	3,950	3,949	3,901	3,901	4,104	4,104	4,016	3,964	3,961
Number of Banks	224	224	210	203	203	73	73	63	58	58	72	72	72	71	71	77	77	75	74	74

Note: robust standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1; Regressions include bank and time fixed effects; Standard errors are clustered at bank and time level.

Table A3b: Hypothesis tests

Variables	(1)		(2)		(3)		(4)		(5)		(1)		(2)		(3)		(4)		(5)		(1)		(2)		(3)		(4)		(5)		(1)		(2)		(3)		(4)		(5)	
	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv	2pv	1pv
$Dep\_share^{I}_{nfc,t-6} - Dep\_share^{II}_{nfc,t-'6} = 0$	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.24	0.12	0.30	0.15	0.25	0.12	0.38	0.19	0.37	0.18	**0.02**	**0.01**	**0.03**	**0.02**	**0.02**	**0.01**	**0.03**	**0.01**	**0.04**	**0.02**	**0.04**	**0.02**	**0.08**	**0.04**	0.36	0.18	0.18	0.09	**0.09**	**0.05**
$Dep\_share^{I}_{hh,t-6} - Dep\_share^{II}_{hh,t-6} = 0$	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	0.29	0.15	0.31	0.15	0.29	0.15	0.46	0.23	0.48	0.24	0.70	0.35	0.39	0.19	0.26	0.13	0.49	0.24	0.56	0.28
$EL^{I}_{t-6} - EL^{II}_{t-6} = 0$	**0.05**	**0.03**	**0.06**	**0.03**	**0.01**	**0.01**	**0.03**	**0.02**	0.11	0.05	**0.08**	**0.04**	0.26	0.13	0.35	0.17	**0.07**	**0.03**	0.21	0.11	0.13	0.07	0.13	0.07	0.16	0.08	0.10	0.06	0.11	0.06	**0.02**	**0.01**	**0.01**	**0.01**	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**	**0.00**
$NIM^{I}_{t-6} - NIM^{II}_{t-6} = 0$			**0.09**	**0.05**					0.28	0.14			0.82	0.41					0.90	0.45			0.98	0.49	0.95	0.47			0.98	0.49			**0.02**	**0.01**					**0.09**	**0.04**
$RoA^{I}_{t-6} - RoA^{II}_{t-6} = 0$					0.72	0.36			0.88	0.44					0.25	0.13			0.47	0.23							0.45	0.22	0.75	0.38					0.97	0.49			0.14	0.07
$Tier1\_R^{I}_{t-6} - Tier1\_R^{II}_{t-6} = 0$							0.68	0.34	0.80	0.40							**0.10**	**0.05**	0.17	0.08									0.44	0.22							0.96	0.48	0.47	0.24

Note: bold numbers highlight significant p-values for p<0.01, p<0.05, or p<0.1; "2pv" denotes two-sided p-value and "1pv" one-sided p-value.

Table A4: Robustness Probit Model

All banks

Variables	(1)	(2)	(3)	(4)	(5)
$Dep\_share^{I}_{nfc,t-3}$	-2.072***	-1.759***	-1.813**	-2.285**	-1.798**
	(0.653)	(0.576)	(0.844)	(0.971)	(0.775)
$Dep\_share^{II}_{nfc,t-3}$	-0.670	-0.514	-0.118	-0.632	-0.296
	(0.571)	(0.528)	(0.816)	(0.925)	(0.773)
$Dep\_share^{I}_{hh,t-3}$	1.200**	0.919*	1.470**	0.911	0.526
	(0.509)	(0.522)	(0.622)	(0.638)	(0.573)
$Dep\_share^{II}_{hh,t-3}$	1.450***	1.089**	1.695***	0.997*	0.993*
	(0.487)	(0.511)	(0.604)	(0.515)	(0.557)
EL^{I}_{t-3}	1.091*	0.996*	1.426**	1.182*	1.259*
	(0.658)	(0.604)	(0.757)	(0.696)	(0.723)
EL^{II}_{t-3}	-0.371	-0.334	-0.317	-0.449	-0.473
	(0.320)	(0.279)	(0.298)	(0.321)	(0.295)
$Other\_liq\_ratio_{t-3}$	1.190*	1.171*	1.369*	1.166	1.316*
	(0.684)	(0.692)	(0.760)	(0.771)	(0.757)
$Size_{t-3}$	0.0256	-0.0349	-0.0336	-0.0850	-0.278*
	(0.0809)	(0.0939)	(0.110)	(0.129)	(0.155)
NIM^{I}_{t-3}		0.0273			-0.0351
		(0.0336)			(0.0418)
NIM^{II}_{t-3}		0.0186			-0.0562
		(0.0294)			(0.0436)
RoA^{I}_{t-3}			-0.511		0.700
			(0.985)		(1.184)
RoA^{II}_{t-3}			-0.595		0.478
			(0.683)		(0.658)
$Tier1\_R^{I}_{t-3}$				-0.770	-0.749
				(0.490)	(0.473)
$Tier1\_R^{II}_{t-3}$				-0.532	-0.800*
				(0.497)	(0.451)
Observations	10,905	10,883	10,271	9,933	9,907
Number of Banks	225	225	212	206	206

Low deposit banks

Variables	(1)	(2)	(3)	(4)	(5)
$Dep\_share^{I}_{nfc,t-3}$	0.0590	-0.289	0.437	0.144	0.108
	(0.627)	(0.577)	(0.852)	(0.896)	(0.814)
$Dep\_share^{II}_{nfc,t-3}$	0.576	0.0768	1.216	0.837	0.280
	(0.626)	(0.509)	(0.876)	(0.915)	(0.748)
$Dep\_share^{I}_{hh,t-3}$	-0.720	-0.450	-0.727	-0.996**	-1.013*
	(0.531)	(0.631)	(0.618)	(0.457)	(0.580)
$Dep\_share^{II}_{hh,t-3}$	-0.313	-0.0684	-0.335	-0.926**	-0.574
	(0.463)	(0.571)	(0.546)	(0.400)	(0.505)
EL^{I}_{t-3}	-0.837	-0.651	-0.918	-1.105*	-0.977
	(0.546)	(0.558)	(0.661)	(0.557)	(0.636)
EL^{II}_{t-3}	0.412*	0.362*	0.372*	0.316	0.347
	(0.250)	(0.220)	(0.221)	(0.335)	(0.346)
$Other\_liq\_ratio_{t-3}$	-0.427	-0.0839	-0.134	0.292	0.614
	(0.770)	(0.781)	(0.908)	(1.029)	(0.992)
$Size_{t-3}$	-0.193**	-0.274***	-0.224**	-0.373***	-0.588***
	(0.0923)	(0.0963)	(0.106)	(0.102)	(0.103)
NIM^{I}_{t-3}		0.0180			0.0455
		(0.0255)			(0.0294)
NIM^{II}_{t-3}		0.0190			0.0236
		(0.0150)			(0.0212)
RoA^{I}_{t-3}			-1.042		-0.568
			(0.934)		(1.104)
RoA^{II}_{t-3}			-0.308		1.002*
			(0.502)		(0.528)
$Tier1\_R^{I}_{t-3}$				-0.313	-0.954
				(0.457)	(0.690)
$Tier1\_R^{II}_{t-3}$				-1.230**	-2.223***
				(0.494)	(0.728)
Observations	3,700	3,678	3,157	2,907	2,885
Number of Banks	76	76	65	60	60

Medium deposit banks

Variables	(1)	(2)	(3)	(4)	(5)
$Dep\_share^{I}_{nfc,t-3}$	-2.674*	-3.217**	-2.701**	-2.803**	-3.254***
	(1.428)	(1.349)	(1.360)	(1.366)	(1.173)
$Dep\_share^{II}_{nfc,t-3}$	-0.705	-0.781	-0.776	-0.608	-0.412
	(1.526)	(1.444)	(1.393)	(1.494)	(1.254)
$Dep\_share^{I}_{hh,t-3}$	3.517**	4.280***	3.452**	1.300	2.169**
	(1.499)	(1.496)	(1.400)	(1.058)	(1.040)
$Dep\_share^{II}_{hh,t-3}$	3.486**	4.238***	3.343**	1.409	2.205**
	(1.435)	(1.410)	(1.330)	(0.949)	(0.924)
EL^{I}_{t-3}	0.278	0.0275	-0.0877	-0.366	-1.369
	(1.645)	(1.806)	(1.684)	(1.924)	(1.679)
EL^{II}_{t-3}	-1.622	-1.579	-1.803*	-2.442**	-2.164**
	(0.985)	(0.998)	-0.984	(0.99)	(0.896)
$Other\_liq\_ratio_{t-3}$	-2.240	-1.421	-1.540	-2.710	-1.390
	(2.197)	(2.197)	(2.171)	(2.021)	(1.783)
$Size_{t-3}$	1.868***	1.874***	1.840***	1.266***	1.318***
	(0.542)	(0.547)	(0.503)	(0.333)	(0.347)
NIM^{I}_{t-3}		0.00424			-0.00187
		(0.0523)			(0.0428)
NIM^{II}_{t-3}		0.0332			0.0467
		(0.0591)			(0.0477)
RoA^{I}_{t-3}			4.781		5.512
			(3.311)		(3.238)
RoA^{II}_{t-3}			-0.978		-2.406
			(1.616)		(1.692)
$Tier1\_R^{I}_{t-3}$				-0.472	-0.528
				(1.443)	(1.585)
$Tier1\_R^{II}_{t-3}$				-0.325	0.0291
				(1.280)	(1.284)
Observations	3,018	3,018	3,018	2,982	2,982
Number of Banks	72	72	72	71	71

High deposit banks

Variables	(1)	(2)	(3)	(4)	(5)
$Dep\_share^{I}_{nfc,t-3}$	-3.360**	-1.835*	-2.640**	-3.542***	-2.282**
	(1.366)	(1.096)	(1.207)	(1.362)	(1.138)
$Dep\_share^{II}_{nfc,t-3}$	-1.852	-1.781*	-1.624	-2.744**	-2.182**
	(1.353)	(1.071)	(1.173)	(1.307)	(1.065)
$Dep\_share^{I}_{hh,t-3}$	1.325*	1.192*	1.28*	0.79	0.184
	(0.794)	(0.722)	(0.771)	(0.859)	(1.024)
$Dep\_share^{II}_{hh,t-3}$	1.489*	0.321	0.951*	0.921*	0.223
	(0.800)	(0.742)	(0.570)	(0.555)	(0.872)
EL^{I}_{t-3}	3.698***	2.395**	3.647***	3.958***	2.538**
	(1.002)	(1.209)	(1.087)	(0.958)	(1.046)
EL^{II}_{t-3}	0.0591	0.957	0.398	0.0696	1.196*
	(0.704)	(0.663)	(0.704)	(0.687)	(0.643)
$Other\_liq\_ratio_{t-3}$	1.425	1.702	1.358	1.537	2.329
	(1.687)	(1.599)	(1.752)	(1.600)	(1.540)
$Size_{t-3}$	-0.231	-0.357	-0.428	-0.453	-0.373
	(0.419)	(0.474)	(0.464)	(0.466)	(0.479)
NIM^{I}_{t-3}		0.0397			-0.000935
		(0.157)			(0.162)
NIM^{II}_{t-3}		-0.0339			-0.100
		(0.150)			(0.160)
RoA^{I}_{t-3}			1.480		-4.741
			(2.677)		(3.406)
RoA^{II}_{t-3}			-1.866		-0.369
			(1.180)		(0.989)
$Tier1\_R^{I}_{t-3}$				-0.492	-1.145
				(1.289)	(1.406)
$Tier1\_R^{II}_{t-3}$				-0.0879	-0.536
				(1.198)	(1.248)
Observations	4,187	4,187	4,096	4,044	4,040
Number of Banks	77	77	75	75	74

Note: robust standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1; Regressions include bank and time fixed effects; Standard errors are clustered at bank and time level.

Table A4b: Hypothesis tests

All banks

Variables	(1) 2pv	(1) 1pv	(2) 2pv	(2) 1pv	(3) 2pv	(3) 1pv	(4) 2pv	(4) 1pv	(5) 2pv	(5) 1pv
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}$= 0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$Dep\_share^{I}_{hh,t-3}$- $Dep\_share^{II}_{hh,t-3}$= 0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.01**	**0.00**	**0.00**
$EL^{I}_{t-3} - EL^{II}_{t-3}$=0	**0.01**	**0.00**	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$NIM^{I}_{t-3} - NIM^{II}_{t-3}$= 0			0.69	0.35					0.29	0.14
$RoA^{I}_{t-3} - RoA^{II}_{t-3}$ =0					0.94	0.47			0.88	0.44
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}$=0							0.53	0.26	0.88	0.44

Low deposit banks

Variables	(1) 2pv	(1) 1pv	(2) 2pv	(2) 1pv	(3) 2pv	(3) 1pv	(4) 2pv	(4) 1pv	(5) 2pv	(5) 1pv
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}$= 0	0.13	0.06	0.29	0.15	**0.10**	**0.05**	0.17	0.08	0.75	0.37
$Dep\_share^{I}_{hh,t-3}$- $Dep\_share^{II}_{hh,t-3}$= 0	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.01**	**0.04**	**0.02**	**0.01**	**0.01**
$EL^{I}_{t-3} - EL^{II}_{t-3}$=0	0.14	0.07	0.33	0.16	0.22	0.11	**0.10**	**0.05**	**0.01**	**0.01**
$NIM^{I}_{t-3} - NIM^{II}_{t-3}$= 0			0.97	0.48					0.48	0.24
$RoA^{I}_{t-3} - RoA^{II}_{t-3}$ =0					0.46	0.23			0.23	0.12
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}$=0							**0.07**	**0.04**	**0.04**	**0.02**

Medium deposit banks

Variables	(1) 2pv	(1) 1pv	(2) 2pv	(2) 1pv	(3) 2pv	(3) 1pv	(4) 2pv	(4) 1pv	(5) 2pv	(5) 1pv
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}$= 0	**0.05**	**0.02**	**0.01**	**0.01**	**0.03**	**0.02**	**0.03**	**0.02**	**0.00**	**0.00**
$Dep\_share^{I}_{hh,t-3}$- $Dep\_share^{II}_{hh,t-3}$= 0	0.93	0.47	0.91	0.46	0.77	0.38	0.80	0.40	0.93	0.47
$EL^{I}_{t-3} - EL^{II}_{t-3}$=0	0.13	0.07	0.28	0.14	0.32	0.16	0.25	0.12	0.63	0.32
$NIM^{I}_{t-3} - NIM^{II}_{t-3}$= 0			0.29	0.15					**0.10**	**0.05**
$RoA^{I}_{t-3} - RoA^{II}_{t-3}$ =0					**0.07**	**0.04**			**0.01**	**0.00**
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}$=0							0.87	0.44	0.59	0.29

High deposit banks

Variables	(1) 2pv	(1) 1pv	(2) 2pv	(2) 1pv	(3) 2pv	(3) 1pv	(4) 2pv	(4) 1pv	(5) 2pv	(5) 1pv
$Dep\_share^{I}_{nfc,t-3} - Dep\_share^{II}_{nfc,t-3}$= 0	**0.01**	**0.00**	0.93	0.47	0.12	0.06	0.28	0.14	0.89	0.45
$Dep\_share^{I}_{hh,t-3}$- $Dep\_share^{II}_{hh,t-3}$= 0	0.84	0.42	0.25	0.12	0.75	0.38	0.54	0.27	0.46	0.23
$EL^{I}_{t-3} - EL^{II}_{t-3}$=0	**0.00**	**0.00**	0.13	0.06	**0.00**	**0.00**	**0.00**	**0.00**	0.11	0.06
$NIM^{I}_{t-3} - NIM^{II}_{t-3}$= 0			**0.00**	**0.00**					**0.00**	**0.00**
$RoA^{I}_{t-3} - RoA^{II}_{t-3}$ =0					0.25	0.13			0.21	0.11
$Tier1\_R^{I}_{t-3} - Tier1\_R^{II}_{t-3}$=0							0.40	0.20	0.34	0.17

Note: bold numbers highlight significant p-values for p<0.01, p<0.05, or p<0.1; "2pv" denotes two-sided p-value and "1pv" one-sided p-value.